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TWO-MINUTE SHUTTLE RUN TEST TO DETERMINE THE SPECIFIC ENDURANCE IN RHYTHMIC GYMNASTICS

Maria Gateva
National Sports Academy „Vassil Levski“, Sofia, Bulgaria

ABSTRACT
Rhythmic gymnastics is a very skillful sport, and the technical preparation is dominant and time consuming. The physical preparation is somehow neglected by our coaches and the main physical ability where the attention is focused is flexibility. Endurance and coordination are implemented mainly into the technical repetition of the exercises and routines the gymnasts do. In gymnastics disciplines there are few attempts to create a specific test to measure the endurance - some are field, and others are laboratory testing.

The aim of the study is to research a field test to measure the specific endurance of rhythmic gymnasts. Twelve high level gymnasts aged 15.7 (±2.1) were involved in this study. Two tests were performed in the laboratory – VO₂max and submaximal 2-min test (author’s test) and two field tests – shuttle run test and competitive routine.

In the preparatory period blood lactate showed the highest values of 10.9 mmol/l after the shuttle run test and the competitive routine had 8.7 mmol/l. In the competitive period the values were 8.0 mmol/l and 7.2 mmol/l respectively. HR values after completing the tests were: preparatory period – 190.1 b/min (shuttle run) and 194.1 b/min (routine); and in competitive period 182.7 & 188.1 b/min.

In this study the shuttle run test in the preparatory period showed response of the body close to the real load of a routine but unfortunately in the second testing (in the competitive period) it did not reach the same percentage of effort. We aimed at 100% in this testing; however, this test was done in the field not the laboratory which may be why it was difficult to achieve the target.

Key words: Fitness level, Rhythmic gymnastics, Submaximal load, Testing

INTRODUCTION
Rhythmic gymnastics is a very skillful sport, and the technical preparation is dominant and time consuming. The physical preparation is somehow neglected by our coaches and the main physical ability where the attention is focused is flexibility. Although some authors (Santos et al., 2015) point out that flexibility and strength play a key role in RG, endurance, strength, and coordination are implemented mainly into the technical repetition of the exercises and routines the gymnasts do. Upon reaching a certain age (Junior and mainly Senior), the main problem of the performance of the gymnasts is their fitness level or level of specific endurance to enable the good level of their technical skills. Anaerobic regime of work is the dominant one when performing a RG routine (Gateva, Andonov, 2006; Gateva, 2008; Manos, Grigore, Popescu, 2012; Batista et al., 2018) although the training session is known to be in an aerobic regime (Gateva & Andonov, 2006; Gateva, 2008). In different research (Marina, Rodríguez, 2014; Powers, Howley, 2018) various percentage of anaerobic power is established. We disagree with the finding (Guidetti et al. 2000) that the most taxed energy source during the ball routine was the aerobic one.

In gymnastics disciplines there are attempts to create a specific test to measure the endurance – some are field and other are laboratory testing (Heller et al., 1998; Gateva, Tarnichkova, Ivanov, 2013; Alves et al., 2015). Rhythmic gymnastics researchers find it difficult to measure the internal and external load and their effects.

Aim of the study was to research a field test to measure the specific endurance of rhythmic gymnasts.

METHODS
Subjects
The subjects were 12 high level gymnasts' (some in the Bulgarian National team) aged 15.7 (±2.1). All of them were category “Elite” and trained 30 to 35 h per week. Two tests were carried out – one in the preparatory period and second – in the competitive period. Two tests were performed in a laboratory – VO₂max and submaximal 2 min test. A shuttle run test and a competitive routine test were done in field. Parental permission and informed consent were obtained from all the participants. The study protocol was conducted in agreement with the principles stated in the Declaration of Helsinki for human studies (WMJ, 2008) and in compliance with the ethical code of the National Sports Academy (2019).

Instruments
We measured the heart rate with POLAR RCX3. The recording started at rest and continued until 10 min post exercise (recovery period). A drop of blood sample was taken from the fingertip to measure blood lactate with the Accutrend Plus Roche. Lactate was taken
before and, on the 3rd, 5th and the 9th min during the recovery period. On the basis of these two indicators, we could compare the load during all the tests. We used a treadmill for the laboratory testing COSMOS h/p (Germany). Gas exchange was monitored during and 10 min after the exercise (load). Breath by breath gas exchange was measured continuously with OxiconPro (Yeger, Germany).

**Study design**

*Laboratory testing (on treadmill)*

The first task we set was to assess gymnasts’ fitness level with standard testing such as VO\(_2\)max. On the basis of the obtained results, we wanted to design a test with a load close in timing and intensity to the rhythmic gymnastics routine. This new test had to provoke work at 95% of the reached maximum HR during the VO\(_2\)max test.

The 2 treadmill tests were the following:

1. **VO\(_2\) max** – it was done through a modification of Balke Treadmill Protocol – Athlete (Franklin et al., 2000). We increased the incline of the treadmill with 0,6° (starting from 0°) every 30 sec. The speed during the test was constant – 8,4 km/h, to determine the level of the load reached at the end of the test in order to calculate the submaximal load for the 2 min test. It was done only once – in the preparatory period.

2. **2 min Submaximal treadmill test with constant load (95% of the maximal test) (authors’ test)** – The test requires a 2 min run on a treadmill with a constant speed of 8,4 km/h and individually set up incline of 95% of the maximum for each athlete. The incline is fixed according to:
   - the reached HR and incline during the maximal test;
   - the extrapolation of the incline as 100% from the theoretical maximal pulse and calculation of the 95% of the incline for each gymnast.

We carried out the 2 min submaximal laboratory test 48 hours after the maximal one. The test was performed in both the preparatory and the competitive period.

**Field testing:**

1. **2 min Shuttle test** – set distance of 10 m within two lines. Each time the gymnast has to run with maximal speed and touch outside the lines. The covered distance in meters (with accuracy of up to 0,5 m) is measured for 2 min. Athletes start in pairs.

2. **Competitive routine** – individual rhythmic gymnastics competitive routine with average duration 1,30 min. We carried out the field testing and the laboratory testing in the same week, at the beginning of the training session in both the preparatory and the competitive periods.

**Warm up**

The beginning of each laboratory test and shuttle run test was preceded by a three-minute light warm up. We did the routine field testing at the beginning of the training sessions after a 30 min warm up, followed by a 10 min specific warm up prior to the routine. After completing each test, the gymnasts had a passive recovery period of 10 min.

**Statistical analysis**

*Descriptive statistics*

*Student’s paired t-test* was applied to find differences in the heart rate and blood lactate between the two periods – preparatory & competitive period. *ANOVA* was used to compare the load provoked by the three tests: laboratory 2 min test; shuttle run test and rhythmic gymnastics individual routine. The level of significance of \( p < 0.05 \) was adopted in all cases.

**RESULTS AND ANALYSIS**

![Figure 1. Average blood lactate values after submaximal lab test & shuttle run test & routine](image-url)

*ANOVA – differences in the preparatory or competitive period between the tests
*T-Student – differences between the periods; \(^{\wedge} p < 0.05\) significant difference between the periods

\(^{\wedge\wedge} p < 0.01\) significant difference between the periods
The data received from collecting the blood lactate samples showed there were significant differences between the tests only in the preparatory period. The shuttle run test had the highest values of 10.9 mmol/l and the competitive routine had 8.7 mmol/l. The values of the 2 min submaximal laboratory test were close to those of the shuttle run test, but no difference was shown based on the statistics. Although some differences were observed in the competitive period, none of them were statistically significant. At the same time, Student's paired T-test gave significant differences in all the three tests from preparatory to competitive period.

Unlike the concentration of the blood lactate, the heart rate during a rhythmic gymnastics routine had the highest values compared to the other two tests with running. The significant difference between the tests in the preparatory period made it possible for us to compare the routine to the submaximal laboratory test. In the competitive period no significant difference was found – the difference between the routine and the shuttle run test was 5 b/min. In both cases (periods) the values of the routine remained higher than those of the running tests. An improvement (decrease in the heart rate values) was shown in the routine and the shuttle run test. The results from laboratory test did not show any difference between the two periods.

Table 1. Descriptive statistics of the HR and concentration of the blood lactate after the load

<table>
<thead>
<tr>
<th>Test</th>
<th>HR mean (SD) (b/min)</th>
<th>HR min. (b/min)</th>
<th>HR max. (b/min)</th>
<th>La mean (SD) (mmol/L)</th>
<th>La min. (mmol/L)</th>
<th>La max. (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory test PP</td>
<td>186.2 (±6.0)</td>
<td>198</td>
<td>190.1</td>
<td>10.9 (±1.8)</td>
<td>8.3</td>
<td>13.4</td>
</tr>
<tr>
<td>Shuttle run test PP</td>
<td>190.1 (±6.3)</td>
<td>191</td>
<td>169</td>
<td>10.9 (±1.8)</td>
<td>8.3</td>
<td>13.4</td>
</tr>
<tr>
<td>Gymnastics routine PP</td>
<td>194.2 (±4.4)</td>
<td>200</td>
<td>187</td>
<td>8.7 (±2.3)</td>
<td>5.7</td>
<td>12.8</td>
</tr>
<tr>
<td>Laboratory test CP</td>
<td>184.3 (±6.5)</td>
<td>193</td>
<td>174</td>
<td>10.7 (±1.6)</td>
<td>8.0</td>
<td>14.1</td>
</tr>
<tr>
<td>Shuttle run test CP</td>
<td>182.7 (±7.1)</td>
<td>199</td>
<td>183.5</td>
<td>8.0 (±2.0)</td>
<td>5.6</td>
<td>12.2</td>
</tr>
<tr>
<td>Gymnastics routine CP</td>
<td>188.1 (±4.0)</td>
<td>194</td>
<td>181</td>
<td>7.2 (±2.2)</td>
<td>5.0</td>
<td>11.7</td>
</tr>
</tbody>
</table>

PP – preparatory period; CP – competitive period

Table 2 shows the changes in the heart rate values in all the three tests every 15 sec of the load. The laboratory test had the same values of the HR for both periods. The other two field tests had significant differences (decrease in the HR values) in the competitive period from the 30th or 45th sec of the registered load until the end.

Table 2. Heart rate dynamics during the testing (means ± SD)

<table>
<thead>
<tr>
<th>t (min)</th>
<th>Laboratory test</th>
<th>Shuttle run test</th>
<th>Gymnastics routine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP</td>
<td>CP</td>
<td>PP</td>
</tr>
<tr>
<td>00:00</td>
<td>113.8 (±17.6)</td>
<td>120.8 (±17.5)</td>
<td>132.5 (±17.5)</td>
</tr>
<tr>
<td>00:15</td>
<td>140.1 (±13.9)</td>
<td>147.5 (±12.3)</td>
<td>157.5 (±13.4)</td>
</tr>
<tr>
<td>00:30</td>
<td>161.5 (±12.4)</td>
<td>163.8 (±8.3)</td>
<td>176.1 (±7.1)</td>
</tr>
<tr>
<td>00:45</td>
<td>169.5 (±10.4)</td>
<td>171.3 (±7.3)</td>
<td>183.9 (±6.1)</td>
</tr>
<tr>
<td>01:00</td>
<td>174.9 (±9.1)</td>
<td>175.6 (±5.6)</td>
<td>186.4 (±6.1)</td>
</tr>
<tr>
<td>01:15</td>
<td>178.1 (±7.9)</td>
<td>177.2 (±5.8)</td>
<td>187.3 (±6.2)</td>
</tr>
<tr>
<td>01:30</td>
<td>181.2 (±6.9)</td>
<td>180.0 (±5.8)</td>
<td>188.0 (±6.5)</td>
</tr>
<tr>
<td>01:45</td>
<td>183.3 (±6.7)</td>
<td>182.0 (±6.1)</td>
<td>189.0 (±6.5)</td>
</tr>
<tr>
<td>02:00</td>
<td>186.2 (±6.1)</td>
<td>184.3 (±6.5)</td>
<td>190.1 (±6.6)</td>
</tr>
</tbody>
</table>

PP – preparatory period; CP – competitive period; *p < 0.05 significant difference between the periods **p < 0.01 significant difference between the periods
When looking at the HR values during the recovery period after the shuttle test, we can see significant differences for the whole recovery period (with few exceptions). The difference varied with eight to thirteen b/min as can be clearly seen in Figure 3. The only differences observed after the load and during the recovery from the submaximal laboratory test were from 1.45 min to 2.15 min. The competitive rhythmic gymnastics routine showed significant differences between the two periods from the end of the load to the 5\textsuperscript{th} min of the recovery time. The average distance covered in the shuttle run tests did not vary much between the two periods – 285 m (preparatory period) to 280.3 m (competitive period) covered by the gymnasts. But it was a bit lower compared to the preparatory period with no significant difference.

DISCUSSION
Blood lactate is good indicator of the anaerobic work of the body systems and can be used to compare the load. In the laboratory test the values increased from preparatory to competitive period. In the other two tests the values decreased. This could be explained with the fact that running is not specific to rhythmic gymnasts, so with the adaptation of the trained muscle it is possible to cope with higher values especially when the dosage is established in the lab. In the field, the same is based on the subjective feeling of the gymnasts. According to
Thompsen et al. (2007) the best results in sport are obtained using training protocols which are as specific as possible to the demands of the sport activity. Both field testing showed improvement – the blood La significantly went lower in the competitive period.

Figures 4 and 5 show the curves of the load during all the three tests in both periods. It is clear that the gymnastics routine had the highest values for both testing. The submaximal laboratory test kept the HR values lower, but the shuttle run test in the first period had values close to the competitive routine. In the second period the values were closer to those of the submaximal test. The difference between the submaximal laboratory and shuttle run test was due to the lack of dosage of the effort when gymnasts started the load. The motor task was the same, but the springing was ceased due to the change in the direction. We can speculate that based on the distance covered and the contradictory values of blood lactate and HR in the preparatory period, the gymnasts did their maximum in the run (sprint) and we achieved the desired goal. However, in the competitive period we can assume that the gymnasts saved some effort, and the distance was slightly lower. This means that the performed test in the competitive period was a submaximal one and close 95% of the submaximal laboratory test which was previously proved (Gateva, 2019) not to be corresponding to the real load of a routine in rhythmic gymnastics.

To be more precise in the dosage of a load in an unobjective and uncontrolled setting (such as the one in field) we can use a rate of perceived exertion in the future. Some authors (Fernández-Villarino et al., 2018) indicated that the subjective rate of perceived exertion and the heart rate can be significant to measure the effects of training. Despite all the contradictory opinions about the reliability of the heart rate, there are supporters who consider it a useful first approach to assess exercise intensity in technical-combinatory sports such as gymnastics (Douda et al., 2008; Marina, M., Rodríguez, F., 2014).

In this study the shuttle run test in the preparatory period showed response of the body close to the real load of a routine but unfortunately in the second testing (in competitive period) the gymnasts did not reach the same percentage of effort. The 100% which are obviously the target in the testing can be subjective and difficult to achieve if it is not set in a laboratory. The coach can stimulate and motivate the gymnasts to achieve their best when performing tired since they know their gymnasts the best. Nevertheless, we assume that only in shuttle run test (in total there are 3 tests within the project) the load was close to the real load of a routine.

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PARENTAL INFLUENCE IN RHYTHMIC GYMNASTICS

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ABSTRACT

Introduction: In the last few years one of the issues often discussed in practice is related to parental influence in modern sport and the impact of parents’ behaviour on gymnasts’ development of psyche and personality as well as on their competitive activities and realisation. The researchers show that the equilibrium in the triangle “coach-athlete-parent” is often disrupted. On the one hand, they emphasize on the positive role of parents; on the other hand, parents’ high expectations and the pressure they exert could become a serious negative factor.

The aim of this study is to examine Parent-Initiated Motivational Climate among rhythmic gymnasts and to seek its relations with Perceived Motivational Climate, Goal orientation, and Cope with Success in sport.

Methodology: The research was done among 61 rhythmic gymnasts aged between 13 and 17 years. We used: 1) Parent-Initiated Motivational Climate Questionaire-2 (PIMCQ-2), White and Duda, 1993. 2) Task and Ego orientation in Sport Questionnaire (Duda & Nicholls, 1992), adapted for Bulgarian conditions (Domuschieva-Rogleva, 2003); 3) Perceived Motivational Climate in Sport Questionaire (PMCSQ-2) (Newton, Duda, & Yin, 2000), adapted for Bulgarian conditions (Domuschieva-Rogleva, 2003); 4) Specially designed scale for examining attitudes towards success.

Results: The highest values were received for the subscales Learning and enjoyment climate Mother and Father, Task orientation and Perceived task-involving climate. There were significant correlations between the researched parameters. The impact of the motivational climate initiated by parents on goal orientation and cope with success in sport was established.

Key words: Parent-Initiated Motivational Climate, Task orientation, Ego orientation, Perceived Motivational Climate, Cope with Success

INTRODUCTION

The role of parents in modern sport is undisputable. In a sport such as rhythmic gymnastics it has a certain specificity. The low age children begin practising this sport at supposes more engagement and help on behalf of parents. The inclusion of rhythmic gymnastics in the family of the Olympic sports broadened its geography. This has led to an increase in the competition and development aimed at enhanced professionalism. As a result, the requirements to gymnasts have grown together with the expectations from their performance – on behalf of communities, national clubs, and in some expressed cases – parents. The inclusion of parents in the process of financing and very often in the club management, as well as their emotional involvement often leads to a disruption in the equilibrium of the triangle “coach-athlete-parent”. Parents’ active role creates the feeling in some of them that they have the right to interfere directly in the sports-competitive activities, taking away some of coaches’ functions. This creates a significant tension both for gymnasts and their coaches.

Logically, in sports psychological literature the interest towards the role and influence of parents on young athletes’ development of sports career is also growing. On the one hand, researchers emphasize on the positive role of parents, on the necessity of maintaining good interaction. On the other hand, they point out that parents’ high expectations, pressure and even interference in coaches’ work and sports-technical management could become a serious negative factor (Wolfenden & Holt, 2005, Iancheva, 2019) which can provoke a significant tension in athletes’ preparation and performance.

Parents’ behavior has been viewed as one of the major situational and contextual factors. Part of the surveys have been aimed at the way parents interact with their children before, during, and after competition (Holt et al., 2008; Dorsch et al., 2015; Tamminen et al., 2017). Others have emphasized on parents’ influence on young athletes’ perceptions, their own abilities and motivation (Dweck, 1986; Nicholls, 1989; Ames, 1992), on their education and socialization, personal and social development (Knight, Dorsch, Osai, Haderlie, & Sellars, 2016, Pomerantz & Thompson, 2008), on the impact of the relationships between parents and their children and its importance for the sports result (O’Rourke, Smith, Smoll, & Cumming, 2013). Some authors point out that the influence can be both positive – through an encouraging and supportive behavior, and negative – perceived as inadequately demanding, pressing in competition, critical to sports failures (Knight, Bo-
Parents’ influence in sport is often viewed in the context of achievement goal theory, and their role in the triangle “coach-athlete-parent” in the preparation and development of talent (Iancheva, 2019). The tendency towards lowering the age limit in rhythmic gymnastics leads to an early performance and early publicity. This is one of the specific problems in our sport. Facing and coping with the problems of fame and publicity is an ordeal for gymnasts. Success inspires, motivates, brings satisfaction. But in the meantime, it can become a serious challenge. The problems of “fame seeking” greatly affect the sphere of sport and art, i.e. the spheres with the greatest extent of publicity and wide social evaluation. Sports fame could be dangerous in provoking some deformities of Self which could lead to a number of problems both during sports-competitive activity and after its completion. The best gymnasts quickly receive attention and recognition on behalf of newspapers, media, and society. The problem related to the way gymnasts cope with success in sport is becoming much more significant for theory and practice – how they define it, how they perceive it, what the consequences from success are, how coaches help their athletes cope with success, how athletes react to success (D. Haglind, 2003; Conroy, Poszwardowski & Henschen, 2001). Regardless of the big practical importance, the issue about cope with success in sport still does not receive enough attention on behalf of specialists. There is lack of experimental data about the role of parents in this process. Parents’ influence in sport is often viewed in the context of achievement goal theory. Nicholls’ achievement goal theory is one of the most widely used theoretical frameworks within the sport psychology literature and addresses the intrapersonal and situational factors which influence individuals’ cognitive perceptions of success and failure, their attributions, affective responses, and subsequent behaviors (Roberts, 2001; Smith et al., 2008). Individuals’ achievement goals within specific situations are determined by an interaction between their goal orientations and the motivational climate created by key social agents (e. g. parents, coaches, peers) (Dweck and Leggitt, 1988; Harwood et al., 2008; Harwood et al., 2019). Achievement Goal Theory suggests that individuals have two kinds of dominant individualistic goal orientations. First of them, task orientation, focuses on individualistic achievement and progress due to effort, while ego orientation, which is the second goal orientation, means having a better performance and obtaining better results. Athletes, who simultaneously have higher task and ego tendency, or athletes with high task tendency and low level of ego tendency, show more adaptive motivational patterns than those with a low task orientation (Moreno, Cervello, & Cutre, 2010). High levels of task-orientation are associated with positive cognitive, affective, and behavioral outcomes, while high levels of ego-orientation are associated with neutral or less optimal outcomes particularly when perceptions of competence are low or not accompanied by task-based goals (Biddle et al., 2003; Harwood et al., 2008; Harwood et al., 2019).

According to Achievement Goal Theory, a situational level, there are two types of motivational climate (Ames, 1992) that influence an individual’s achievement goal state in an achievement context such youth sport competition. A mastery/task-involving climate is created when social agents are perceived to place emphasis on self-referenced improvement, effort, and cooperative learning. Performance/ego involving climate is created when there is a perceived focus on outcomes, the emphasis is placed on outperforming others.

In this context, the aim of present study is to examine Parent-Initiated Motivational Climate among rhythmic gymnasts and to seek its relations with Perceived Motivational Climate, Goal orientation and Cope with Success in Sport.

**METHOD**

**Participants**

The research was done among 61 rhythmic gymnasts aged between 13 and 17 years, with sports experience $M=9.07$ years $(SD=2.50)$. The mean age of the researched individuals is 14.75 $(SD=1.82)$. At the beginning of the research all participants were informed about the aim of the survey and granted their agreement.

**Measures**

To fulfil the aim of the research we used:

1. Parent-Initiated Motivational Climate Questionnaire-2 (PIMCQ-2), White and Duda, 1993. The questionnaire includes three subscales for each parent related to the task involving climate (Learning/Enjoyment Climate) and ego involving climate (Worry-Conductive Climate).
and Success Without Effort). The questionnaire shows very good psychometric characteristics in Bulgarian conditions (LCM α = .763; WCCM α = .774; SWEM α = .817; LCF α = .733; WCCF α = .737; SWEF α = .836).


3. Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2) (Newton, Duda, & Yin, 2000), adapted for Bulgarian conditions by Domuschieva-Rogleva, 2003. The PMCSQ-2 includes two higher order dimensions: the perceived task-involving climate and the perceived ego-involving climate. Each contains three first order subdimensions. The perceived task-involving climate: cooperative learning, effort and improvement and important role, the perceived ego-involving climate: intrateam member rivalry, unequal recognition and punishment for mistakes.

4. Specially designed scale for examining the attitude towards success which includes three parts – definition and experience of success; interpretation of the reason for success; behaviour after success. Each of them comprises two subscales, as follows: Confidence, assertion, Prestige, Mobilization and belief in abilities, Emotional reactions, lack of effort, Preparation, efforts, Expectations. The scale includes 33 items. The evaluation is given along a five-point Likert Scale. The scales show very good psychometric characteristics.

**Statistical analysis**
The assessment of the initial data from the research was made with the statistical packet SPSS 21. We made Reliability, Descriptive, Correlation, Regression analysis.

**RESULTS AND DISCUSSION**
Table 1 presents the results from descriptive statistics.

The analysis of the results from our research on Parent-Initiated Motivational Climate revealed that the highest values were found for the subscales Learning and enjoyment climate Mother and Father (Mm = 4.17; Mf = 4.20) – parents’ stimulation of a climate aimed at development and improvement of abilities, perfection through making the efforts needed, i.e. stimulating and supporting behavior. The subscales which followed were Worry-conductive climate (Mm = 2.48; Mf = 2.22), and Success without effort climate (Mm = 1.65; Mf = 1.76). Our results confirm, as a whole, the data in literature (Veskovic at al., 2013; Kolayis at al., 2017; Gomes at al., 2019; Iancheva, 2019).

**Table 1. Descriptive statistics of study variables**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mother</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning and enjoyment climate</td>
<td>61</td>
<td>2.60</td>
<td>5.00</td>
<td>4.17</td>
<td>.58</td>
</tr>
<tr>
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<td>61</td>
<td>1.00</td>
<td>4.60</td>
<td>2.48</td>
<td>.97</td>
</tr>
<tr>
<td>Success without effort climate</td>
<td>61</td>
<td>1.00</td>
<td>3.00</td>
<td>1.65</td>
<td>.63</td>
</tr>
<tr>
<td><strong>Father</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning and enjoyment climate</td>
<td>61</td>
<td>2.80</td>
<td>5.00</td>
<td>4.20</td>
<td>.56</td>
</tr>
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<td>3.60</td>
<td>2.22</td>
<td>.74</td>
</tr>
<tr>
<td>Success without effort climate</td>
<td>61</td>
<td>1.00</td>
<td>4.71</td>
<td>1.76</td>
<td>.88</td>
</tr>
<tr>
<td><strong>Task orientation</strong></td>
<td>61</td>
<td>3.14</td>
<td>5.00</td>
<td>4.44</td>
<td>.40</td>
</tr>
<tr>
<td><strong>Ego orientation</strong></td>
<td>61</td>
<td>1.00</td>
<td>4.33</td>
<td>2.26</td>
<td>.95</td>
</tr>
<tr>
<td><strong>Perceived task-involving climate</strong></td>
<td>61</td>
<td>4.12</td>
<td>5.00</td>
<td>4.53</td>
<td>.40</td>
</tr>
<tr>
<td>Task-involving</td>
<td>61</td>
<td>3.87</td>
<td>5.00</td>
<td>4.57</td>
<td>.31</td>
</tr>
<tr>
<td>Important role</td>
<td>61</td>
<td>2.83</td>
<td>5.00</td>
<td>4.70</td>
<td>.44</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>61</td>
<td>2.25</td>
<td>5.00</td>
<td>4.21</td>
<td>.57</td>
</tr>
<tr>
<td><strong>Perceived ego-involving climate</strong></td>
<td>61</td>
<td>1.31</td>
<td>3.38</td>
<td>2.41</td>
<td>.52</td>
</tr>
<tr>
<td>Ego-involving</td>
<td>61</td>
<td>1.00</td>
<td>3.57</td>
<td>2.27</td>
<td>.62</td>
</tr>
<tr>
<td>Unequal recognition</td>
<td>61</td>
<td>1.75</td>
<td>3.75</td>
<td>2.65</td>
<td>.58</td>
</tr>
<tr>
<td>Punishment</td>
<td>61</td>
<td>1.00</td>
<td>5.00</td>
<td>2.60</td>
<td>.88</td>
</tr>
<tr>
<td>Intrateam member rivalry</td>
<td>61</td>
<td>1.00</td>
<td>5.00</td>
<td>2.60</td>
<td>.88</td>
</tr>
</tbody>
</table>
The data showed that the researched rhythmic gymnasts were characterized with a domineering goal orientation towards the task (Task orientation: $M=4.44$) and Perceived task-involving climate – $M=4.53$ (Table 1). The motivational climate related to making more efforts in order to increase the abilities was the dominating one. The lowest values were found with Success without effort climate (Father).

The competitors perceived success mostly as a source of confidence ($M=3.84$) and mobilization of efforts ($M=3.83$). The established fact that the gymnasts explained success to the greatest extent with the good preparation and invested efforts was favorable ($M=4.54$). They believed outer expectations influence mostly negatively success.

One of the tasks of our research was connected with establishing the dependencies between parents' behavior and parent's initiated motivational climate and Task and Ego orientation, Perceived Motivational Climate, and Cope with Success (Figure 1).

There were significant correlations between Ego orientation and Worry-conductive climate Mother ($r=.370^*$) and Success without effort climate Mother ($r=.388^*$), and Success without effort climate Father ($r=.578^{**}$), Perceived task-involving climate, Task orientation and Learning and enjoyment climate (Mother), between Ego-involving climate, Worry-conductive climate (Father), Ego orientation, Worry-conductive climate (Mother) and Success without effort climate (Father). The results make us assume that parents initiated anxious behavior and the motivational climate aimed at seeking success without efforts - Success without effort climate Mother and Father are connected to goal orientation towards ego. Parents’ anxious behavior correlated with enhanced emotional reactions and worries as a result of higher expectations after success.

![Figure 1. Results from regression analysis](image-url)
To check the direction of the established dependencies, we used two-step regression analysis. The results revealed that Parent-Initiated Motivational Climate stimulated Perceived Motivational Climate (Figure 1) and Goal orientation. Learning mother influenced Perceived Task Motivational Climate ($\beta = .268^*$). Parents’ initiated Worry-conductive Climate (mother and father) stimulated Perceived Ego Motivational Climate. Success without effort climate (mother and father) influenced Ego orientation.

### Table 2. Regression analysis

<table>
<thead>
<tr>
<th>Learning mother:</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig.</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ego orientation</td>
<td>.388</td>
<td>2.380</td>
<td>.023</td>
<td>.124</td>
</tr>
<tr>
<td>Learning father:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ego orientation</td>
<td>.324</td>
<td>2.904</td>
<td>.007</td>
<td>.612</td>
</tr>
<tr>
<td>Success without effort climate mother</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ego orientation</td>
<td>.528</td>
<td>3.573</td>
<td>.001</td>
<td>.124</td>
</tr>
<tr>
<td>Task Orientation</td>
<td>-.426</td>
<td>-2.855</td>
<td>.008</td>
<td>.213</td>
</tr>
<tr>
<td>Success without effort climate father</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ego Orientation</td>
<td>.861</td>
<td>4.778</td>
<td>.000</td>
<td>.311</td>
</tr>
<tr>
<td>Prestige</td>
<td>-.430</td>
<td>-2.386</td>
<td>.023</td>
<td>.399</td>
</tr>
<tr>
<td>Worry-conductive Climate mother</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional reactions</td>
<td>.407</td>
<td>2.726</td>
<td>.010</td>
<td>.267</td>
</tr>
<tr>
<td>Worry-conductive Climate father</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>.527</td>
<td>3.506</td>
<td>.001</td>
<td>.278</td>
</tr>
</tbody>
</table>

### DISCUSSION

The obtained results from this research, as a whole, confirm the data in literature, but also reveal a certain specificity of the manifestation among the researched rhythmic gymnasts. The relation between Parent-Initiated Motivational Climate, Perceived Motivational Climate and Goal orientation is justified (Veskovic at al., 2013; Kolayis et al., 2017; Gomes at al., 2019, Atkins et al., 2015; Davies, Babkes, Nichols, & Coleman, 2016; O’Rourke, et al., 2013, 2014, Iancheva, 2019).

Another positive fact we established is that the researched sample is characterized with a domineering Learning and enjoyment climate Mother and Father, i.e. stimulated by a parental climate aimed at development and improvement of abilities, perfection through making the efforts needed, Task orientation and Perceived task-involving climate. The stimulated by parents Worry-conductive Climate enhances Ego Orientation, and Perceived Ego-involving Climate, associated with neutral or less optimal outcomes particularly when perceptions of competence are low or not accompanied by task-based goals (Biddle et al., 2003; Harwood et al., 2008; Harwood et al., 2019). The established fact is very important for practice. This kind of parental behavior also enhances the emotional reactions as a result from success and leads to an increase in tension related to future expectations for success. Success without effort climate enhances Ego Orientation and stimulates behavior aimed at execution, prestige and seeking success without efforts.

The obtained results make us pose more seriously the question of the role of parents in rhythmic gymnastics. The disrupted equilibrium in the triangle “coach-athlete-parent” could lead to some negative effects and influence negatively competitive and personal realization of gymnasts – high, often unrealistic expectations which lead to increased tension of competitors and coaches, frequent conflicts and strong emotional reactions, very often a desire for changing the coach or club, impaired motivational climate and work environment. Unfortunately, the very young gymnasts are the ones to suffer the most from this all.

At the same time, we should point out the outlined specificity of the motivational climate in different sports, established in previous research (Iancheva, 2019). This poses the question of researching the motivational climate in the context of the environment and the subjects involved: coaches, competitors, parents, management, as well as regarding the specificity of the sports environment.

The main psychological and pedagogical consequences:

- Widening the scope of research and identifying the most often met problems connected with the relationships “coach-athlete-parent”.
- Educating and consulting parents about the effects of parental behavior and its influence on the psyche, personality, and realization of gymnasts. Very often, parents do have an unrealistic
idea about the consequences from their behavior and are convinced they do their best to help their children.

- Educating and consulting coaches and helping them build up an individual approach to their competitors and their parents.
- Psychologically helping and supporting gymnasts to cope with possible negative consequences – high expectations, tension, anxiety, psychic weakness, sometimes refusal to train and compete, etc.

This research has certain limitations related to the number of the researched sample. Broadening the scope of research would allow for a more in-depth analysis and interpretation, as well as more adequate approaches for coping.

REFERENCES


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RHYTHMIC GYMNASTICS – FUTURE TRENDS IN PUBLICATIONS BASED ON A SYSTEMATIC ANALYSIS OF THE LAST 10 YEARS

Liliya Doncheva, Daniela Dasheva
National Sports Academy „Vassil Levski”, Sofia, Bulgaria

ABSTRACT
Rhythmic gymnastics has been an Olympic sport since 1984. However, there are relatively few recent studies regarding its development and scientifically based methods of preparation. To trace future scientific directions in rhythmic gymnastics, the purpose of this study was to review the publications over the last 10 years and identify the future topics of research. Systematic computerized searches were performed from 2010 to 2020 in the following databases: PubMed, Web of Science, Scopus, and Journal “Science of Gymnastics”. The sources of information were Internet publications on various topics for the last 10 years. The search identified a total of 56 studies only in English language. The main selection criteria were publications in RG (Rhythmic Gymnastics) low and high-level performance, individual and group gymnastics. To make the analysis, we divided the publications into groups according to the topic of investigation – sports pedagogy - 30, psychology - 7, biology - 10, physiotherapy and injuries – 3 and judging in rhythmic gymnastics and expert preparation - 6. The results from this systematic review showed that the further investigations must be dedicated to the use of technology and injury prevention; the genetic polymorphism flexibility of elite rhythmic gymnasts; the new and virtual reality; the teaching models, top-form management, and loading and recovery in different structures of sports preparation.

Key words: database, sports performance, training, technology

INTRODUCTION
Rhythmic gymnastics has been part of the Olympic Games since 1984. It is a complex artistic and aesthetic sport with high demands on physical and psychological stress in competition. Rhythmic gymnastics requires high technical mastery and well-developed motor and artistic abilities (Debien et al., 2020; Douda, Toubeakis, Avloniti, & Tokmakidis, 2008). Individual gymnasts and elite groups involved in international competitions may have more than five or six events in one season including two or three main competitions (e.g., World Championship, Continental Games/Championship, Olympic Games). This poses a lot of challenges before both athletes and coaches regarding the training load, the difficulty and execution of the exercises, the mastery of various elements in the composition, etc. The development of elite rhythmic gymnasts requires a specific knowledge of the sport. Rhythmic gymnasts start practicing and competing from a very young age – from childhood or adolescence – which is a rather critical period in each person’s life. They often work under pressure to meet the extremely high-performance standards (Dallas G., Dallas C., Simatos J, 2016). Previous research has shown that throughout their sporting careers, the vast majority of these athletes try to acquire and preserve the “perfect” body with specific body proportions and unrealistically low body weight and fat mass (Avila-Carvalho, Klentrou, da luz Palomero & Lebre, 2012; D’Alessandro, Morelli, Evangelisti, Galetta & Franzoni, 2007; Klentrou & Plyley, 2003). They work long hours in the gym trying to master their motor skills because the perfect execution of gymnastics exercises depends directly on the level of their technical expertise. Rhythmic gymnastics (RG) athletes need high-performance training since a high degree of precision is required in their exercises. However, it is one of the sports in which competition results greatly depend on judges’ evaluation. Despite the complexity and specificity of the sport, there are relatively few recent studies regarding rhythmic gymnastics development and scientifically based research and investigations. The purpose of this study was to review in a critical way the publications in rhythmic gymnastics over the last 10 years and identify the future topics of research.

METHODS
Data sources and searches
Systematic computerized searches were performed from 2010 to 2020 in the following databases: PubMed, Web of Science, Scopus and Journal “Science of Gymnastics”. The sources of information were Internet publications on various topics for the last 10 years. The search identified a total of 56 studies only in English language. To perform the systematic data analysis, we used qualitative methodology which comprised the following: formulating the research problem; develop-
ing and using clear inclusion/exclusion criteria; analysing the findings across the studies – comparison and synthesis of the results, as well as recommendations for future research. Each manuscript found in the databases was read (title, abstract, key words, full text) and analysed respecting the methodology. According to the content of each article they were divided into 5 groups.

RESULTS
The main selection criteria used in this research were the year of publication and articles regarding RG (Rhythmic Gymnastics) low and high-level performance, individual and group gymnastics. For the purpose of the analysis, we divided the publications into groups according to the topic of investigation – sports pedagogy – 30 articles, psychology – 7 articles, biology – 10 articles, physiotherapy and injuries – 3 articles and judging in rhythmic gymnastics and expert preparation – 6 articles (Table 1).

In a similar survey performed from 2000 to 2012 (Gatева, 2012), 93 articles in English in the field of rhythmic gymnastics were found and analysed. The main topics covered were similar: biology and injuries – 45 articles, sports pedagogy – 29 articles, physiology – 6 articles, judging – 3 articles, psychology – 3 articles, biomechanics – 4 articles, biochemistry – 3 articles.

Table 1. Number of publications per year

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1</td>
</tr>
<tr>
<td>2011</td>
<td>4</td>
</tr>
<tr>
<td>2012</td>
<td>5</td>
</tr>
<tr>
<td>2013</td>
<td>5</td>
</tr>
<tr>
<td>2014</td>
<td>5</td>
</tr>
<tr>
<td>2015</td>
<td>5</td>
</tr>
<tr>
<td>2016</td>
<td>7</td>
</tr>
<tr>
<td>2017</td>
<td>6</td>
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<td>2018</td>
<td>6</td>
</tr>
<tr>
<td>2019</td>
<td>9</td>
</tr>
<tr>
<td>2020</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 1 shows the dynamics of the publication activity by year for the period 2010-2020. We observe an upgoing trend throughout the years. The number of publications rose dramatically at the beginning of the period and represent the 3rd degree polynomial. There was just one article in Rhythmic gymnastics in 2010 and over a period of just two years (2010-2012) their number increased five times to level off from 2012 to 2015. After some fluctuations the number of articles reached a peak in 2019 (9 articles). There is again a drop in 2020 but this might be explained with the emergency situation all over the world and the sudden disruption of all scientific activities for an extended period of time.

Figure 1. Dynamics of the publication activity (2010-2020)

All in all, we can divide the research period into two halves – until 2015 and from 2016 to 2020. The second period is characterized with a more intensive but irregular publication activity – 31 articles (55,4%) compared to the first period where we find 25 articles (44,6%) but their number is more evenly distributed throughout the years.

After identifying the number of publications related to rhythmic gymnastics, we grouped them according to their topics (Figure 2).
Sports pedagogy
This group comprises the biggest number of the select-ed publications in rhythmic gymnastics over the last 10 years. For the purpose of the analysis we selected some of the most indicative publications in this field (Table 2). Mostly, they are dedicated to the problems of competitive performance and routines, technical and tactical aspects of sports preparation, body and apparatus difficulties, training load and recovery and conditioning (plyometric and specific endurance). One of the important issues discussed was related to the recovery between the season periods and competition weeks being a crucial factor for success in competition. The highest functional and morphological effect is obtained when the training load is optimal, i.e. most effective for each new stage and phase of sports training.

**Figure 2. Specific Scientific Context of Rhythmic Gymnastics in the last 10 years**

Another interesting direction of study concerns the competitive performance and routines, the development of young children's flexibility and posture and their influence on the final score. Each factor contributing to the successful performance of gymnasts in competition was identified and analyzed. Modeling the learning/teaching approaches may outperform more traditional methodologies with respect to predicting athlete responses to training and competition process. These approaches enable further individualization of load monitoring, leading to a more accurate training prescription and evaluation.
The articles dedicated to the technical aspect and technical preparation in rhythmic gymnastics discuss the differences in the ranking depending on the dance steps and mastery, the execution factors when introducing an apparatus, the risky technical elements used in the routines, the weekly training volume, etc. Three articles investigate the importance of the conditioning in rhythmic gymnastics, namely plyometric and plyometric training, specific endurance training and control, and flexibility. Three articles are linked to the problems of difficulty in rhythmic gymnastics and six are focused on the talent identification, maturation, and early sports preparation. Some of the publications consider the learning process in rhythmic gymnastics, musical attributes, dance steps, ecological theory and rhythmic gymnastics.

**Psychology**

The psychological topics related to RG concern primarily motivation, anxiety, eating disorders, and self-esteem. The most representative publications in this group are shown in Table 3.

### Table 3. Publications in Psychology

<table>
<thead>
<tr>
<th>Key words</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>eating disorders, female athletes, &quot;significant others&quot;, health</td>
<td>C. Ioamidou, F. Venetsanou - Social physique anxiety, disturbed eating attitudes and behaviours, and perceived pressure for thin body in competitive rhythmic and aerobic gymnastics.</td>
</tr>
<tr>
<td>Body esteem, Eating attitudes, Athletes, Rhythmic gymnastics, Pressure to be thin</td>
<td>E. Kosmidou, E. Giannitsopoulou, M. Proios - Are body esteem, eating attitudes, pressure to be thin, body mass index and training age related in rhythmic gymnastics athletes?</td>
</tr>
<tr>
<td>anxiety, competition, concentration, rhythmic gymnastics</td>
<td>S. Hammoudi Nassib, B. Mkaouer, S. Nassib, S.Hammoudi Riahi, Y. Arfa - Precompetitive anxiety effect on concentration and performance on elite rhythmic gymnastics.</td>
</tr>
</tbody>
</table>

All they found and conclude that the psychological preparation and support are very important for both young gymnasts and high-level athletes. Nowadays, achieving high performance requires not only exceptional biological characteristics, but also psychological skills and outstanding personality traits. In this context, knowing the athletes’ personality in order to shape and develop it, gains increasing importance in the specialised contemporary sports psychology.
Biology
This group contains 10 articles mostly dedicated to the nutritional status and dietary assessment of elite rhythmic gymnast, urinary incontinence, and body composition. The main conclusion is that targeted nutritional guidelines and psychological support for young elite athletes are required and UI is common among rhythmic gymnasts and may influence sports performance (Table 4).

Physiotherapy and injuries
Only three articles were found in this group (Paxinos, Mitrogiannis, Papavasiou, Manolarakis, Siempenou, Alexeli, Karavasil, 2019; Rutkowska-Kucharska, Szpala, Jaroszczuk and, Sobera, 2018; Todri, Lena, Gomez Gallego, 2019). The research done in this field concerns the overuse type of injuries, gastrocnemius medialis (GM) and gastrocnemius lateralis (GL) activities related to the effect of balance exercises on young children's physique, and the low back pain experienced by elite rhythmic gymnasts.

Judging in rhythmic gymnastics and expert preparation
This group is composed by 6 articles, strictly related with the judgement and judge and expert preparation. The topics discussed are: evaluation of body difficulty elements and the disagreement among the judges on some of them (Leandro, Ávila-Carvalho, Sierra-Palmeiro, Bobo, 2015); judging at different levels of performance and the practical skills judges should possess (Leandro, Ávila-Carvalho, Sierra-Palmeiro, Bobo-Arce, J Hum Kinet, 2013; 2017). The major conclusions in this area of studies postulate that experience is not a decisive factor in assessing skills. Rhythmic gymnastics judges must implement and optimize a set of skills that contribute to the effectiveness of the assessment process. These findings might help in the design of programs and training models that contribute to effective professional development.

DISCUSSION
To our knowledge, this is the second systematic review examination of the publication profile in rhythmic gymnastics over the last 10 years. The main finding of this study was the paucity of evidence, especially as in the qualitative synthesis a few studies were found on the topics of planning the training, training load and recovery. Most of the studies are dedicated to the technical, and tactical aspects of rhythmic gymnastics. Very few investigations have been carried out concerning important areas in Rhythmic Gymnastics, such as physiology, biochemistry, psychology, and training load (Gateva, 2012).

Table 4. Publication in Biology

<table>
<thead>
<tr>
<th>Key words</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>gymnastics, females, nutritional status, dietary intake.</td>
<td>George Dallas, Kostas Dallas, Jeremy Siatras Nutritional status and dietary assessment of elite female artistic and rhythmic gymnasts – a case study</td>
</tr>
<tr>
<td>Preferred Lower Limb, Non-preferred Lower Limb, Flexibility, Rhythmic Gymnastics, High Level gymnasts</td>
<td>Amanda Batista Santos, Maria Elisa Lemos, Eunice Lebre, Lurdes Ávila Carvalho Active and passive lower limb flexibility in high level rhythmic gymnastics</td>
</tr>
<tr>
<td>Training load, Stress Cortisol, Testosterone, Monitoring training, Sports</td>
<td>Antuálp, K., Aoki, M. S., &amp; Moreira, A. Salivary steroids hormones, well-being, and physical performance during an intensification training period followed by a tapering period in youth rhythmic gymnasts.</td>
</tr>
<tr>
<td>female athletes; pelvic floor, performance, rhythmic gymnastics; urinary incontinence</td>
<td>Marte Charlotte Dobbertin Gram, Kari Be High level rhythmic gymnasts and urinary incontinence: Prevalence, risk factors, and influence on performance</td>
</tr>
<tr>
<td>body composition; female; growth; peak height velocity; rhythmic gymnastics.</td>
<td>Cristiane Teixeira Amaral Camargo, Rossana Anelice Gomez-Campos, Marco Antonio Cossio-Bolaños, Vinícius Justino De Oliveira Barbeta, Miguel Arruda, Gil Guerra-Junior Growth and body composition in Brazilian female rhythmic gymnastics athletes.</td>
</tr>
<tr>
<td>constitution; elite athletes; kinanthropometry; rhythmic gymnastics; selection.</td>
<td>Tijana Purenović-Ivanović , Ružena Popović Somatotype of top-level serbian rhythmic gymnasts</td>
</tr>
<tr>
<td>APT, mobile multimedia classroom, technology</td>
<td>Carla C. Silva, Lucilene F. Silva, Camila R. Santosc, Tamara B. L. Goldberg, Solange P. Ramose, Emerson J. Venancio Genetic polymorphism on the flexibility of elite rhythmic gymnasts: State of art</td>
</tr>
</tbody>
</table>

Researchers have not established models of training and sports performance (as well as their interaction) of rhythmic gymnasts of different ages and levels. If sports science verifies which parameters are a useful indicator and which ones contribute to a successful performance in rhythmic gymnastics, we could have some guidelines for talent identification, selection, development and promotion. The further investigations must be dedicated to the use of technology in injury prevention; genetic polymorphism flexibility of elite rhythmic gymnasts; the virtual reality; teaching models, top-form management,
and loading and recovery in different structures of sports preparation.

CONCLUSIONS
After the analysis of 56 articles about Rhythmic Gymnastics and Performance from four databases we could draw the following conclusions:

1. The digital references are increasing in the Databases every year.
2. The topics studied were: training protocols and programs; learning - training process; physical condition; technical aspects; training load and recovery; specific endurance; plyometric training; competitive routine; different levels of performances and competitions; talent identification and somatotype; pubertal period; motivation; self-Concept, anxiety, attitudes and behaviour; goal orientation; motor imagery; resilience; nutritional status; body composition; flexibility and low limb asymmetry; energy expenditure; muscle coactivation and stability exercises; low back pain; musculoskeletal injuries; judging and judges’ performance and faults; expert development.
3. Some of the future scientific work in the field of rhythmic gymnastics should be directed towards researching the different aspects of sports training, loading and recovery periods, injury prevention, psychological profile of athletes and its influence on in-competition performance, and proper teaching models applied to both low- and high-level rhythmic gymnasts.

This study has only investigated the publication in English language found in four databases. Despite this we believe our work could be a starting point for future research and sheds some light on the main topics of interest for sports specialists in this area.

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DEVELOPMENT OF STANDARDIZED RHYTHMIC GYMNASTICS MOVEMENT SCREEN

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ABSTRACT

Participation in rhythmic gymnastics is growing, and in the United States the registered number of gymnasts has doubled (with the number of coaches tripling) over the last 6 years. To keep up with the growing popularity, and to further advance the competitiveness of participants, it is essential to develop training programs based on the strengths and weaknesses of individual gymnasts. For this reason, a team of former-gymnast physical therapists and dance educators developed a battery of skill tests for rhythmic gymnasts; this series of tests is called the Rhythmic Gymnastics (RG) Movement Screen. In its development, essential skill tests were considered by referencing scientific materials including the Dance Functional Outcome Survey (DFOS) (Bronner, McBride, & Gill, 2018, Bronner, Chodock, Urbano, & Smith, 2019), a self-report functional outcome questionnaire for dancers. The initial version of RG Movement Screen (Version 1) was composed of movement tests on 11 skills for elite-level gymnasts that serve as foundations for major body difficulties (e.g., balance, pivot, and jumps) and injury risk reduction. It was administered in-person to the USA national team gymnasts (n = 26) in 2019. Based on Version 1 results, RG Movement Screen was modified into 9 skills (Version 2) that allows it to be administered virtually and is adjustable for lower-level gymnasts. Version 2 was administered in-person or remotely to the national team gymnasts (n = 20) as well as lower-level gymnasts (n = 36) in 2020. The assessment time was reduced from 25 minutes per gymnast for Version 1 to 15 minutes for Version 2. The assessment results were then shared for educating individual gymnasts on needed exercises. Both versions of the movement screen were useful in identifying biomechanical flaws and creating an environment where athletes, coaches, and medical providers could work together on performance goals and injury prevention.

Key words: USA Gymnastics, Physical Preparation, Online Assessment, Injury Prevention, Pre-Participation Screen

INTRODUCTION

Rhythmic gymnasts are performance athletes. The sport requires a blend of flexibility, athleticism, and aesthetics. Rhythmic athletes must demonstrate excellent dance technique while managing hand apparatus and coordinating all movements to music. The tendency for rhythmic gymnasts to specialize in the sport at a young age, train year-round, and train greater than 16 hours per week, predisposes these athletes to a higher risk of overuse injuries (Meyer et al., 2015). Skeletally immature rhythmic gymnasts often perform high repetitions of stretching unilaterally. This leads to imbalances that affect spinal development, possibly leading to scoliosis (Tanchev et al., 2000). It is important for coaches and athletes to understand that imbalances in training could lead to musculoskeletal deformities that can limit participation in the sport and could ultimately lead to injuries. While asymmetrical spinal loading on skeletally immature spines may lead to back pain, it is also important to recognize that low back pain in rhythmic gymnasts could also be related to strength imbalances. It has been noted by Koutedakis et al. (1997) that an imbalance in strength in the lower extremity may lead to increased severity in low back injury. Once a rhythmic gymnast perfects a certain type of skill, it is common to use this skill in all of their routines. This reduces the variety in the musculoskeletal activation patterns, thus accentuating the imbalances in the same limb, especially within antagonistic muscle groups. Rhythmic gymnasts, much like dancers (Jacobs et al., 2017), will continue to train through pain and injury. Olympic level rhythmic gymnasts rate their health as lower than other international rhythmic gymnasts, report decreased variety in childhood activities, and less fun and enjoyment in their sport (Law et al., 2007). Jacobs et al. (2017) found that despite high injury rates (54.8%), dancers do not report injuries or seek early medical intervention. Additionally, the years of participation at an elite level increases the injury rate (Jacobs et al., 2017). Rhythmic gymnasts share many traits with dancers, and it is important to create an environment where athletes can report pain early and receive appropriate treatment to return to optimal performance, thereby prolonging careers and improving their satisfaction with the sport. The high physical demands of rhythmic gymnastics make it important to assess fundamental phys-
ysical skill capacity for safety and efficient long-term training. Some sports have specifically designed movement screens (Sleeper et al., 2012; Sleeper et al., 2016; Uljevik et al., 2013; Bronner, 2018) or use more generalized testing such as the Functional Movement Screen (FMS). These screens can be useful in assessing movement quality, but are not a reliable way of predicting likelihood of injuries (Dorrel et al., 2015; Dorrel et al., 2018). Currently, there is no established protocol for assessing fundamental physical skills from the perspective of biomechanical appropriateness and safety for rhythmic gymnastics. The purpose of this study was to develop an easily administered Rhythmic Gymnastics (RG) Movement Screen that provides feedback to coaches and athletes, tracks improvements, and significantly improves communication between coaches, athletes, and health care providers.

**Aim of Study**

Develop a standard protocol that is easy to administer and accurately assesses fundamental physical skill capability for performing rhythmic gymnastics safely and efficiently.

**METHODS**

The U.S. Rhythmic Gymnastics Program has used movement evaluations since 2012. The first evaluations were implemented at national training camps and included testing of body skills specific to rhythmic gymnastics. This was regularly updated as the athletes improved or the Code of Points was revised and the physical demands of the sport changed. In 2018, a movement evaluation was administered at training camps that exclusively examined ballet-specific body positions. The 2018 movement screen provided helpful training information to athletes and coaches, but the testing and evaluation were not standardized. In 2019, a process was started to formalize a Rhythmic Gymnastics (RG) Movement Screen that could be administered at national training camps with the intended outcome of improving performance, tracking improvements, and facilitating communication between athletes, coaches, and health care providers.

Initially, feedback was solicited from athletes and coaches regarding desired skill inclusion in the RG Movement Screen. Movement skills from the previous screens were discussed and evaluated for relevance. In addition, a review of movement screens for other performance sports was conducted including figure skaters, artistic gymnasts, and dancers (USA Figure Skating, 2019; Sleeper et al., 2012; Bronner et al., 2016; Bronner et al., 2019). The research that was the most applicable to the development of the RG Movement Screen was that created by Bronner (2018) and Bronner et al. (2019). This research includes manual muscle testing with dynamometry, functional skill evaluation, and health questionnaires. In contrast to the full work by Bronner and movement screens for other sports, the 2019 RG Movement Screen (Version 1) focuses on functional skill evaluation. It is composed of movements that assess flexibility, strength, and body skills that are specific to rhythmic gymnastics. A binary scoring system was used in the evaluation of most skills (Table 1). While administering the movement screens, it was found that a binary system was not ideal and therefore it was necessary to grade between Yes and No, thereby creating a third category.

**Table 1. Binary scoring for RG Movement Screen Version 1**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Assessment</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plank</td>
<td>Hold for 20 seconds</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good scapular position</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good lumbar position</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Side Plank (right and left)</td>
<td>Hold for 20 seconds</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good pelvic position</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Exercise Description</td>
<td>Criteria</td>
<td>Result</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Relevé with gesture leg in neutral passé</td>
<td>Five repetitions w/o loss of balance</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good foot/ankle position</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good lumbopelvic/hip position</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Seated lotus position (right and left)</td>
<td>Top leg is lower than the waist</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Hip extension strength (right and left)</td>
<td>Able to lift off ground</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Able to lift without hip ER</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Three slow jumps in first position (sauté)</td>
<td>Heels touch the ground</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good trunk control</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Three fast jumps in first position (sauté)</td>
<td>Heels touch the ground</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good trunk control</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Penché (right and left)</td>
<td>Split position equal or greater than 180 degrees</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Penché with upper knee bent (right and left)</td>
<td>Foot touches head when knee bends</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>
Two of the tests had an alternative scoring system and used a testing curtain with reference angles for arm height and leg lowering, respectively (Table 2).

This facilitated quick testing and consistency in the scoring of the angles (Figure 1, 2).

**Table 2. Non-binary scoring for RG Movement Screen Version 1**

<table>
<thead>
<tr>
<th>Test</th>
<th>Scoring System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder flexibility/strength</td>
<td>Height of arms lifted from the floor</td>
</tr>
<tr>
<td>Leg lowering test</td>
<td>Angle of legs as they were lowered</td>
</tr>
</tbody>
</table>

**Figure 1.** Shoulder flexibility/strength test (The inside numbers are referenced for this test)

**Figure 2.** Leg lowering test

The RG Movement Screen was designed for yearly administration at National Team camps, allowing the athletes and coaches to monitor their progress. However, the COVID-19 Pandemic of 2020 forced a change in the RG Movement Screen. In Version 2, the testing needed to be conducted virtually due to the postponement of National Team Camps. In developing a movement screen that could be conducted virtually, several modifications were needed. First, it was difficult to see certain biomechanical errors over online platforms therefore some movement tests were modified. Second, the testing curtains that were required for the leg lowering and shoulder flexibility/strength tests could no longer be used. And, finally, because of changes in the Code of Points, many athletes added the *fouetté* pivot to their routines and coaches requested that we evaluate the body position and strength required for this skill. Consequently, it was determined that an assessment of *développé a la seconde* was necessary.

In the RG Movement Screen Version 2, a kneeling arch test replaced the shoulder strength/flexibility test, the quick *sauté* test was eliminated from the movement screen, and evaluation of the *développé a la seconde* position was added. Scoring criteria was established for the new movements (Table 3).
Table 3. Binary Scoring for RG Movement Screen Version 2

<table>
<thead>
<tr>
<th>Movement</th>
<th>Assessment</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kneeling Arch</td>
<td>Good shoulder mobility</td>
<td>Yes or No</td>
</tr>
<tr>
<td><em>(Athlete in tall kneeling with knees hip-width, she holds a rhythmic ball between both hands, then reaches back toward the ground)</em></td>
<td>Good use of thoracic spine</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Full length through the front of the hips</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Good form with returning to starting position</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Appropriate use of whole spine</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Développé a la seconde</td>
<td>Good lumbopelvic position</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Appropriate use of hip flexor</td>
<td>Yes or No</td>
</tr>
<tr>
<td></td>
<td>Leg at 90 degrees</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>

Both RG Movement Screen Version 1 and Version 2 can be utilized in screening rhythmic gymnasts. Version 1 must be performed in-person and has 11 testing components. Version 2 can be performed remotely or in-person and has 9 components. Version 2 has been administered to the United States National Team both remotely and in-person, based on the location of the gymnast and the availability of a National Team physical therapist.

Version 2 also added an injury observation component by requesting that all National Team Members complete the Dance Functional Outcome Survey (DFOS) (Bronner et al., 2019). This survey was originally developed to monitor the health of high-level dancers and to evaluate their readiness to return to dance after a lower extremity injury. Due to the close relationship between dance and rhythmic gymnastics, it was determined that this survey may be applicable to rhythmic gymnasts. This survey will be used to monitor self-reported pain and functional limitations in dance-specific body skills in the future. In addition to using the DFOS, parallel questionnaires on athlete health, pain, and performance goals were created for the coach and athlete. These questionnaires were used to facilitate communication between the athlete, coach, and medical team to ensure that the feedback from the movement screen was consistent with the goals of the athlete and coach. The athlete and coach were asked if there were any modifications in training due to pain or injury, as this helped the physical therapist administering the RG Movement Screen know if any portion of the movement screen needed to be modified and to determine if referral for further injury evaluation was needed.

The assessment data were de-identified for detailed group data analysis. Results illustrating associations between movement control and rhythmic gymnastics body difficulties, as well as results showing improvements in movement screen scores from 2019 to 2020, are reported elsewhere (Shinohara, 2020).

RESULTS AND ANALYSIS

RG Movement Screen Version 1 required approximately 25 minutes per athlete to complete the evaluation. RG Movement Screen Version 2 was completed in approximately 15 minutes either virtually or in-person. Following the completion of RG Movement Screen (both Version 1 and Version 2), the physical therapists reviewed each athlete’s test and completed an individualized Analysis Form, requiring an additional 5 minutes for analysis. The form had three columns (green, yellow, and red) that signified how well the athlete performed each skill (USA Figure Skating, 2019). The green column advises the athlete to “Continue to maintain strength, stability/mobility through training and dynamic warm-ups as directed by your coach.” The yellow column advises, “There are movement mechanics that can be improved through appropriate exercise prescription that will support mobility, stability, proprioception and balance, respectively.” The red column indicates, “Consider follow up with a qualified medical provider (physical therapist, certified athletic trainer, or sports medicine physician) for more information and exercise prescription. Instability, limitations in mobility, and/or asymmetry were identified in your test results, and continued deficiencies could eventually increase your risk of injury” (Table 4).

Table 4. Excerpt from RG Movement Screen Analysis Form

<table>
<thead>
<tr>
<th>Green</th>
<th>Yellow</th>
<th>Red</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Plank</td>
<td>X</td>
<td></td>
<td>Notes:</td>
</tr>
<tr>
<td>Side Plank: Right</td>
<td>X</td>
<td></td>
<td>Notes:</td>
</tr>
</tbody>
</table>

The athletes and coaches were provided education on what each test evaluated, why it is important to rhythmic gymnastics, and how it relates to injury prevention. For Version 1, performed in 2019, this information was shared in a presentation and a handout was provided to further impress upon the athletes and coaches the applicability of the screen to rhythmic gymnastics. For Version 2, performed in
2020, the athletes and coaches received, in an email, their RG Movement Screen Analysis Form and comparison information on their 2019 versus 2020 movement screen. Additionally, each 2020 National Team member and coach had a virtual meeting with a physical therapist to review individualized exercise recommendations for further improvements in body position and rhythmic gymnastics performance. The gymnast and coach questionnaires were discussed, and it was noted that sometimes the athlete and coach did not share the same view on athlete training limitations due to pain or injury. These differing perceptions were reviewed, and plans were developed to improve communication regarding athlete health. It became evident that by performing the screens virtually, RG Movement Screen could be administered to athletes that do not typically attend national training camps. To make the movement screen appropriate for lower-level athletes, some movements were modified, creating the RG Movement Screen Version 2 for Level 5-6. These adaptations included replacing the single leg relevé test in passé with a double leg relevé test, and a standing passé was evaluated instead. Finally, it was determined that the penché and penché with upper knee bent were too challenging for lower level rhythmic gymnasts and that square body position with splits would be evaluated instead. This eliminated the balance component of the test and allowed the younger athletes to focus on their body position.

**DISCUSSION**

The RG Movement Screen Version 1 and Version 2 are tools that identify weakness in the musculoskeletal system and detect incorrect movement patterns. The screens also provide a platform for improved communication between athletes, coaches, and medical providers. The screens are easy to administer and do not require sophisticated medical equipment. They can be completed in 15-25 minutes depending on which version is utilized. It is possible for a coach, judge, ballet instructor, or health care provider to administer the screen with proper education on the scoring criteria. The RG Movement Screen can be used at educational camps, training camps, or virtually (Version 2 only). While some of the components of the screen may be useful for dancers or other performance athletes, this tool was specifically designed to meet the needs of rhythmic gymnasts. Version 2 was originally designed to be complaint with COVID-19 Pandemic social distancing guidelines, however other benefits to virtual administration were also identified. One benefit is that the medical team is able to continue to work closely with the National Team even when in-person training camps are not possible. Additionally, there is more time for individualized consultation on the results of the movement screens. During a regular training year, athletes and coaches often report to the medical team that there is not enough time to focus on fundamentals, but due to COVID-19 causing gym closures and altered training schedules, an ideal situation was created for focusing on body technique, fundamental strength, and symmetrical flexibility. Both in-person and online applications of the RG Movement Screen were successful for evaluating rhythmic gymnasts. The modifications that were made between Version 1 and Version 2 allowed for information to be collected virtually and will improve future data collection. The standardized survey (DFOS) and confidential gymnast and coach questionnaires that were added to Version 2 will assist with future data collection on self-reported pain and injury rates. These questionnaires also identify where athlete and coach perceptions diverge and will facilitate future dialogue that will help with performance goals and injury awareness.

There is a potential need for updates to the RG Movement Screen based on our experiences with Version 1 and Version 2. The subjective assessment of the body skills needs further clarification, especially if there are new assessors. For Version 1, there was not a clear enough criterion for converting the binary scoring system into the three-point (green/yellow/red) scale. A detailed scoring criterion was established for Version 2; however, this criterion was still subjective. In addition, the binary scoring model itself may need to be modified because it does not indicate degree of failure on a “No” result, and as such, often times a gymnast was graded in between “Yes” and “No.”

For future screening, it would be helpful to have a faster way to collect and analyze the data. An electronic documentation system could be used to directly enter the assessments and a score could be immediately calculated. This would further decrease the time needed to administer and analyze the movement screen, thus leaving more time for developing corrective exercises. Some of the data from the 2019 and 2020 RG Movement Screens has been analyzed (Shinohara, 2020), and revisions may be necessary in future versions of the screen based on this analysis. There may be some body skill evaluations that do not provide adequate information and will be eliminated or modified. Group data analysis will be helpful in refining the RG Movement Screen.

In conclusion, the RG Movement Screen was useful in identifying biomechanical flaws that lead to injury, and it also created an environment where athletes,
coaches, and medical providers could work together on performance goals and injury prevention. Both in-person and online applications of the RG Movement Screen were successful for rhythmic gymnasts.

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Christina Brown, Physical Therapy Assistant and ballet teacher, Tracy Halloran, Professor of Dance at Madonna University, and Amanda Scully, Doctor of Physical Therapy contributed in the development and modification of the movement screens. Caroline Hunt, U.S. Rhythmic Program Director, assisted by organizing and promoting health and wellness camps and trainings for athletes and coaches.

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MEANING AND ROLE OF COORDINATION SKILLS IN RHYTHMIC GYMNASTICS

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ABSTRACT
Rhythmic gymnastics is a complex-coordination sport, where not enough and purposeful attention is paid to training the different types of coordination skills from an early age. In modern rhythmic gymnastics, the importance of different degrees and types of coordination and agility is a prerequisite for a breakthrough in elite sport. This sets the aim of this study – to determine the level of development of coordination abilities and its influence on the execution of training tasks. For this purpose, 32 elite gymnasts (age experience M=7.7 years) were studied. Each of the subjects was a competitor participating in competitions of international level, as 9 of them were members of national teams. The number of scheduled training hours per week was 36 for all. The results from the obtained data and the statistical processing showed that when it comes to coordination between an apparatus and body movement, the gymnasts with a greater sense of technique gave better results than those, who did not have the same technical skills. For most of the athletes, there was a correlation between the level of technique and the level of development of coordination, whose growth is in direct interdependence. In conclusion, the gymnasts, who showed better results in the coordination tests, had a better vision of how to accomplish the assigned tasks. They quickly corrected their mistakes and succeeded to maintain stable level of performance. It is a fact that well-coordinated gymnasts had better perceptions for time, space, and effort; their routines were more complex with high level of difficulty. This explains why these gymnasts were able to cumulate more points and to achieve higher final score compared to those with lower level of coordination.

Key words: elite gymnasts, coordination tests, results.

INTRODUCTION
Flexibility and coordination are considered the most important motor skills in rhythmic gymnastics (Gateva, 2013). Interestingly, however, while flexibility has been constantly researched in science and emphasised in practice, coordination skills are somehow lagging behind in this regard. A reason for this might be the fact that the character of coordination is complex and often misunderstood. Actually, the ability to perform complex movements, to solve complex motor tasks, to perform with high speed of acquired motor programs, and speed for adoption of new motor programs (Miletić, 2005) is known as motor coordination. The coordination criterion is the accuracy of reproducing the movements, in terms of time, space, and muscular effort (Terebova, Arkhipova, 2016; Zhelyazkov et al., 2020).

Rhythmic gymnastics is a sport that is constantly changing, getting more complicated, and evolving, especially over the last few decades. The specific coordination plays an important role in creating the prerequisites for optimizing technical preparation (Hafez, 2016). The requirements for maximum complexity and purity of execution of technical movements do not stop increasing. The results from this are the actions in gymnasts’ routines, performed in unexpected situations, which have been significantly increased in the last years. In such situations, the girls are supposed to demonstrate fast reaction and concentration (Gantcheva, 2018). The open Difficulty’s score (D) and the unlimited number of exercises with apparatuses, combined with a perfect performance of body movements, according to musical accompaniment (FIG, 2017-2020) are part of the modern challenges in this sport. Therefore, the following question arises: How, by what means, and methods can perfect performance be achieved, and what skills are needed for this aim? It is clear and proven, that those rules impose the need for suitable physical fitness and the development of an excellency in coordination skills. Such skills are demonstrated through whole-body coordination, reaction and moving time, dynamic and static balance, sense of kinaesthesia and hand-eye coordination (Pavlova, 2011; Purenović-Ivanović et al., 2016). According to Mackenzie (2011), the maximum development of static balance and spatial-temporal orientation, which are closely related, are a guarantee for successful sports realization.

A well-coordinated gymnast is able to save energy and train productively in longer and heavy workloads. In addition, the girls, who possess high level of coordination abilities can perform more elements for limited time (individual routines - 1:30 min; group - 2:30 min), to correct some inaccuracy faster than the rest and to work with a body and apparatus in different planes with different speed. Therefore, it is important to answer the question how to develop
and improve coordination skills. Some authors (Dimitrova, 2015) highlight that coordination abilities are genetically dependent and will not change significantly under workload (phenotypic factors): heredity factor of “motion precision” can reach 95%; “muscle coordination” - 79%. We believe that phenotypic factors could influence the development of coordination. This is possible through using proper methodology with a tailor-made approach to each gymnast and of course, with the right understanding and acquisition on her part.

It should be noted, that the development of coordination skills is directly connected to the development of the other motor skills. Without sufficient level of flexibility, speed, strength, and endurance high level of coordination would be hard to be demonstrated, because all qualities are interrelated in their manifestation. Coaches need to be well-aware of those scientific facts and to pay attention not to selective motor qualities, but to all in synchronous by working with 1, 2, or more apparatus together, performance of complex exercises, where the different parts of the body move in different planes with different time and rhythm. In any way, the training approaches for developing coordination must be carefully selected and applied, because they often lead to fatigue. For a coach, it is important to understand how to combine various movements of different nature, different by type of organization, and order of execution to develop coordination. The principle “from the simple to the complex”, along with exercising regular control should be implemented.

**Aim of the study**

The main aim of this study was to determine the level of development of coordination abilities and its influence on execution of training tasks.

**METHODS**

The studied group included 32 elite gymnast (23 – competing on FIG international level, and 9 – members of national teams) aged between 13 and 15 years old with average age – 14.2 years. Six of them had 9 years of experience in rhythmic gymnastics, others 7 gymnasts – 8 years of experience; 13 were with 7 years, and 6 gymnasts - 6 years of experience. The average experience in rhythmic gymnastics for the group was 7.7 years. The number of scheduled training hours per week for each gymnast was 36 hours or 6 days with 6 training hours per day. To achieve the aim of our study, 6 author’s tests were used based on the most common exercises in the gymnastics’ routines. The gymnasts were not familiar with the content of the test battery in advance. Each of them had the opportunity to try the exercise for 2 minutes before the start of the testing for each individual test. Additional attempts were not allowed after the allotted time. The necessary equipment for the testing included hoops, ribbons, balls, clubs, stopwatch, bandages for eyes, meter, and materials for marking boundaries of used area in the space. Variation and comparative analysis were used to determine the level of development of coordination skills of elite rhythmic gymnasts. Correlation analysis and statistical significance of the results were used to determine the relationships between the individual numerical values of the coordination tests.

**Table 1. Author’s test battery**

<table>
<thead>
<tr>
<th>Test №</th>
<th>Performance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1.</td>
<td>Start position- the gymnast stands on tip-toe. Right hand holds hoop, inverted in the transverse plane; left hand is to the side, executing spirals in a transverse plane with a ribbon. The gymnast performs throwing of the hoop, fast front transmission of the ribbon in the right hand, two right rotations of 360° with collected feet under the flying hoop, simultaneously with execution of spirals in facial plane. The hoop is caught with left hand; the right one performs large transverse circles from a shoulder, during the catching.</td>
<td>10 attempts are made and the successful ones are counted. A successful attempt is: a cleanly caught hoop with hand and fingers, a visible circular shape of the spirals, as ribbon does not touch the body and the floor and is monitored for 2 full rotations of the body. The maximum score is 10, the minimum – 0. The highest numerical value is the best achievement.</td>
</tr>
<tr>
<td>T2. With two apparatuses, three-level coordination is measured: between both apparatuses (different shape but hard) and body movement.</td>
<td>Start position- the gymnast stands on flat feet. In her right hand she holds a ball, in the left- a club. The gymnast performs a squat with a small throwing of the club with a single rotation in the transverse plane, at the same time she bounces the ball, as the hands are changing the apparatuses, so the right catches the club, the left- the ball when the girl is straightening from squat and returning to the start position. The exercise is also performed in the opposite direction, where the right hand starts handling with a ball, the left one – with a club. The squats are repeated many times without interruption, as the hands constantly swap the apparatuses with the specified technical movements.</td>
<td>The number of the correctly executed squats, made for a minute, is recorded. The apparatuses need to be caught cleanly (ball and club), as the gymnast have to maintain balance without additional steps, coordinating her movements with both the apparatuses and the body without interruptions of the test. The highest numerical value is the best achievement.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>T3. Two-level coordination is measured: between movements with a hoop and efforts for saving balance at a certain position of the body.</td>
<td>Start position-gymnast stands on flat feet; the hoop is in front of hip joints, caught with both hands in the horizontal plane. The gymnast performs “penche” balance (Code of Points, 2017-2020) on flat support foot (right/left). During the balance, the hoop moves in the horizontal plane, in the right (right support leg)/left (left support leg) direction, by executing transmissions of the apparatus behind and in front of the support leg.</td>
<td>The number of hoop’s transmissions (front and behind separately) is recorded until losing the balance or disturbing the body shape (penche balance). The highest numerical value is the best achievement.</td>
</tr>
<tr>
<td>T4. Two-level coordination is measured: between movement with a hoop and efforts, directed for maintaining a balance at certain position of the body with reduced supporting area.</td>
<td>Start position- the gymnast stands on tip-toe. She performs a balance with a raised back bent leg (attitude balance on tiptoe – Code of Points), the hoop is forward in the horizontal plane, held with two hands. During the balance, the girl does small uninterrupted throws, which are performed with half-turn of the hoop (the throwing and catching are with two hands).</td>
<td>The number of the throws (half rotations) is recorded until disturbance of the balance or loss of shape. The highest numerical value is the best achievement.</td>
</tr>
<tr>
<td>T5. Three-level coordination is measured: between two apparatuses (different shape- soft and hard) and body movement.</td>
<td>Start position- the gymnast stands on tip-toe. Right hand holds a ribbon, left one is to the side with a hoop, which is in a horizontal plane. The gymnast performs a large transverse-circle with the ribbon, scrolls the stick through the hand and throws the ribbon high. After this she catches the hoop with both hands in the frontal plane, jumps through the hoop together with forward scroll of the hoop between fingers, the body rotates 180° and the gymnast performs a quick second jump through the hoop with backward scroll. The body continues to rotate until the girl finishes full 360° rotation. All this is executed under the flying apparatus. In the final part the right hand catches the ribbon; the left one stays with the hoop. 10 attempts are made and the successful ones are counted. A successful attempt is: a correct-caught ribbon (Code of points) after full body’s rotation of 360°, clearly visible planes during a handling with the hoop and well-executed directions (front-back) during the jumps. The maximum score is 10, the minimum – 0. The highest numerical value is the best achievement.</td>
<td></td>
</tr>
</tbody>
</table>
**T6.** Orientation in the space and balance control at dynamic rotation movements with isolated visual analyser.

Starting position: the gymnast stands on tiptoe in the beginning of a 1-meter-wide path, the arms are bent, while the hands are placed on the waist. The gymnast performs 3 rotations of 360° with collected feet and a roll. Her eyes are covered with a bandage in order to limit her visibility. The test is performed with rotations to the right side (right roll) and the left (left roll) side.

The objective of this test is to be executed for the shortest possible time. Upon the gymnast’s exiting the path, the test is considered invalid and cannot be executed again. The gymnast should have no visibility and the shape of the body during the exercise must be clear and easily recognized. The lowest numerical value is the best achievement.

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**RESULTS AND ANALYSIS**

**Table 2. Descriptive analysis (Test 1-Test 6)**

<table>
<thead>
<tr>
<th>Number</th>
<th>T1/Num</th>
<th>T2/Num</th>
<th>T3/Num</th>
<th>T4 Right/Num</th>
<th>T4 Left/Num</th>
<th>T5/Num</th>
<th>T6 Right/Time</th>
<th>T6 Left/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>7.14</td>
<td>33.43</td>
<td>28.57</td>
<td>13.71</td>
<td>7.43</td>
<td>6.14</td>
<td>2.95</td>
<td>3.21</td>
</tr>
<tr>
<td>Median</td>
<td>7</td>
<td>35</td>
<td>25</td>
<td>11</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Mode</td>
<td>7</td>
<td>-</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>-</td>
<td>3.1</td>
</tr>
<tr>
<td>SD</td>
<td>1.6</td>
<td>5.9</td>
<td>20.9</td>
<td>8.6</td>
<td>4.1</td>
<td>3.3</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Range</td>
<td>5</td>
<td>15</td>
<td>61</td>
<td>22</td>
<td>10</td>
<td>9</td>
<td>1.06</td>
<td>1.2</td>
</tr>
<tr>
<td>Min</td>
<td>4</td>
<td>25</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Max</td>
<td>9</td>
<td>40</td>
<td>69</td>
<td>27</td>
<td>13</td>
<td>10</td>
<td>3.36</td>
<td>4</td>
</tr>
<tr>
<td>Confidence Level (95.0%)</td>
<td>1.45</td>
<td>5.47</td>
<td>19.37</td>
<td>8</td>
<td>3.77</td>
<td>3.09</td>
<td>0.3</td>
<td>0.34</td>
</tr>
</tbody>
</table>

**Table 3. Correlations (Test 1-Test 6)**

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4 Right</th>
<th>T4 Left</th>
<th>T5</th>
<th>T6 Right</th>
<th>T6 Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>-0.03</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>0.40</td>
<td>0.78</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4 Right</td>
<td>-0.60</td>
<td>-0.38</td>
<td>-0.37</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4 Left</td>
<td>-0.27</td>
<td>0.02</td>
<td>0.19</td>
<td>0.66</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>0.60</td>
<td>0.32</td>
<td>0.44</td>
<td>-0.89</td>
<td>-0.64</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6 Right</td>
<td>-0.27</td>
<td>-0.32</td>
<td>-0.06</td>
<td>0.37</td>
<td>0.39</td>
<td>-0.31</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>T6 Left</td>
<td>-0.12</td>
<td>-0.59</td>
<td>-0.40</td>
<td>0.06</td>
<td>0.05</td>
<td>-0.05</td>
<td>0.79</td>
<td>1</td>
</tr>
</tbody>
</table>

In the first test (T1), where the three-level coordination is measured, the average score of the studied group was 7.14 attempts. If we look at the number of the successful attempts out of 10 fulfilled, it is clear that the results of most of the gymnasts were close, but there was a serious difference between the best (9) and the worst (4) result (5 attempts – Table 2). This means that some gymnasts lagged from the others in terms of coordination skills, although all participants in the study competed on a professional level. In elite rhythmic gymnastics, the coordination skills need to be very well-developed, because gymnasts cannot achieve significant results without that. The sports profile of these athletes, independently from their individual characteristics, should include high-level of technical qualities and possibility for performance of complex movements in space, which is extremely difficult to be achieved, if gymnasts do not possess high-developed coordination skills. The gymnast, who achieved the best result (9 attempts), in fact, was the youngest (13 years old), with the least competitive experience (6 years). However, she completed her training plan almost always successfully and on time, and she did not commit serious mistakes in a competition (control training). This gives us a reason to believe, that despite the lack of great competitive and training experience, the gymnast showed rapid reactions and succeeded to deal with the set tasks. The most common result for the entire group was 7 attempts, which was closer to the best shown score (9) than to the weakest (4 attempts). These 7 most common successful attempts were shown by 10 gymnasts (the sample included 32 gymnasts). This shows variety of results and different level of development of coordination, independently from the common competitive and the same weekly training time.

Test 2 (T2) measures the coordination ability between left and right hand, each of which executes different handlings with an apparatus simultaneously performing simple body movements. The test is
based on maintaining a certain rhythm of the performance throughout its duration. The best result in this test was 40 squats, completed for one minute (60 seconds), in combination with accurate handling the apparatuses. The worst result in T2 was 25 squats for the same allotted time. The difference between the best and the worst result was significant – 15 attempts and this shows that a certain gymnast was greatly lagging from the other ones in the elite group. This is surprising because they are all athletes from an approximately homogeneous group, characterized with high level of technical and physical qualities. The average score for the group was 33.43 attempts, again indicating that a score of 25 successful squats was weak for this sample. An individual approach to these athletes (with the weakest result) is needed in order to improve their level of coordination between the different parts of the body. The gymnast who achieved the best result in T2 was the same, who showed the best numerical value in T1. This result was independent for the various apparatuses she had to perform the test, the character of the movements with them, and the weak correlation between both tests - T1, T2 (0.3 – Table 3). The gymnast with the best level of development of coordination skills in T2 was able to distribute her attention in time, direction, and effort. She overtook some of her colleagues with more experience in rhythmic gymnastics (7-9 years).

Test 3 (T3) researches the level of balance resistance in one of the most commonly used exercises in rhythmic gymnastics. The attention of the gymnasts in this test was distracted by the speed of working with the apparatus (maximum number of transmissions between left and right hand) before loss of balance. The difference (61 transmissions) between the best (69) and the worst result (8) in T3 was enormous. An even more negative aspect is that the weakest result was the most common result in this test (mode – 8, Table 2). The average value for the group (28.57 transmissions) means that some individuals in this sample were significantly lagging behind in balance resistance compared to the others. This could be the reason for those gymnasts to fail to complete their daily training plan and to encounter problems in performing exercises related to balance stability (rotations, balances). The correlation between T3 and T1 was moderate (0.4), and between T3 and T2 it was strong (0.78) (Table 3). This is confirmed by the fact that in this case once again the best achievement (69) was the result of the gymnast with the best scores in the previous two tests. Her level of coordination was a basis for success and a unique advantage for a stable performance of dynamic and static exercises. Furthermore, she succeeded to execute many different types of manipulations with the apparatuses and this is crucial for modern rhythmic gymnastics.

In T3 the results of comfortable side (right) were used primarily because none of the 32 gymnasts could do a left split, so respectively there was no shape during the balance and the transmissions were not counted. In T4 there were positive results for the left and right side. One reason for this could be the fact that lower amplitude of the lifted back leg was required in this test. Again, balance stability was measured, but this time with a reduced support area of lower limb, together with small throws (half rotation) with a hoop. The best result for the right leg was 27 throws while on the left (uncomfortable side) it was only 13 – half the value of the comfortable leg. Both results were shown by the same gymnast. The weakest achievements for the right and the left side were 5 and 3 throws, respectively. The difference between the lowest results in the throws during the balance of both legs was insignificant. Some gymnasts, despite the reduced amplitude of the lifted leg and the rhythmic movement of the apparatus, failed to maintain a stable position of the body even when they performed it on their comfortable side. The group average values (13.71 – right side, 7.43 – left), as well as the big differences between the highest and the lowest achievement for both sides (right – 22, left – 10) make us believe that the group did not possess a developed enough coordination between right and left side symmetrically. Furthermore, it could be concluded that the balance stability of 32 gymnasts was developed to a very different degree, although all gymnasts had almost similar D1- scores (put in their routines) where this quality, especially in terms of rotations and balances is essential. Improving the left-side results in the future could lead to improvement in the right-side results as well. A comfortable side would be improved harder, if the uncomfortable one lags. This limits the gymnasts’ ability to perform complex movements in space with ease and finesse. This is also proved by the fact that there was a moderate correlation between the numerical values in T4 for both legs – 0.66 (Table 3).

Test 5 examines the coordination level between two apparatuses and body movement. The maximum number of successful attempts out of 10 made was recorded. The best achievement was 10 attempts, the worst – 1. This means that in T5 there is a realized maximum score and a result very close to the minimum (0). In the group, where the members should be selected on the basis of similar (high level) physical and technical qualities, some gymnasts apparently fulfilled the assigned tasks and others were greatly lagging behind (average score for the group – 6.14
successful attempts). This could be explained with the fact that the sample consisted of representatives of various countries with different methodology, history, and traditions in rhythmic gymnastics. An elite athlete in one country can have different sports characteristics from an elite athlete in another country, even though “an elite athlete” is considered a highly qualified athlete, competing on a professional and Olympic level. For the gymnasts who showed lower results than 5 successful attempts in T5, it was clear they had difficulties in executing their training plans regardless of the great number of approaches attempted. It is interesting to consider the correlation between T1 and T5 because both tests are performed with the same apparatuses, and the thing that makes them different is the exchange of the apparatuses in both hands in the starting position (T1 – right hand-hoop, left hand-ribbon; T5 – vice versa). The character of the movement is also not the same. The moderate correlation between the tests (0.60, Table 3) gives reason to believe that there is a possibility that gymnasts who can execute T1 well is also able to execute T5 successfully. In the basis of both tests was the coordination between left and right arm as well as the work with the same apparatuses and the body movement in rotation. This is proved by the fact that the gymnast who showed the best score in T5 (10) actually gave 8 successful trials out of 10 in T1 (close to the best result – 10 attempts). In T6, the time of rotations in different directions and planes of left and right side was measured. We recorded the shortest execution time. This showed the gymnast’s ability to coordinate the movements in space without the presence of a visual factor. It was observed that in all 32 gymnasts the test time of the left (uncomfortable) side was increased compared to this of the right one. We accept this as logical, because rhythmic gymnastics athletes train their comfortable side daily for many hours and very often the uncomfortable one is neglected. Therefore, coaches should develop asymmetry in the qualities of their competitors, or in the future, if the trend is not changed, the gap between the left and the right side will deepen (Mean: right – 2.95 sec.; left – 3.21sec.). Table 3 displays a strong correlation between T6 Right and T6 Left, which clearly shows that insufficient development of coordination qualities in one side (left) will necessarily affect the development of the same skills in the other (right side) and vice versa. Coaches should build complete athletes and not ones with limited capabilities and uncertainty for action. The best achievement for the right side was 2.30 sec. and the worst – 3.36 sec. The right (comfortable) side is definitely important for elite gymnasts, they present their routines mainly on it. However, developing the uncomfortable side should not become a second priority: firstly, because of health and secondly, because of beauty, elegance, and ease of execution. A highly qualified gymnast cannot waste time saving a situation, but rather take it as an opportunity to show virtuosity. The time difference between the highest and the lowest achievement (right side) in this group was 1.06 seconds. For the left hand, this difference was 1.2 seconds. We cannot claim that this is a small difference although there was a complicated circumstance (exclusion of a visual factor). In practice the speed of movements with rotations is important, because it gives time to react if the apparatus flies. It also gives time for placement of more exercises in gymnastics’ routines, which increases the final score.

**DISCUSSION**

Coordination skills in rhythmic gymnastics have multiple manifestations, ranging from intermuscular coordination, coordination between different parts of the body, working in different planes and directions, with different speed and muscle efforts; coordination between body and apparatus, body and two apparatuses, body-apparatus-space-music (rhythm, tempo). All of these define artistry. We look for the perfect symbiosis between all these components. Many professionals highlight that coordination skills are mostly genetically determined but they do not deny the possibility for their development in the future. The fact that fifteen of the gymnasts in this study, whose results were better than the average ones, actually showed that they could learn faster than the rest and understand the character of the movements of the test battery for relatively short time. We also found that gymnasts with better results in the tests succeeded to show better execution of most exercises in their competition routines and to cumulate more points than their colleagues (Achieved average D-scores – 9.2 vs. 6.95; Achieved average E-scores – 7.3 vs. 4.5). They even had fun experimenting with new and more-complex elements (related to structure or points) during training and were ready for complication of the routines, if necessary (coach’s observations). The gymnasts with weaker results learned the test exercises more slowly (therefore they failed to be effective in the first few attempts, they had no consistency in the correct execution) and looked like quite stressed when the tests were showed and at the end of the allotted time. They were not confident in their abilities. Coaches can improve these gymnasts’ results with a specific individual approach. They should design individual tasks, find the problem areas, and look for solutions which will
help their athletes to be calmer and more confident in the future tests. This research justifies the importance and the exceptional need of high level of coordination abilities. Specialists should be motivated to research this motor quality as a factor in elite rhythmic gymnastics and look for ways to increase the level of coordination development in athletes who lack it and optimize it in those who genetically possess it.

CONCLUSION
In most of the tests (T1, T2, T3, T4, T5) the differences in the best and the lowest achievement were great (Table.2). This reflected in the training tasks, where the most important was the achievement of scores close to the values set in the routines for difficulty (D-score) with minimal inaccuracies for E (execution). The gymnasts (15) with the results above the mean in all tests showed average D-score – 9.2 points and average E-score – 7.3 points from 3 control competitions in 3 different training days. The gymnasts (17) with results lower than the mean for all the tests, average D-score was 6.95 points and E-score – 4.5 points, obtained in the same 3 control competitions. Differences in the scores (D – 2.25 points; E – 2.8 points) of the individual components of the routines between the subsequently separated groups (one with scores above the mean value in the tests and one with scores below the mean value) confirmed the differences in the scores of the test battery. We will note that all 15 gymnasts (with higher final average scores for D and E) gave values above the mean for each test and there were no exceptions. So, the gymnasts who showed high results on 1 test also did well on the rest tests, despite the difference in the character of the movement and the change of the apparatuses. This ability for coordination allowed the girls to cope both with training and competition tasks regardless of the situation and the type of the task (test or routine or just separate exercises).

REFERENCES

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AMBIDEXTERTY DEVELOPMENT IN RHYTHMIC GYMNASTICS

Ana Kezić, Iva Macan & Ina Lalić
Faculty of Kinesiology, University of Split, Croatia

ABSTRACT
The execution of elements and compliance with choreography rules in rhythmic gymnastics greatly depends on ambidexterity. Most rhythmic gymnastics athletes, even elite ones, have trouble when using the non-dominant hand/leg/side of the body. Aim: This study aimed to determine to which extent rhythmic gymnastics beginner's training develops the relationship between the right and left side of the body (ambidexterity). We used a 6-month standard training process. Methods: The sample consisted of 40 participants (7-9 years old). New measuring instruments were designed to assess the degree of acquisition of specific techniques (5 in total, one for each apparatus). The athletes demonstrated the techniques with their dominant and then non-dominant side of the body and were videotaped. Three experienced judges made an assessment based on the videotaped material and the coefficients of asymmetry were calculated for each technique according to the prescribed formula. Results: The obtained reliability parameters showed that the analyzed tests with the corresponding criteria were a reliable measuring instrument and could be used to evaluate the ambidexterity in novice gymnasts. The 6-month standard training process numerically improved the total ambidexterity, although a significant difference was noticed only in the coefficients of asymmetry for the rope technique. Since the rope is one of the apparatuses that needs to be handled with both hands and, additionally, is well known to beginners, this result was not surprising. Conclusion: Rhythmic gymnastics training is largely aimed at the equal development of both sides of the body/arms/legs and the coefficients of asymmetry should be regularly checked throughout training to properly adjust training programs if necessary.

Key words: laterality, handedness, coefficient of asymmetry, specific technique

INTRODUCTION
Rhythmic gymnastics (RG) is a sport of aesthetic and harmonious movement accompanied by dynamic movements in harmony with rhythm and music. It is a sport marked by grace, the beauty of movement, elegance, and a specific combination of dance, ballet, gymnastics, and sports competition. Rhythmic gymnastics requires a high degree of physical, technical, and psychological ability to present a perfect performance of complex elements while manipulating with apparatus (Laffranchi, 2001). Besides this, rhythmic gymnastics is a complex sport that requires a large amount of physical and mental stress during the competition (Bobo Arce, Méndez Rial, 2013). Observing the structure of the human movement system, there is no perfect symmetry. The normal upright position of a man divided into a coordinate system shows a horizontal plane that divides the body into upper and lower halves, which are extremely different. The forehead plane divides the body into posterior and anterior halves, which also differ. However, the sagittal plane divides the human body into right and left sides, which are very similar in content, but not identical. When one arm or leg is favored, an asymmetrical posture is formed (Bjelica, 2007). From the aspect of rhythmic gymnastics, there is a whole range of asymmetries in the application of technical elements. Most athletes, even elite ones, perform actions with the dominant hand/leg/bodyside more easily than with the other hand/leg/bodyside. The word “ambidextrous” is derived from the Latin root “ambi”, meaning “both” and “dexter”, meaning “right or favorable”. Ambidexterity is the ability to use the left and right arm or the left and right leg equally well. It is especially valued in sports games, such as football, but also in aesthetic movements where the motor performance of both sides of the body directly affects the competitive success (Bozanic, Miletić, 2011). The problem of developing ambidexterity through the training process follows not only sports of aesthetic movements such as rhythmic gymnastics but also other sports where there are also elements performed by the right and left side of the body. Top coaches’ goal is for their athlete to bring their technique of performing elements to perfection with their motor skills and other virtues, so they discovered that symmetrical exercises improve the final results of the athlete’s skills. Ambidexterity or bilateral skill in executing motor tasks improves performance. Symmetrical preparation is recognized as a factor responsible also for expanding and improving the coordination ability of athletes in general (Lyakh, Sadowski, Witkowski, 2011). The coefficient of asymmetry (CA) is closely related to ambidexterity in the training process, and it reflects the relationship between the motor performance of both sides of the body. The opinion that left-handers are more successful athletes in many sports due to innate neurophysiological advantage and tactical and strategic aspects in team sports, is supported in sports circles and also by scientific
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research (Cavill, Bryden, 2003; Barenett, Corballis, 2002; Grouios et al., 2000) although some authors report that dominant right-handers had a greater predisposition to use both hands in a particular dance motor task, compared to left-handers (Grigore, 2017). The CA is calculated after the athlete adopts a certain element, after which the coach evaluates the technical level of the performance. Also, after the athlete masters the technical element in the non-dominant side, the coach evaluates it and calculates the CA (Jastrjembskaia, Titov, 2016). The number obtained indicates the ratio of motor performance of the dominant and non-dominant side of the body for the technical element whose performance was evaluated. Logically, the lower the percentage, the greater the ambidexterity. To get the whole perspective, it is necessary to choose a few specific technical elements that can be performed on both sides of the body. In this way, it is possible to gain a complete insight into the ambidexterity of the trainee in a particular sport or sports discipline, discover what needs to be worked on, and thus plan and program the training process to achieve the highest possible level of motor performance.

In elite RG, the desired coefficient of asymmetry for performing technical elements with hoop, ball, and ribbon is 41% and less, and for clubs and rope - 21% or less (Jastrjembskaia, Titov, 2016). These percentages have probably decreased over time and the evolution of the Code of Points, so rhythmic gymnastics today requires a very high level of ambidexterity of gymnasts. It is important to point out that to assess ambidexterity, i.e., to calculate the asymmetry coefficient, the trainee must reach a high level of performance stability, both with the dominant and non-dominant side of the body, so a coach can assess the ambidexterity as accurately as possible.

Ambidexterity greatly contributes to the aesthetic appearance of the performance of elements in rhythmic gymnastics (Bozanic, Miletic, 2011). Artistic performance is visible through creativity and talent, but also movement control. Since technical mistakes in the execution of numerous elements often occur, especially in younger categories, the most interesting ability is the one that requires several other abilities to improve it, and that is the asymmetry of the right and left sides of the body, hence ambidexterity. Since elite rhythmic gymnasts have already developed their ambidexterity on a high level, their development in that field would not be noticeable. So, it is logical to track the development of ambidexterity on a sample of beginner rhythmic gymnasts. The question is in which pace the ambidexterity develops and if it equally develops using all apparatuses?

**Aim of the study**

The basic aim of the study was to investigate the influence of a 6-month standard RG training on the development of ambidexterity in beginner gymnasts. Specific aims of the study were (1) to construct and validate the measuring instruments for assessing the specific techniques of RG with left and right body side; (2) to analyze the differences in coefficients of asymmetry between initial and final measurement for each apparatus; and (3) to analyze the differences in the general coefficient of asymmetry between initial and final measurement.

**METHODS**

The sample consisted of 40 female participants, rhythmic gymnastics practitioners. All were members of the same RG club from Croatia and all had been practicing RG for over one year (1.2±0.2) and had not yet entered formal competitions. The chronological age of the participants was 8 years (7 to 9 years). Children without health problems and motor disorders were included in the research (all had a valid medical exam). All children participated in at least 80% of the training sessions and at both measurement sessions. Their standard training included sessions three times per week for 1.5 hours, led by the same two coaches. Before the survey, each respondent was asked about their willingness to participate, and parents also signed an official consent for the child’s participation in the investigation.

The selection of tests for the assessment of technical skills was performed primarily according to the existing apparatus in rhythmic gymnastics in such a way that one test was constructed for each apparatus, which was then performed with the right and left side of the body. In total, 5 (10) tests were constructed: spirals with the rope folded in two (gymnasts needed to do 3 correct circles with the rope), sagittal throwing and catching the hoop (inside hoop catch), figures eight with the ball, horizontal snake with the ribbon (gymnasts needed to maintain 4 correct snakes), and horizontal figure eight with the club (Figure 1). All participants were videotaped by their coach doing the tests individually, in a separate gym with a 1-minute rest between each test. A qualitative assessment approach was used to evaluate each test/technique in such a way that certain criteria had to be met for a particular assessment. The Likert grading scale from 1 to 5 was used. The evaluation was performed by three judges with experience in judging RG (Croatian national judges and one FIG brevet 3 judge), according to clearly
set performance criteria. The assessment was made based on video material and the judges were completely independent of each other. After the judges evaluated all the skills, raw grades were entered in the following formula (Jastrjembskaia, Titov, 2016):

\[
CA = \frac{D - ND}{D}
\]

where:
- \(D\) is the dominant side of the body
- \(ND\) is the non-dominant side of the body

Test 1. Rope
Test 2. Hoop
Test 3. Ball
Test 4. Ribbon
Test 5. Clubs

**Figure 1. Performance of all 5 tests (all tests were done with the right and then with the left arm/body side)**

The number obtained indicated the ratio of motor performance of the dominant and non-dominant side of the body for the technical element whose performance was evaluated. Logically, the lower the number, the greater the ambidexterity. To get the whole perspective about the participants' ambidexterity, all the grades were summarized and divided by five, so a general CA was obtained.
After the initial check-up at the beginning of the season, the trainees continued with their planned training in the clubs. They trained for 1.5 hours three times per week. The training program consisted of a warm-up, learning body and apparatus techniques (both sides of the body), learning small choreographies, and stretching. After six months from the initial verification, the final testing of the same techniques was done according to the same testing protocol as in the initial check-up.

All data were presented using mean±standard deviation (SD) and minimal (MIN) and maximal (MAX) results. Cronbach alpha coefficient was used for testing the inter-rater reliability and normality of distribution was tested with the use of the Kolmogorov-Smirnov test. Furthermore, a series of t-tests for dependent samples was used to check the differences between the initial and final measurements of ambidexterity. For all statistical analyses, the type one error was set at α=5%. All calculations were performed with the use of the data analysis software system Statistica v.13 (TIBCO Software Inc., USA).

RESULTS AND ANALYSIS

When looking into the Cronbach's alpha coefficient values in the initial and also the final measurement, we can see they ranged from 0.92 to 0.99 for some tests. Overall, these are very high correlative values. Furthermore, the results of the Kolmogorov-Smirnov test for the normality of distribution showed that all variables were normally distributed.

Table 1. Descriptive data on raw grades for each skill (apparatus) with right and left bodyside

<table>
<thead>
<tr>
<th></th>
<th>INITIAL</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>CLUBS R</td>
<td>2.45±1.44</td>
<td>4.55±0.93</td>
</tr>
<tr>
<td>CLUBS L</td>
<td>1.76±1.07</td>
<td>4.36±0.83</td>
</tr>
<tr>
<td>BALL R</td>
<td>2.06±1.50</td>
<td>4.56±1.05</td>
</tr>
<tr>
<td>BALL L</td>
<td>1.90±1.48</td>
<td>4.31±0.68</td>
</tr>
<tr>
<td>ROPE R</td>
<td>3.41±1.41</td>
<td>4.86±0.58</td>
</tr>
<tr>
<td>ROPE L</td>
<td>2.81±1.50</td>
<td>4.70±0.46</td>
</tr>
<tr>
<td>RIBBON R</td>
<td>3.16±1.48</td>
<td>4.58±0.92</td>
</tr>
<tr>
<td>RIBBON L</td>
<td>2.80±1.31</td>
<td>4.30±0.80</td>
</tr>
<tr>
<td>HOOP R</td>
<td>2.71±1.53</td>
<td>4.25±1.26</td>
</tr>
<tr>
<td>HOOP L</td>
<td>2.48±1.41</td>
<td>3.91±1.01</td>
</tr>
</tbody>
</table>

Legend: R – right bodyside, L – left bodyside

The descriptive data on raw grades for each skill (Table 1) revealed that the mean values of each observed test showed higher values in the final than the initial measurement session. Also, higher values were noted for skills performed with the right than the left body side, for all individual RG skills. But, to get a real insight into the ambidexterity, coefficients of asymmetry were calculated for each apparatus.

Table 2. Descriptive data on calculated coefficients of asymmetry for each skill (apparatus) in initial and final measurement point; results of t-test for dependent samples between the two measurements (p – the level of significance)

<table>
<thead>
<tr>
<th></th>
<th>Mean±SD</th>
<th>MIN</th>
<th>MAX</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA_CLUBS_I</td>
<td>0.22±0.24</td>
<td>0.00</td>
<td>0.75</td>
<td>0.07</td>
</tr>
<tr>
<td>CA_CLUBS_F</td>
<td>0.09±0.14</td>
<td>0.00</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>CA_BALL_I</td>
<td>0.08±0.15</td>
<td>0.00</td>
<td>0.50</td>
<td>0.90</td>
</tr>
<tr>
<td>CA_BALL_F</td>
<td>0.08±0.11</td>
<td>0.00</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>CA_ROPE_I</td>
<td>0.20±0.25</td>
<td>0.00</td>
<td>0.80</td>
<td>0.01</td>
</tr>
<tr>
<td>CA_ROPE_F</td>
<td>0.05±0.10</td>
<td>0.00</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>CA_RIBBON_I</td>
<td>0.20±0.22</td>
<td>0.00</td>
<td>0.66</td>
<td>0.08</td>
</tr>
<tr>
<td>CA_RIBBON_F</td>
<td>0.08±0.15</td>
<td>0.00</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>CA_HOOP_I</td>
<td>0.12±0.16</td>
<td>0.00</td>
<td>0.50</td>
<td>0.09</td>
</tr>
<tr>
<td>CA_HOOP_F</td>
<td>0.05±0.08</td>
<td>0.00</td>
<td>0.25</td>
<td></td>
</tr>
</tbody>
</table>

Legend: CA – coefficient of asymmetry, I – initial measurement, F – final measurement

Table 2 reveals the mean values of the CA for each skill in both measurements. According to those values, numerical progress was made during the 5-month exercise in almost all techniques. According to the significance levels of the t-test, we notice a statistically significant difference between the CA at
the initial measurement and the CA at the final measurement in only one technique, the one with the rope (p = 0.01), while for other apparatus this progress was not statistically significant. Also, minimal and maximal values revealed that there were participants who already had excellent ambidexterity since their CA was 0.00 but also that the rope technique was the one with the highest (worst) level of ambidexterity with even 0.80, thus 80%.

**Table 3. Results of the t-test for dependent samples on the total coefficient of asymmetry between the initial and final measurement point**

<table>
<thead>
<tr>
<th></th>
<th>INITIAL</th>
<th>FINAL</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA TOTAL</td>
<td>0.16</td>
<td>0.07</td>
<td>1.42</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Legend: CA – coefficient of asymmetry

The t-test for dependent samples we used to test the difference between the initial and final measurements in the general CA showed that no statistically significant difference was found between the measurements.

**DISCUSSION**

To investigate the level of ambidexterity of rhythmic gymnastics novices, it was necessary to develop valid tests that would be used to assess the technical skills of RG. Thus, one of the partial goals of the research was the construction and validation of measuring instruments for assessing specific RG techniques (skills). Inter-rater reliability parameters, in this case, showed how the applied tests are reliable measuring instruments and how they can be used to assess technical skills in novice gymnasts. To obtain quality and as accurate as possible results of further statistical processing, it is necessary to successfully differentiate the participants, as evidenced by the results of the Kolmogorov-Smirnov test. Although not the most accurate, it is certainly the simplest and most commonly used method. In the case of this study, no significant deviations from the normal distribution were found.

After calculating the coefficients of asymmetry, it is obvious that the rhythmic gymnastics novices initially showed the best ambidexterity in the ball technique (figure eight). This result in rhythmic gymnastics is surprising because it is a demanding element for beginners that is very difficult to perform with a non-dominant hand. However, this seems to be the only technique that included the movement from the shoulder joint, not the wrist. As it was proven that it is very hard for children this age to control and perform movements from the wrist (Miletic, Katic, Males, 2004), this result could be easily explained. When comparing it to the post-test measurement, their ball skills ambidexterity didn't improve significantly, probably because the calculated coefficient of asymmetry was already very high so there was very little space for improvement. On the other hand, the greatest difference occurred in the rope technique (spirals with the rope folded in two) where the only statistically significant difference between the two measurements was recorded. The reason could be that, although it demands the wrist joint, this technique is quite easy to acquire and the participants had the most success with it. Other techniques (with hoop, ribbon, and clubs) and their coefficients of asymmetry had numerically increased, which indicates better ambidexterity, however, without statistically significant differences. The probable reason is that these techniques and skills are complex, done from the wrist joint, and demand more time of training that the observed period of six months. The latter is noticeable when looking into the overall coefficient of asymmetry that didn't show significant differences between initial and final measurements. It seems that a six-month training process in novices is not enough to significantly improve their ambidexterity skills, and consequently, their performance.

**CONCLUSION**

What is important to emphasize, RG training does develop the ambidexterity skills in beginners which is very important for success in this sport (Bozanic & Miletic, 2011). In addition to success in sports, the very ability of ambidexterity is important for functioning in everyday life, and ultimately for avoiding postural disbalances. The demands of top sports today are quite high and the pursuit of success in some sports necessarily leads to the forcing of asymmetric training, which hen very often ends with health problems for athletes (distortions, overloads, etc.). Therefore, we can conclude that rhythmic gymnastics training should be largely focused on the equal development of both sides of the body/arms/legs, so it can have a positive effect on the overall health of the trainee.

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EXPERIMENTAL RESEARCH ON THE INFLUENCE OF CORE TRAINING ON THE DIFFICULTY OF RHYTHMIC GYMNASTICS

Qing Han
College of Physical Education and Sports, Beijing Normal University, Beijing, China

ABSTRACT
Rhythmic Gymnastics is known for its high level of difficulty and complex motion, which requires gymnasts to stabilize their center of gravity especially when performing rotation and balanced moves. The focus group in the experiment consisted of 6 athletes from the youth group of China's National Rhythmic Gymnastics team. To evaluate the impact of core training on the athletes and specifically on the performance of difficult moves, athletes in the focus group underwent 12 weeks of core training. Evaluations were conducted comprehensively, of which observation, experiments, interviews, and video analytics were incorporated. The conclusions derived are the following: (1) Post-training results: Functional Movement Screen FMS Score improved by 27%; joint stability increased as smoothness of kinetic chain increased in sagittal plane; (2) Indices correlating with core stability and rotation explosiveness demonstrated significant improvements in post-training experiments (P<0.01); (3) Inconsistency in the dynamic balance capability showcased a downward trend. The result from proprioception test showed consistent improvements on bilateral sides. Weakness of single axis tests yielded difference after core training (P<0.05). Motor control for bilateral muscles converged after training; (4) Successful completion of core training correlated positively with the high-quality performance of difficult moves for rhythmic gymnasts. Quality measurements of difficult moves showed differences in post-training test (P<0.05).

Key words: Rhythmic Gymnastics, Difficulty, Core Stability

INTRODUCTION
The core of rhythmic gymnastics competitions stresses increasing the difficulty level, improving performance quality, and embodying high artistic expression (Kioumourtzoglou et al., 1997). This leads to the expectation that rhythmic gymnasts should not only evoke the artistic beauty of rhythmic gymnastics through maintaining fit physical appearance, but also come equipped with strong overall competitive ability and high level of fitness reservation ability to adjust to the ever-changing competition rules and expectations of difficult moves.

The core area incorporates the whole body (Akuthota & Nadler, 2004), which includes chest and spine. Other expert view states that the core area of the body consists of rectus muscle, transverse abdominal muscle, oblique muscle, dorsi muscle, lower back muscle and erector spinae, together with muscles near the hip joint - gluteus, lumbar muscle, and biceps muscle (Isaacs, 1998). According to Paul J. Goodman, over 29 muscles consisting of rectus muscle, musculus obliquus externus abdominis, abdominal internal oblique muscle, transversus abdominis muscle, thoracolumbar fascia, quadratus lumbarum muscle, iliopsoas muscle, gluteus and erector spinae located in the LPH (lumbo-pelvic-hip) complex are considered core muscles (Isaacs, 1998).

Core stability training was first implemented in physical medicine and rehabilitation and increasingly has gained popularity in sport fitness since the early 90s (Li, 2009). Now, core stability training receives wide acclaim in athletic sports, for its experimental values in studying the athletes’ physical training to yield insights on prevention and rehabilitation of athlete-related injuries.

Research shows that core stability training has the following effects: improves the body’s ability to control its muscles in an unstable state, enhances body balance, improves the training effects on small muscle groups in the deep tissues, coordinates the strength output of large and small muscle groups, enhances sports functionality and prevents sports injuries (Law et al., 2007).

Does the core stability training have a positive impact on the completion of difficult movements by rhythmic gymnasts? How can core stability training be effectively integrated with rhythmic gymnastics? How can we optimize a training plan to effectively improve the performance of certain movements? In consideration of the above questions, the article examines relevant issues to the core stability training of rhythmic gymnasts, which proffers impactful insight for the improvement of athletes’ basic movement performance as well as enhancement of athletic skills (Tournis et al., 2010).

Objectives
The research aims to uncover the correlation between core training and the performance of difficult movements by rhythmic gymnasts through evaluation of the performance of difficult movements under core
training intervention (Cavallerio et al., 2016). In lieu of specific components of core training designed tests were conducted with the selected gymnasts to extrapolate the relationship between core strength and movements such as balancing and rotating.

**METHODS**

**Experiment Subjects**

We selected 6 athletes from the youth group of the Chinese National Rhythmic Gymnastics Team as experiment subjects.

**Table 1. Basic Information of Athletes (N=6)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Age</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LX</td>
<td>Female</td>
<td>13</td>
<td>155</td>
<td>35.2</td>
</tr>
<tr>
<td>YSY</td>
<td>Female</td>
<td>13</td>
<td>152</td>
<td>34.5</td>
</tr>
<tr>
<td>JKB</td>
<td>Female</td>
<td>13</td>
<td>156</td>
<td>36.8</td>
</tr>
<tr>
<td>HYH</td>
<td>Female</td>
<td>13</td>
<td>155</td>
<td>33.8</td>
</tr>
<tr>
<td>WJY</td>
<td>Female</td>
<td>13</td>
<td>149</td>
<td>32.9</td>
</tr>
<tr>
<td>SJY</td>
<td>Female</td>
<td>13</td>
<td>155</td>
<td>37.5</td>
</tr>
</tbody>
</table>

**Experiment Design**

The entire experiment consisted of three tests: initial screening test, (observation phase), pre-experiment test, (intervention experiment), and post-experiment test. Location: National Rhythmic Gymnastics Team Training Center. Experiment Timeline: The intervention experiment lasted for 12 weeks, with 3 physical training sessions per week. Each session lasted for 120 minutes, half of which was taken up by core training. The hours of physical training sessions per week accounted for 15% of total training hours.

**Table 2. Physical Training Timetable and Content Outline**

<table>
<thead>
<tr>
<th>Training Period</th>
<th>Content Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every Monday 8:00 - 10:00</td>
<td>Ballistic Training, Core Training</td>
</tr>
<tr>
<td>Every Thursday 10:00 - 12:00</td>
<td>Coordination, Agility Training, Core Training</td>
</tr>
<tr>
<td>Every Saturday 16:00 - 18:00</td>
<td>Aerobic Endurance Training, Core Training</td>
</tr>
</tbody>
</table>

**Test Indices**

In consideration of expert opinions in the field of physical training and rhythmic gymnastics via surveying and interviewing, we selected the following four indices as test indices of interest. The index selection also takes into account special features, accompanied by Development and Evaluation Methods of Russia's Rhythmic Gymnastics Training (Isaacs, 1998). (1) FMS (Functional Movement Screen) Index: Four movements were selected as most closely relevant to the research, and the scoring standard was categorized into four levels from 0 to 3. Scores between 1 and 3 get assigned based on athlete's performance of tested movements; if there exists pain throughout the movement, a score of 0 is assigned. (2) Suspension Stability Test: While the gymnast maintains the qualified movement, we measure the distance between legs. (3) MJS Dynamic Balance and Proprioception Test. (4) Specialized Motion Assessment: Expert rating on the video footage of athletes performing balancing and rotating movements prior to and after the training.

**Experiment Plan**

Twelve weeks of core stability training on the focus group can be categorized as follows: (1) Training external conditions: stable and unstable conditions. (2) Loads: Freehand and weight-bearing loads. (3) Motion directions: one-dimensional and multi-dimensional motions. (4) Force: static, dynamic and alternating static – dynamic force. Based on Jeffrey’s Developing a Progressive Core Stability Program (Isaacs, 1998), and fully considering the trajectory and technical characteristics of difficult movements in rhythmic gymnastics, the research concentrated on examining the ultra-large ballistic strength of the waist, abdomen and hips, and the ability to control the core area of the body as well as the neuromuscles.

The training methods of this study consisted of:

![Figure 1. Training Methods](image-url)
RESULTS AND ANALYSIS

Functional Movement Screen Test (FMS)
The purpose of the FMS test is to better understand the strengths and weaknesses of the 6 Junior athletes of the National Rhythmic Gymnastics Team, to evaluate their bodies’ basic flexibility and balance, to identify the existing deficiencies and to provide the subsequent corrections (Fotiadou et al., 2002). Moreover, this system helps with the formulation of the athlete’s personal training plan, focusing on the improvement and strengthening of their weaknesses. Post-test a significant improvement can be reported for all the athletes, with an overall growth rate of 27%. It must be noted that one athlete scored 0 on the in-line lunge due to injury pain, thus negatively influencing the entire group’s score.

TRX Suspension Stability Test.
Figure 3 shows that at post-test there was a significant difference in suspension stability ($P<0.01$). When using the Unilateral Lower Limb Suspension, the free leg is able to open laterally at a wider angle, with a more noticeable improvement inside bridge support. This result highlights the lack of bilateral muscle groups training in pretest observation. At the same time, during the test the athletes demonstrated a better muscle strength and control of the right side of the body compared to the left side, which reveals the presence of a dominant right side in the athletes (Hutchinson, 1999).

MJS Dynamic Balance and Proprioception Test
Figures 4, 5 and 6 show that there was no significant difference in the total stability index pre and post-test. The result was influenced by the small size of the sample taken into consideration, or by the pre-existing dynamic balance skills already possessed by the Rhythm Gymnastic athlete’s pretest. From the line graph, it is evident that following the experimental intervention, the athletes test error decreased significantly, while the stability index revealed an upward trend. Proprioception Test – Utilizing an accurate tracking test, the line graph shows a decrease in the tracking error of both sides of the body, with a greater decrease in the right-side $p<0.05$, and a general improvement of the multi-axis proprioception ability.
The general regression method of SPSS multiple regression was used for the experimental data of special action test results, and the independent variable was entered into the prediction equation by the enter method. As shown in the figure, the core training had a positive impact on the improvement of the quality of difficult movements of rhythmic gymnasts. There were very significant differences in the score of rotation and kneeling balance time (P < 0.01), and there was a significant difference in the balance time of standing (P < 0.05). The athlete's posture adjustment, balance control, fixed time extension improved significantly, and the overall performance tended to be smooth and coordinated. And through the equation substitution, it is concluded that the control ability of the core area on one side of the balance dynamic leg plays a more important role in completing the whole balance action (Law et al., 2007).
Table 1. Balance Test Results (n=6)

<table>
<thead>
<tr>
<th>Test Item</th>
<th>1st Mean Value $\bar{x} \pm s$</th>
<th>2nd Mean Value $\bar{x} \pm s$</th>
<th>3rd Mean Value $\bar{x} \pm s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance with Support on the Knee Forward (Right Support)</td>
<td>23.833 ± 12.189</td>
<td>24.5 ± 11.778</td>
<td>57.833 ± 21.729**</td>
</tr>
<tr>
<td>Balance with Support on the Knee (Left Support)</td>
<td>22.667 ± 12.987</td>
<td>24.167 ± 11.94</td>
<td>56.333 ± 25.105**</td>
</tr>
<tr>
<td>Balance with Support on the Knee (Right Support)</td>
<td>26 ± 8.485</td>
<td>26 ± 10.02</td>
<td>75.667 ± 22.187**</td>
</tr>
<tr>
<td>Passé Balance (Left Support)</td>
<td>9.5 ± 6.124</td>
<td>11.167 ± 6.5</td>
<td>44.833 ± 32.987*</td>
</tr>
<tr>
<td>Passé Balance (Right Support)</td>
<td>12 ± 7.042</td>
<td>15.833 ± 10.05</td>
<td>32.667 ± 21.676*</td>
</tr>
</tbody>
</table>

NOTE: ** means p<0.01, * means p<0.05

Table 2. Rotation Test Results (n=6)

<table>
<thead>
<tr>
<th>Test Motion</th>
<th>1st Mean Value $\bar{x} \pm s$</th>
<th>2nd Mean Value $\bar{x} \pm s$</th>
<th>3rd Mean Value $\bar{x} \pm s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passé Rotation 720°</td>
<td>4.833 ± 0.408</td>
<td>5 ± 0.633</td>
<td>8.167 ± 0.753**</td>
</tr>
<tr>
<td>Attitude Rotation 720°</td>
<td>5 ± 0.632</td>
<td>5.5 ± 1.049</td>
<td>7.833 ± 0.753**</td>
</tr>
</tbody>
</table>

NOTE: ** means p<0.01

DISCUSSION

The Impact of Core Strength Training on the FMS Test. Following the FMS test, there was an evident improvement in the athletes’ joint stability, overall stability, and movement quality (Jeffreys, 2002). The symmetrical stability of athletes’ torso in sagittal plane was improved, with a better transmission of strength between the upper and lower limbs, creating a kinetic chain. There was also an evident increase in stability in the asymmetrical body rotation, which still needed improvement. Individual team members were able to complete the movement on the same side, indicating the athletes’ potential and room for improvement. Due to the difficulty and the sequencing of the movements in Rhythmic Gymnastics, there are many symmetrical and asymmetrical power transmissions between the upper and lower limbs in movements such as jumps, rotations, acrobatics, throwing the apparatuses, etc. The torso must be stable in order to transfer enough power into each movement and to increase the quality of the movement, so as to avoid injury.

Suspension Stability Test
In Pretest, it was found that the athletes’ core and back muscles were stronger and more stable compared to the lateral muscles. This is in line with the program’s traditional emphasis on the front and back of the body’s major muscle groups, while neglecting the lateral and deep layer muscle groups. Therefore, the athletes’ control on the side bridge and other similar indicators are generally weak (Vicente-Rodriguez et al., 2007). The equipment improves neuromuscular proprioceptor function by providing a condition in which the body constantly needs to adjust its balance. At the same time, it stimulates the engagement of muscle groups that have been neglected in traditional lumbar and abdominal training, with a significant improvement of strength transmission and particular focus on coordination and muscle control. The progress noticed during the Suspension Stability Test revealed that the athletes still have room for improvement.

Dynamic Balance and Proprioception Test.
Proprioception is the conscious or unconscious perception of the spatial position of the body mediated from neurons within muscles, joints and ligaments, and it includes position sensation and motor sensation. Most movements present in Rhythmic Gymnastics are open kinetic chain exercises with little or no support, which increases the requirements for the athletes’ muscle proprioception control, the strength in the extension of the extremities, the stability of the core area, and the coordination of total body strength. During the routine movements, the position of the body and of the apparatus itself, the angle of the body, the throw of the apparatus and the stability of the limbs, are all precisely controlled by the proprioceptors, which are fundamental for the
athletes to build their skills. According to the experimental test results, the difference in dynamic balance between the two sides of the body tended to decrease, but there was no statistical difference. The reason behind this result is relatable to the improvement of the vestibular apparatus functions through the implementation of the Swiss ball, air cushion, suspension lines and other training methods which focus on external stimulation of balance and the body’s constant need of adjustment, thus strengthening the nervous system control efficiency (Zetaruka et al., 2006). From the first stage of the test, it is evident that the gymnasts’ proprioceptive trajectory error was mainly concentrated in the ante lateral location of both sides of the body. After a particular focus on the core muscle group, the lateral calf muscle group was added into the training. The post-test results showed a noticeable improvement in both groups, demonstrating the efficiency of the training method, and significantly reducing the risk of potential injury.

Balance and Rotation Difficulty Test
Pretest research revealed that due to the lack of strength in the core muscle group and the hip muscle group, the athletes tend to compensate with the activation of the torso and the arms. This not only affects the fluidity and quality of the movement and posture, but also impacts the range and speed of the motion, making it less pleasing to the eye. Post-test, the gymnasts showed a better control of posture, managing to maintain the upper body in a perpendicular position, which improved the athletes’ balance, as well as their posture in stationary positions. There were significant differences in the balance retention time before and after the experiment (P<0.05), with a significant increase of balance in the kneeling position (P<0.01). Rotation Difficulty – Core strength is fundamental in rotation. If the core muscles are not strong enough, once the movement has started, the muscle direction might change or disperse causing the body axis to become unstable or tilt. Set in the middle of the kinetic chain, the core muscles are those that support athletes in rotation. Hence a good control of the core can help athletes to perform a good rotation and is fundamental to rapidly progress into a different position from the rotation, thus completing a compound rotation.

CONCLUSION
The movements of rhythmic gymnastics are usually multi-dimensional, multi-joint and with a variable trajectory. Most of the movements are performed on one leg or without support (Zetaruka et al., 2006). This research demonstrates that through 12 weeks of core strength training the athletes improved their movement functions, stimulated the deep muscle groups in the core area through movement that challenge balance. Dynamic balance and proprioception were improved. Activation of the core to stabilize the trunk and transfer muscle strength during the completion of movements was ensured, and stability in movement construction was established.

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RHYTHMIC GYMNASTICS IN THE CONDITIONS OF PANDEMIC COVID-19 – PSYCHOLOGICAL PROBLEMS AND PEDAGOGICAL CONSEQUENCES

Tatiana Iancheva
National Sports Academy „Vassil Levski”, Sofia, Bulgaria

ABSTRACT

The pandemic COVID-19 constituted one of the greatest ordeals the world has seen in the last decades. Social isolation has rhythmic gymnast lives completely and brought a number of consequences. The aim of this study was to investigate the dominant psychic conditions and perfectionism and their relation to the preferred coping strategies during the pandemic COVID-19 among rhythmic gymnasts from Bulgaria and to outline their specificity depending on their qualification.

The research was done among 53 rhythmic gymnasts, aged between 15 and 26 years, divided into groups according to their qualification. The research methods included: 1) Multidimensional Perfectionism Scale (FMPS, Frost, Marten, Lahart & Rosenblate, 1990), adapted for Bulgarian conditions by T. Iancheva, 2009; 3) Profile of Mood States (McNair, Lorr, & Droppleman, 1971); 4) Approach to Coping in Sport Questionnaire (ACSQ-1; Kim 1999; Kim & Duda, 1997).

There are significant differences depending on qualification. The specific role of adaptive and maladaptive perfectionism was viewed in relation to the dominant psychic conditions during social isolation and the preferred coping strategies.

Key words: Rhythmic gymnasts, Perfectionism, Mood States, Coping strategies, COVID-19

INTRODUCTION

The pandemic COVID-19 put the world of sport against serious ordeals. The usual lifestyle of those engaged in sport – athletes, coaches, sports-technical personnel, menagers underwent a serious transformation. From a lifestyle full of physical activity, numerous journeys, competitions, self-expression, and success seeking, strong emotions provoked by sports competitive activites, they had to adapt to a way of life in an isolated environment. In the beginning they could not practice their usual activity, then they had to engage in activities bearing unclear prospects and fear of getting diseased. In this unusual environment - full of tension and lack of clarity, the need to adapt, to actively cope and to anticipate the sports-competitive activities in the conditions of COVID-19 is becoming much more crucial.

Sport, and rhythmic gymnastics in particular, is facing very serious challenges – sports-technical psychological, pedagogical, administrative, which threaten its normal functioning. The pandemic COVID-19 first led to a cancellation of the whole sports calendar. The most serious blow was of course related to the cancellation of the most significant sports event – the Summer Olympic Games in Tokyo, 2020. So far, only the World Wars and a few political riots have prevented some nations from taking part in the Olympics. Each part of the chain of sports activities have suffered – gymnasts, teams, coaches, sports-technical personnel, media, business, sports education. All international – world and continental championships, world cups, Olympic qualifications, international tournaments, as well as national championships were cancelled. Now we have only the European championship in Kiev, but many countries declined the invitation to take part, and others perhaps will give up participating too. While the restrictions for the unorganized sport gradually were abolished, the elite, professional sport is facing extremely serious challenges – both sports-technical and psychological, maybe to a greater extend. The uncertainty about the future, lack of certain reference points about the way of preparation and forthcoming competitions, fear of probable infection, fear of travelling and the related risks of desease, competitions without any audience, danger of an overall restructuring of sports life, etc. are a premise for increasing stress, for problems related to motivation and maintaining athletes and coaches' activity, to the overall planning and management of preparation, the choice of coping strategies, emotional reactions, etc. COVID-19 affected gymnasts, coaches and sports organizations in a different way. There are understandable problems related to the lack of clarity and anxiety connected to the qualifications, preparation planning, fitness maintenance in a state of uncertainty and lack of information regarding the forthcoming sports calendar. This leads to a number of psychological consequences for the gymnasts: fear they
will be less physically prepared for future competitions and will be at a disadvantage compared to their rivals. They are wondering what they are about to do if the Olympic Games are to be cancelled again and whether to continue their sports career. Other issues they are unclear about are how they will cope with social isolation during their preparation in the current situation, how they will maintain their everyday motivation and activity, etc.

On the one hand, isolation is very important because it is connected to preserving gymnasts and coaches’ health and life, but on the other hand, it can influence one’s psyche considerably especially if it lasts for a longer period of time, and this is already a fact (Brooks et al., 2020). It can also lead to a number of negative psychological effects – stress, depression, increased anxiety, loss of motivation, decrease in activity, goal setting problems, irritability, aggressive reactions, risky behavior, etc.

The application of adequate psychological and pedagogical interventions aiding gymnasts and coaches requires an objective analysis based on real experimental data. What are the real consequences among gymnasts with different level of qualification; how do they react, experience, interpret and cope with the current situation – these are questions which seek their solution on the basis of objective empirical data.

The analysis of the scientific publications as regards the psychological consequences from self-isolation in conditions of pandemic is still episodical, and there are no such publications in the field of rhythmic gymnastics. Part of the surveys are related to the analysis of the psychological aspects of athletes’ behavior in conditions of self-isolation – regulating emotions, overcoming stress, stability, psychic health and wellbeing, the role of athletes as role models and motivators of behavior during a pandemic (MacIntyre et al., 2020). Others emphasize on knowledge regarding perceiving risk and uncertainty related to the pandemic, the role of social influence, behavior, emotions, stress, coping, wellbeing and social trust, emotional reactions to communication (Sokolowska, Ayton and Brandstätter, 2020). Wang, Wang, Yang (2020) pointed out that COVID-19 affected not only the physical health of Chinese people, but also their psychological health.

Van Bavel et al. (2020) paid attention to the significance of research and unifying the efforts in studying the consequences of the pandemic on people’s behavior. Schinke, Papaioannou, Henriksen, Si, Zhang, & Haberl (2020) believe that COVID-19 has changed our civil life and has set a number of issues and possibilities before sports psychologists related to sports indications, physical activity and health. Some authors (Zhou, et al., 2020) analyzed emotions and coping strategies which people use during a pandemic. Proneness to risky behavior and its consequences make researchers look for their relation to different coping strategies.

The application of adequate psychological interventions aiding athletes requires an objective analysis, based on real experimental data – what are the real consequences for athletes with different level of qualification, how do they cope with the current situation? This requires research aimed at different groups (Arden & Chilcot, 2020).

The aim of this study was to investigate the dominant Mood States, levels of anxiety and perfectionism and their relation to the preferred coping strategies during the pandemic COVID-19 among rhythmic gymnasts from Bulgaria and to outline their specificity depending on level of qualification.

**MATERIALS AND METHODS**

**Participants**

The research was done among 53 rhythmic gymnasts aged between 15 and 26 years. For the purposes of the research the participants were divided into 3 groups according to their level of qualification (regional competitions, national championships, international competitions, qualified for the Olympic Games in Tokyo, 2020).

The survey was carried out online in Bulgaria over the period 13-30 April 2020 in conditions of emergency situation in relation to the pandemic COVID-19. At the beginning of the research all participants were informed about the aim of the survey and their consent was obtained.

This research is part of an international survey initiated by Alejandro García-Mas, Department of Psychology, University of the Balearic Islands, Spain and Aurelio Olmedilla Department of Personality, Evaluation and Psychological Treatment, Faculty of Psychology, University of Murcia, Spain.

**Instruments**

In order to fulfil the aim of the research we used complex methods including:

- Parental Expectations (PE), Concern over Mistakes (CM), Parental criticism (PC), Doubts about actions (DA),...
and Organization (O).

Profile of Mood States (McNair, Lorr, & Droppleman, 1971) was used in its Spanish adapted and validated version by Fuentes, Balaguer, Meliá and García-Merita (1995). The scale reports five moods: tension, anger, vigor, fatigue and depression.

Approach to Coping in Sport Questionnaire (ACSQ-1; Kim 1999; Kim & Duda, 1997) was used in its Spanish version (Kim, Duda, Tomás, & Balaguer, 2003). The five dimensions of coping assessed are: emotional calming (EC), active planning/cognitive restructuring (CR), mental withdrawal (MR), seeking social support (SSS), and risk behavior (RB).

Statistical Analysis

In order to process the initial data from the research we used the statistical program SPSS 21, and did an alternative analysis, correlation analysis, comparative analysis (U-criterion of Mann-Whitney and Criterion of Kruskal-Wallis), and step regression analysis.

RESULTS AND ANALYSIS

The analysis of the results from our survey revealed that the Adaptive Perfectionism (M=4.70) is dominating among the gymnasts we researched (Table 1). The subscales Organization (M=4.65) and Personal Standards (M=3.62) received the highest results, and the subscales of Maladaptive Perfectionism (M=2.31) Parental criticism (M=1.71) and Parental Expectations (M=2.25) – the lowest.

The results from our research on the dominant Mood States during the emergency situation because of the pandemic COVID-19 revealed (Table 1) that the pandemic and social isolation did not have a strong negative impact on the mental state of the gymnasts we researched. The highest values were received for Vigor (M=3.71). Despite the imposed lockdown and the related isolation, the researched gymnasts felt quite energetic, alert, and motivated. These results were justified by the real behavior and acts of the elite Bulgarian gymnasts who, through their online appearances, turned into role models as regards the ways of coping with this harsh and unusual situation. Next subscale was Tension (M=1.99), i.e., despite being relatively vital and energetic, the researched gymnasts experienced nervousness, anxiety, excitement. The fact that Anger (M=1.36) and Depression (M=1.49) received the lowest values is favorable.

One of the tasks of our research was to investigate how the researched individuals coped with the current situation of isolation and lack of normal sports-competitive and educational activities.

Table 1. Descriptive statistics of Perfectionism, Mood States, and Coping strategies

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concern over Mistakes (CM)</td>
<td>53</td>
<td>2.3113</td>
<td>.60100</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Doubts about actions (DA)</td>
<td>53</td>
<td>2.6800</td>
<td>.61386</td>
<td>1.80</td>
<td>3.50</td>
</tr>
<tr>
<td>Parental Expectations (PE)</td>
<td>53</td>
<td>2.2467</td>
<td>.69666</td>
<td>1.40</td>
<td>3.60</td>
</tr>
<tr>
<td>Parental criticism (PC)</td>
<td>53</td>
<td>1.7133</td>
<td>.63666</td>
<td>1.00</td>
<td>2.80</td>
</tr>
<tr>
<td>Maladaptive perfectionism (MAP)</td>
<td>53</td>
<td>2.3133</td>
<td>.56062</td>
<td>1.30</td>
<td>3.20</td>
</tr>
<tr>
<td>Personal Standards (PS)</td>
<td>53</td>
<td>3.6200</td>
<td>.69798</td>
<td>2.00</td>
<td>4.60</td>
</tr>
<tr>
<td>Organization (O)</td>
<td>53</td>
<td>4.6533</td>
<td>.26488</td>
<td>4.30</td>
<td>5.00</td>
</tr>
<tr>
<td>Adaptive perfectionism (AP)</td>
<td>53</td>
<td>4.1600</td>
<td>.42475</td>
<td>3.20</td>
<td>4.70</td>
</tr>
<tr>
<td>ANX</td>
<td>53</td>
<td>41.0667</td>
<td>4.67520</td>
<td>34.00</td>
<td>49.00</td>
</tr>
<tr>
<td>Tension</td>
<td>53</td>
<td>1.9933</td>
<td>.58306</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Depression</td>
<td>53</td>
<td>1.4933</td>
<td>.41267</td>
<td>1.00</td>
<td>2.40</td>
</tr>
<tr>
<td>Anger</td>
<td>53</td>
<td>1.3600</td>
<td>.35194</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Vigor</td>
<td>53</td>
<td>3.7067</td>
<td>.75701</td>
<td>2.40</td>
<td>5.00</td>
</tr>
<tr>
<td>Fatigue</td>
<td>53</td>
<td>1.6000</td>
<td>.62588</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Emotional calming (EC)</td>
<td>53</td>
<td>3.7333</td>
<td>.60420</td>
<td>2.70</td>
<td>4.70</td>
</tr>
<tr>
<td>Active planning/Cognitive restructuring (CR)</td>
<td>53</td>
<td>4.2600</td>
<td>.64733</td>
<td>3.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Mental withdrawal (MW)</td>
<td>53</td>
<td>1.8667</td>
<td>.48090</td>
<td>1.30</td>
<td>3.30</td>
</tr>
<tr>
<td>Behavioral risk (BR)</td>
<td>53</td>
<td>2.4467</td>
<td>.91340</td>
<td>1.00</td>
<td>3.70</td>
</tr>
<tr>
<td>Seeking social support (SSS)</td>
<td>53</td>
<td>3.0133</td>
<td>1.01700</td>
<td>1.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Active planning, Cognitive restructuring (M=4.26) and Emotional calming (M=3.73) were dominant in the sample we researched (Table 1). The researched gymnasts tried to get the positive out of the situation, to learn something new, to restructure their goals. They tried to block the negative thoughts, to keep their positive emotional state so that they could counter the problem and concentrate on important things. They showed a weaker proneness to Seeking social support (M=3.01) from their coaches, psy-
chologists, parents, friends to cope with the problem. Mental withdrawal (M=1.87) received the lowest score - they did not quit trying to achieve their goals, get reconciled with the situation nor did they refuse to be active.

The comparative analysis of the results along the factor qualification revealed significant differences as regards Organization, Tension, Anger, Emotional calming, Mental withdrawal, Behavioral risk, and Seeking social support. The researched Olympic competitors had the highest values on the Organization, Mental withdrawal and the lowest score on the Tension, Anger, Behavioral risk, and Seeking social support. They showed the highest level of organization. They are more tension stable and least often react with anger or aggressive behavior. They are not prone to risky behavior as a coping stress strategy and least often seek social support. They are more willing to cope with the situation by themselves.

Table 2. Results from comparative analysis along the factor qualification

<table>
<thead>
<tr>
<th></th>
<th>O</th>
<th>Tension</th>
<th>Anger</th>
<th>EC</th>
<th>MR</th>
<th>RB</th>
<th>SSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>8.907</td>
<td>10.691</td>
<td>10.749</td>
<td>5.981</td>
<td>12.824</td>
<td>6.070</td>
<td>11.271</td>
</tr>
<tr>
<td>df</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
<td>.012</td>
<td>.005</td>
<td>.005</td>
<td>.045</td>
<td>.002</td>
<td>.048</td>
<td>.004</td>
</tr>
</tbody>
</table>

One of the tasks of our study was to clarify the role of perfectionism in terms of how a situation of threat, uncertainty and risk is experienced, in the case of COVID 19, as well as the coping strategies used to deal with the situation. The results from correlation analysis of the data revealed significant relations between the subscales of Perfectionism, Mood States and Coping strategies (Figure 1). We established significant correlation dependencies (Figure 1) between Adaptive perfectionism and Coping strategies – positive with Emotional calming (r = .774**), Cognitive restructuring (r = .792**), Behavioral risk (r = .595**), and negative with Mental withdrawal (r = -.425**), between Adaptive perfectionism and Mood States – positive with Vigor (r = .623**), and negative with Fatigue (r = -.420*), between Personal Standards and Emotional calming (r = .621**), Cognitive restructuring (r = .687**), Behavioral risk (r = .624**), Mental withdrawal (r = -.394*), and Vigor (r = .432*), between Organization and Emotional calming (r = .794**), Cognitive restructuring (r = .612**), Vigor (r = .700**), and negative with Fatigue (r = -.483*).

There were significant negative correlations between Maladaptive perfectionism and Fatigue (r = -.495**), and positive with Emotional calming (r = .689**), Cognitive restructuring (r = .743**).

The data from the correlation analysis revealed the specific role of perfectionism in its two forms – adaptive and maladaptive. While the scales of the adaptive perfectionism correlate positively with Vigor and active constructive coping strategies (Figure 1) and negatively with those of Fatigue, the scales of the Maladaptive perfectionism are related mostly to negative experiences - Tension, Depression, Anger, Fatigue. We should point out the specially established significant correlations between parental criticism and parental expectations on some negative psychic conditions (Figure 1) - Tension, Depression, Anger, Fatigue. This fact is of great practical value and once again poses the issue of the influence of parents’ behavior on gymnasts’ psyche and performance.
To check this hypothesis, we applied a step regression analysis. In the first model, the independent variable was Adaptive perfectionism, and the dependent variables – strategies for coping and Mood States.

The results from the regression analysis showed that the high levels of Adaptive perfectionism influenced Vigor and Concern over Mistakes (Table 6).

### Table 3. Results from Regression analysis

<table>
<thead>
<tr>
<th></th>
<th>( \beta )</th>
<th>( t )</th>
<th>Sig.</th>
<th>( \Delta R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adaptive</td>
<td>Perfectionism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigor</td>
<td>.192</td>
<td>5.419</td>
<td>.000</td>
<td>.991</td>
</tr>
<tr>
<td>Concern over Mistakes</td>
<td>.141</td>
<td>2.803</td>
<td>.010</td>
<td>.993</td>
</tr>
</tbody>
</table>

In the second model, the independent variable was Maladaptive perfectionism. The results from the regression analysis showed that the high levels of Mal-adaptive perfectionism influenced Tension, Cognitive restructuring, Seeking social support.
Table 4. Results from Regression analysis

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>t</th>
<th>Sig.</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maladaptive Perfectionism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tension</td>
<td>.313</td>
<td>3.567</td>
<td>.001</td>
<td>.797</td>
</tr>
<tr>
<td>Cognitive restructuring</td>
<td>.491</td>
<td>4.787</td>
<td>.000</td>
<td>.536</td>
</tr>
<tr>
<td>Seeking social support</td>
<td>-.334</td>
<td>-4.005</td>
<td>.000</td>
<td>.773</td>
</tr>
</tbody>
</table>

DISCUSSION

The pandemic COVID-19 changed the environment, the usual rhythm of life and the activities of rhythmic gymnasts. From a lifestyle full of physical activity, numerous journeys, competitions, and strong emotions, they had to adapt to living in an isolated environment, to maintaining their motivation given the unclear prospects and sports calendar, as well as to the fear of getting diseased. How do they react, how do they experience, how do they cope with this situation – these are issues seeking their solution on the basis of objective empirical data.

The results obtained from our research on dominating emotional states and perfectionism and their relation to gymnasts preferred coping strategies in times of the pandemic COVID-19 revealed a certain specificity in the manifestation of the researched indicators depending on qualification. The obtained results from the research revealed a certain specificity among the researched rhythmic gymnasts in comparison with the results obtained among athletes from other sports established in other surveys (Iancheva et al., 2020; Iancheva, 2020).

Our results confirmed the hypothesis that Perfectionism is an important psychological variable which influences the way athletes’ cognitive, affective, and behavior characteristics function (Davis, 1997; Frost, Heimberg, Holt, Mattia, & Neubauer, 1993; Hamashek, 1998; Terry-Short, Owens, Slade, & Dewey, 1995). Therefore, the fact that adaptive perfectionism and its subscales Organization and Personal Standards were dominating among the researched gymnasts is a positive finding. The lowest values were received for Parental criticism and Parental Expectations. The obtained results, as a whole, support previous finds (Iancheva, 2013, Iancheva et al., 2020).

Vigor dominates the athletes we study. Having in mind that the research was conducted within 30-40 days after the start of the emergency situation, we can claim that the researched individuals were coping relatively well with the current situation. Regardless of the imposed lockdown and isolation, the researched gymnasts feel quite energetic, alert, and motivated. Next is Tension, i.e., regardless of preserving a relative vitality and energy, the researched gymnasts experience nervousness, anxiety, agitation. The established fact that Anger and Depression had the lowest values is favorable. Further research, given the ongoing epidemic situation, would be useful for planning adequate pedagogical approaches, psychological interventions, and overall administration of sports-competitive activity.

The comparative analysis of the data revealed significant differences along the factor Qualification. We established significant differences depending on the qualification of the researched gymnasts as regards Organization, Tension, Anger, Emotional calming, Mental withdrawal, Behavioral risk and Seeking social support. The researched gymnasts with the highest qualification – competitors who have won quotas and are preparing for participation in the Olympic Games in Tokyo are coping with the situation the most successfully and are the most adaptive during the pandemic. They are more organized, demonstrate higher stability to tension and emotional stability. They are more rarely prone to anger and aggressive reactions. Most often resort to Emotional calming as a coping strategy. They are not prone to risky behavior as a stress coping strategy, least often seek social support and prefer to deal with the situation by themselves.

Our results confirm other research on the differences in coping strategies depending on the level of sportsmanship and successful realization in sports (Rogaleva, Malkin, et al., 2019).

The results from correlation analysis of the data revealed significant relations between the subscales of Perfectionism, Mood States and Coping strategies. Our results reveal the specific mediator role of perfectionism and its two forms – adaptive and maladaptive as regards the way one experiences a threatening, uncertain, and risky situation, in this case – COVID-19, and the preferred coping strategies. The adaptive perfectionism and its subscales correlate with Vigor and active constructive coping strategies and in this way help the adaptive behavior. Maladaptive perfectionism is connected mainly with negative experiences - Tension, Depression, Anger, Fatigue and lowering of Vigor, as well as elements of risky behavior. In this sense, our results support the surveys of Enns & Cox (2002) about
RHYTHMIC GYMNASTICS IN THE CONDITIONS OF COVID-19 and considering their specifics depending on the qualification, especially because there are still few surveys on the subject.

The obtained results related to the psychological consequences from the pandemic COVID-19 on rhythmic gymnasts can be a valuable reference point for coaches, sports-technical personnel, and managers. On this basis they can choose adequate pedagogical approaches in managing the sports-competitive activities. As key pedagogical challenges stemming from the psychological consequences, we could outline the following:

Management of motivation and activity in conditions of unclarity (duration of the crisis, unclear sports calendar, monotony of preparation);
Support in goal setting (lack of clear reference points regarding the way of preparation and forthcoming competitions, disrupted or cancelled sports calendar);
Management of emotions and psychic conditions (fear of getting diseased, fear of travelling and the related risks, competitions without audience, danger of overall restructuring of sports life, disruption of the usual emotional background, high psychic pressure, deficit of positive emotions and emotions related to competitions);
Planning of preparation, maintaining and management of sports shape in conditions of uncertainty and lack of information about the future sports calendar.

We should point out, however, that the adequate pedagogical approaches require objective empirical data, as well as tracing the dynamics in the researched indicators by regarding the peculiarities of the situation.

LIMITATIONS

This research has a few limitations - the number of the researched sample and the fact it was carried out online. A wider scope of research would allow for a more in-depth analysis and interpretation.

It is also necessary to take into consideration the changes in the epidemic situation and its influence on gymnasts’ psyche.

Future research should be directed towards surveying the psychological consequences of the pandemic on coaches’ psyche as well as on the overall environment related to rhythmic gymnastics.

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EVALUATION OF COMPETITION ROUTINES IN RHYTHMIC GYMNASTICS: HISTORICAL ASPECTS

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ABSTRACT
Since time immemorial peoples around the world have expressed their feelings and emotions through dance. Dance plays an important part in their lives and has often led to the development of other physical activities involving movements synchronized to music.

Rhythmic gymnastics, much like other sports described as artistic, is rooted in dance. Gymnastics and dance come together in various forms of disciplines, known as dance gymnastics, expressive gymnastics, rhythmical gymnastics, gymnastics for graceful and stage expression. It is hard to distinguish any significant differences between these, but their core shared characteristic is the use of musical accompaniment and a wide range of dance moves.

Evaluation of dance in gymnasts’ competition programs was included in the very first known Code of Points, in one of the Final Score components, namely the overall impression score. A retrospective overview of the requirements in the competition rules shows that despite the enormous transformation of rhythmic gymnastics and its evolution into a challenging sport, the link to dance has been retained and tolerated with the sole purpose of preserving the uniqueness of the physical activity. The overall impression score has changed its name (it was called harmony and overall impression in 1963, 1965, 1968, and 1971; overall impression between 1976 and 1984; artistic value between 1997 and 2005; artistry in 2009), the criteria have also been partly modified, but in its core, it has always evaluated the artistic aspect of the routines. This score has given rise to serious discussions during evaluation for two reasons: firstly, evaluation of artistry has followed criteria of various structure, distribution, and points over the years; and secondly, that in practice, the evaluation is performed by two groups of judges: on the one hand these are the official juries, and on the other – the audience, whose criteria tend to be individual and fundamentally different from the ones laid down in FIG’s Code of Points.

Key words: Rhythmic Gymnastics, History, Evaluation, Artistry

INTRODUCTION
Dance was born out of religious gestures as a spontaneous expression of celebration, an act of the unit of spirit and body. According to people’s understanding, dance was a form of art which takes one away from one’s enemies, drove away diseases, gave one the powers of Gods. Dance as a means of expression of feelings and emotions has persisted throughout human history (Diem, 1966).

People sometimes danced in group by taking different body postures, followed by returning to initial position in strict obedience to a certain rhythm.

Figure 1. Cave drawings (circa 2000 BC), (Diem, 1966)

The use of different objects was found in a number of historical records. They were given mysterious and divine meaning or were just objects bringing variety into a game.

In their dances, the Aztecs used a ball as a symbol of the sky. It was made from the juice of a rubber tree which is interpreted as a symbol of the sacred, of God’s soul (Diem, 1966).

In ancient China, during the rule of emperor Yan-Kang-Shi, gymnastics exercises in a group were practiced with or without an apparatus or with small apparatuses. The exercises included bends backwards, bridges and exercises for overall development (Petrova, 1982, Liang, 2012). The play with a ball...
involved balance exercises, tossing the ball in the air while leaping or other exercises and subsequent catching the ball in a sitting position (Bobo, 1998). In ancient Greece people practiced strength and dance gymnastics, including various preparatory and imitation dances, different postures and exercises with balls, hoops, and veils, performed with musical flute accompaniment (Lisitzkaia, 1987).

**Figure 2. Dance Gymnastics**

Later on, dance played a central role in dance gymnastics, whose principles as defined by George Demeny (1850–1917) were also applied to rhythmic gymnastics (Biriuk, Ovchinnikova, 1990):

- each movement should follow in sequence;
- all body parts should participate harmoniously in the executed movement;
- limbs should move in all planes and directions;
- balance and spatial orientation should be developed to a high level;
- the principle of gradual complexity should be obeyed, etc.

Demeny further developed common principles taken from the traditional activities, smooth and oval motions, rhythmic movements for flexibility and at a later stage he included skipping, play with clubs, play with a hoop and with two apparatuses (Vigarello, 1993, Zoro, 2002).

**Figure 3. 1910: Dancing in a group, rounded and consecutive movements (Zoro, 2002)**

Isadora Duncan (1878-1927) rejected the constrained and conventional methods of classical dance (Atanassova, 1977), because she found them rigid and formal (Dunkan, 1972) and created a new style of natural movements as well as developing a system consisting of basic dance movements which called "notes from the scale of movements" (Naipak, 1985).

**Figure 4. 1925: Rhythm exercises with a small ball (Zoro, 2002)**

**Aim of the study**

In the process of reviewing codes of points in rhythmic gymnastics, starting with the first Code published in Russia, as well as FIG’s 1963 rules, we came upon the idea to learn more about the structure and distribution of evaluation criteria.

To this end, the aim going forward was defined as tracing the evolution of competition rules, specifically where the evaluation of competition routines’ artistic aspect was concerned.

**METHODS**

A method based in theory and synthesis was used to analyze the following: codes of points; technical requirements for composing competition routines; historical texts concerning the sport; photographs and videos; relevant publications; interviews; and websites.
RESULTS AND ANALYSIS
Women's desire to dance to musical accompaniment, the use of small portable apparatuses of varying nature and shape, and the influence of different gymnastics schools and systems laid the foundation of the emerging physical discipline practiced in Russia (Petrova, 1982, Geshev, Petrova, 1970). Studios, schools and extracurricular activities with different kinds of artistic and graceful movements were created, known under various names, such as “expressive gymnastics”, “rhythmical gymnastics”, “gymnastics for graceful and stage expression” (Karpenko, 2003, Tzvetkova, 2002).

The Supreme School for artistic movements initiated the in-depth work in the field of artistic movements and in 1934 the school was transformed into a department at sports-pedagogical faculty of the institute “P. F. Lesgaft”, Sankt Peterburg. Thirty people enrolled in the first year, divided into 3 groups (one of them consisted of men), (Brikina, Smolevskii, 1985).

The curriculum included (Shishkarevoi, Orlov, 1954, Naipak, 1985):

- Rhythmic gymnastics
- Musical and stage etudes
- Music literacy and solfeggio
- Typical dances
- Staging
- Basic gymnastics
- Athletics and fencing

On the 22 October 1946, an order of the All-Union Physical Culture and Sport Committee at the Council of Ministers of the USSR was published – “For the development of female rhythmic gymnastics” - which was the official recognition of the new kind of sport. It was named art gymnastics because it was believed that this type of sport had a close affinity to art (Karpenko, 2003).

The first competitions were held in the form of contests, with the winners receiving awards such as paintings, small statues and other works of art made by young talented artists instead of medals (Petrova, 1984, Tzvetkova, 2002).

The program for participants in contest competitions consisted of two parts:
First part – compulsory program
Second part – finals, the top ten gymnasts compete

The compulsory program, which was the qualification for the finals, included four exercises (Biriuk, 1990):
1. Compulsory routine without an apparatus.
2. A routine with acrobatic exercises.
3. One of the six compulsory routines with an apparatus (the apparatus was determined by a draw, but competitors prepared routines with all apparatuses).
4. One of the three compulsory jumps off a springboard.

During the compulsory exercises, following a decision made together with her coach, the gymnast could raise her hand to waive her score and was then allowed to repeat her routine.

The competition finals were held on a theatrical stage, comprising two free routines – one with and one without an apparatus. For the apparatus-free routine, elements of dance, pantomime, acrobatics and somersaults were permissible.

The traditional apparatuses used at the time were: hoop, ball, ribbon, steamer, clubs, veil, and rope. Gymnasts were allowed to perform their routines with two apparatuses simultaneously: two ribbons, two hoops, a ball and a hoop, and a ball and a steamer. The choice of apparatus was often dictated by competitors and coaches’ fantasy and that is why there were often strange decisions (Biriuk, 1990).
A veil on a stick
A ball, threaded on a rope
data-colored in gold
balls covered with glowing sequins
clubs in the shape of snowflakes
a ribbon with the width of a veil

The name of the music piece chosen for musical accompaniment and the name of its author were announced in competition. The rules allowed for various elements of improvisation in the competition dress, such as gymnastics leotards, skirts, and dresses, decorations made with embroidery, braids, sequins, and other glittering ornaments. The competitive routines were judged in three aspects (Biriuk, 1990):

![Figure 7. Score components](image)

No data about the values of the different components or the final score have reached us, nor about the specific requirements for the contents of the competition routines, but these components of the final score have undoubtedly been an indisputable basis for the evaluation of rhythmic gymnastics competition routines ever since it was recognized as an official discipline at the 41st Congress of the International Gymnastics Federation in Prague, Czechoslovakia, in June 1962. Since then, it has been known as modern rhythmic gymnastics (gymnastique rytmique moderne), later just rhythmic gymnastics. In Eastern Europe, the name of the discipline is art gymnastics (Gantcheva, G. 2018).

### Table 1. Routine contents and evaluation method: Codes of Points 1963–2005 (Rodenas, 1996, Gantcheva, 2008).

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SCORE DIVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>Range form 0 to 10 points</td>
</tr>
<tr>
<td>1965</td>
<td>5 p. – composition</td>
</tr>
<tr>
<td></td>
<td>3 p. – value of the elements of the difficulty</td>
</tr>
<tr>
<td></td>
<td>2 p. – originality of connections and technical value of composition</td>
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<tr>
<td></td>
<td>5 p. – execution</td>
</tr>
<tr>
<td></td>
<td>execution of elements</td>
</tr>
<tr>
<td></td>
<td>Harmony and overall impression</td>
</tr>
<tr>
<td>1968</td>
<td>Range form 0 to 10 points</td>
</tr>
<tr>
<td>1971</td>
<td>7 p. – composition</td>
</tr>
<tr>
<td></td>
<td>5 p. – value of the elements of the difficulty</td>
</tr>
<tr>
<td></td>
<td>1 p. – originality of connections and technical value of composition</td>
</tr>
<tr>
<td></td>
<td>1 p. – connection music and movements</td>
</tr>
<tr>
<td></td>
<td>3 p. – execution</td>
</tr>
<tr>
<td></td>
<td>1.5 p. – execution of the elements</td>
</tr>
<tr>
<td></td>
<td>1.5 p. – Harmony and overall impression</td>
</tr>
<tr>
<td>1976</td>
<td>Range form 0 to 10 points</td>
</tr>
<tr>
<td>1978</td>
<td>7 p. – number and value of difficulty</td>
</tr>
<tr>
<td></td>
<td>1 τ. – connection music and movements</td>
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<tr>
<td></td>
<td>0.5 p. – technical value of composition</td>
</tr>
<tr>
<td></td>
<td>Division of the difficulty of the routine</td>
</tr>
<tr>
<td>1982</td>
<td>Connections between difficulties and the elements</td>
</tr>
<tr>
<td>1984</td>
<td>Variety of the groups, rhythm, planes, and directions</td>
</tr>
<tr>
<td></td>
<td>0.5 p. – originality, new elements, new connections</td>
</tr>
<tr>
<td></td>
<td>3 p. – Execution</td>
</tr>
<tr>
<td></td>
<td>1.5 p. – execution of the elements</td>
</tr>
<tr>
<td></td>
<td>1.5 p. – overall impression</td>
</tr>
<tr>
<td></td>
<td>Certainty, Elegance, Coordination, Dynamics, Easiness, Amplitude of the movements</td>
</tr>
<tr>
<td></td>
<td>Expression, presence</td>
</tr>
</tbody>
</table>
### Evaluation of Competition Routines in Rhythmic Gymnastics

<table>
<thead>
<tr>
<th>Year</th>
<th>Composition</th>
<th>Technical Value</th>
<th>Bonus Originality</th>
<th>Bonus Risk</th>
<th>Execution</th>
<th>Technical Value</th>
<th>Artistic Value</th>
<th>Music</th>
<th>Choreography</th>
<th>Difficulty</th>
<th>Artistry</th>
<th>Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>10.0 p.</td>
<td>9.5 p.</td>
<td>0.3 p.</td>
<td>0.2 p.</td>
<td>10.0 p.</td>
<td>9.7 p.</td>
<td>0.3 p.</td>
<td></td>
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<td>1993</td>
<td>0.5 p.</td>
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</table>

**DISCUSSION**

The literature review showed that when it first started evolving into a sports discipline, rhythmic gymnastics was of entertainment nature and was a field of innovation and creativity. At the same time, it was aimed at developing a physical activity suited to the female body, and simultaneously presented a way of expressing various artistic capabilities due to its affinity to dance and music.

The overall impression score, separate from the technical execution score, evaluated the gymnast's charm, grace, the expressiveness of her movements and face, the communication of images, emotions, feelings, and suggestions to the audience, achieved through the connection between music and movements. Their sum total comprises that part of art gymnastics which, in addition to giving the sport its name, is the artistic quality pursued by both coaches and athletes. The components listed above are a relative category and defy precise definitions and as such, precise evaluation. Creating scoring systems for the expressiveness of the execution, for the ability to express through movements the emotional nuances of the musical accompaniment, is impeded by the awareness that they are largely dependent on gymnasts’ individual characteristics.
This is why judging this part of the routines is always hard, as it stands closer to the spectators (audience), who for their part evaluate it by their own criteria which vary from person to person. There is no real possibility for these criteria to be defined, systematized, and awarded the same value for everyone in the audience, which also plays the role of a judge in a sense.

As a result of coaches’ artistic pursuits, the discipline’s content is continually enriched with new exercises, connecting elements, and combinations. The Judges’ Rules should guide the use of these exercises, while evaluating the artistic aspect of the routines. The creators of the Code of Points have made attempts over the years to define a precise score structure and have proposed the development of a quantitative scoring system for qualitative expressions of various emotions in rhythmic gymnastics (Averkovich, 1979). At times it seemed like the contents of the routines and the method for their evaluation were aligned. But it never lasted long, as in the meantime coaches usually discover new difficult and original exercises and connecting elements. Thus, the rules must be adapted to the novelties, and in this sense they are in a catching-up position.

Table 1 shows the increase in the number of exercises over the years, and with the duration of routines unchanged, the total difficulty has been increased again and again, with no Code of Points daring to overlook the evaluation of the artistic part of the routines, even if it adds a decidedly subjective element to the overall evaluation.

The overall impression score in the first Code has consistently been kept in later editions, though under different names (harmony and overall impression in 1963, 1965, 1968, and 1971; overall impression between 1976 and 1984; artistic value between 1997 and 2005; artistry in 2009), as part of the composition score, with varying values, with changing criteria, but rhythmic gymnastics has been keen on preserving its main element, the foundation of its emergence as a physical activity.

CONCLUSION

Rhythmic gymnastics as a sports discipline has been developing towards a constant increase in the difficulty of exercises, but it has invariably maintained the artistic aspect of the routines. Competition rules put serious emphasis on this component of the competitive sport. Even though evaluation of the artistic aspect has been based on criteria of varying structure, distribution, and values over the years, the core philosophy of the discipline has remained the same. The overall impression score continues to play its part in the final score calculation and helps preserve the specific characteristics of this gymnastics discipline.

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THE JAPANESE STYLE OF MEN’S RHYTHMIC GYMNASTICS: HISTORY AND OUTCOMES

Tabata Larissa Almeida Kikuti, Myrian Nunomura
1State University of Campinas - Brazil, 2University of São Paulo - Brazil

ABSTRACT
Rhythmic Gymnastics practiced by men has two different styles, both known as Men’s Rhythmic Gymnastics. One of them emerged in post-war Japan and continues to grow in its territory and other countries like Russia and USA. This research aims to review the history and outcomes about the Japanese Men’s Rhythmic Gymnastics style. We conducted a systematic literature review and semi-structured interview with athletes, former athletes, academics, and coaches. We used Reflective Thematic Analysis as data treatment. We identified that during the 19th century, Japan opened its doors to the world, and teachers from other countries, such as Niels Bukh from Denmark, brought Gymnastics to Japan. Based on his proposal, Japan developed their own style of Men’s Rhythmic Gymnastics. After a national growth of the sport, Japan sent coaches to several countries, so that the sport could gain popularity. After 2003 and 2005 international championships, many countries stopped developing the sport. In short, the internationalization and the organization of those events did not bring many outcomes. Japan lost the investment and opportunity to establish its Men’s Rhythmic Gymnastics style in other countries due to the language barrier, lack of experience, adaptation of Japanese coaches abroad to the gymnastics classes in other cultures, and lack of a master development plan for the sport in the international context. Currently, countries such as Russia, Canada and the USA continue to practice the sport. Nevertheless, the rules have not been translated nor the practice manuals, so we cannot yet conclude that there has been internationalization of this style. For now, making the Code of Points available in English language, i.e., translating the books and information about Men’s Rhythmic Gymnastics, could be a starting point to a real internationalization of the sport.

Key words: Men’s Rhythmic Gymnastics, History, Internationalization, Popularization

INTRODUCTION
In spite of being a sport considered essentially female, Rhythmic Gymnastics (RG) has two different styles of practice by the male audience, both known as Men’s Rhythmic Gymnastics (MRG). The first one is identical to the one practiced by women and can be found in several European countries such as Spain - a pioneer in the practice of this type of MRG; the second one emerged in post-war Japan and continues to grow in its territory in some countries such as Russia, Canada and United States. Despite being called MRG, the Japanese style is extremely acrobatic and is practiced with slightly different apparatus compared with the conventional ones: two small hoops, a pair of clubs, a rope, and a stick. The individual routines make use of the apparatus, and the group routine is performed with free hands, as a mixture between Group Aesthetic Gymnastics and Acrobatic Gymnastics, causing many people involved with RG to doubt whether this sport could really be called MRG.

Aim of the study
The aim of the study is to deepen the historical knowledge on Men’s Rhythmic Gymnastics in Japan since its emergence up to now and to analyze its presence in several countries nowadays.

METHODS
As a starting point, we conducted a systematic literature review (Sampaio; Mancini, 2007) that covered diverse sources related to MRG such as books, academic papers, theses, dissertations, newspapers, and other documents. To carry out a more in-depth analysis of the MRG in different locations and cultures of practice, we interviewed athletes, former athletes, academics and coaches who are involved with the sport in different countries. For this purpose, we conducted a semi-structured interview, as it is the most appropriate form of “providing information or opinions on a certain topic, done orally, by the interviewee” (Triviños, Neto, 2010). As research that goes beyond national borders and reaches other continents, we decided to use online platforms to carry out the interviews (Zoom, Google Meet and Skype). For Janghorban et al (2014) “the online interview overcome financial and time restrictions, geographical dispersion and physical mobility limits, which negatively affected the interviews in person”.

The scripts had the same structure, adjusted according to the background that the interviewee had with the MRG. After obtaining the data related to the interviews and the bibliographic review, in order to organize, classify, and present the themes related to the collected data, we proceeded to the Reflective Thematic Analysis (RTA), which has the advantage of being more flexible and used in different research contexts (Braun, Clarke, 2006). Finally, the pieces of the participants’ interview can be found during the course of the text (with their pseudonym, country and page from the original research), in order to
complement the literature research and our attempt to explain this gymnastic phenomenon.

RESULTS AND ANALYSIS
For more than two centuries (1639-1868) Japan remained politically and economically closed (Hata, Sekine, 2010). According to the authors, after the Meiji restoration, this national policy of isolation ceased, so that, in the middle of the 19th century, the country opened its doors to the foreign trade and international relations. In the course of this modernization process in Japan, with the formation of a modern national state and the arrival of capitalism, the body of the Japanese citizen needed to be remodeled from different points of view (Kwon, 2018). According to the author, this measure was necessary to improve the physical strength of the people involved with military might, as well as to improve the bodies of those who were the necessary labor force for the industrialized market. As a result of modernization, many students and teachers from different fields of knowledge were sent to Western countries (Hata, Sekine, 2010) and, in the same way, teachers and students were brought from different countries to Japan. The body of the Japanese citizen was transformed into an object of extreme importance as a social and cultural product, making the country dependent on this body for the purposes to be achieved, determined by the opening of Japan (Kwon, 2018). Danish Niels Bukh played a paramount role in the introduction of European Gymnastics in Japan. In the middle of 1916-1917, he created what Hans Bonde (2006) called the Gymnastics for Men and, in 1920, opened the Physical Education and Sports school, the first in Denmark and in the world. After knowing and studying the Swedish and German Gymnastics methods, among other forms of practice developed until that time in Europe, he created his own method, currently known as Fundamental Gymnastics (Langlade; Langlade, 1970). For Bukh, rural work caused certain muscles to be used more than others, and this ended up weakening unused muscles (Bonde, 2007). Therefore, the goals of Danish Gymnastics involved transforming the body of working youth, men and women, into a flexible body, with strength and agility (Langlade, 1970).

The "acrobatic" and "powerful" body of his students became a symbol beyond the Danish border (Bonde, 2006). For the author (Bonde, 2004), his creativity in assembling exercises and the forms of stretching he created still play an important role in the culture of international gymnastics, not only in Japan. For Bonde (2004), "Niels Bukh used his gymnastic pedagogical and national fame to politicize almost everywhere he stepped in the world, including Japan and Germany. In 1931, Niels Bukh and his gymnasts were on a tour in Danzig, the Soviet Union, China, Korea, Japan and the USA". During the 1930s, there was a strong nationalist feeling among Japanese authorities. With this nationalist attitude, they showed aversion to foreign sports, such as baseball. Despite this, this aversion did not seem to match Denmark, a small and friendly European country that apparently had nothing to do with the political struggles of the great Asian powers at that time (Bonde, 2004). The author further stated that, as a benefit to Japan, the Danes advertised in the Danish media reporting the Japanese view of the political conflict.

Japan has become the only country in the world where Niels Bukh's gymnastics has achieved the greatest spread. This is still obvious in Japan today, and surprisingly, Danish gymnastics probably contributed more to Japanese body culture than Japanese martial arts contributed to Danish body culture (Bonde, 2004, p.02).

Through this Asia tour, Danish Gymnastics, with calisthenics movements and music, small and large apparatus, was appropriated by Japan and transformed for its needs. This introduction of a culture of Western civilization and, consequently, the introduction of a physical education and sport system in the country, caused profound changes in Japan's political and social structures. Initially, sports practices were introduced in schools and universities. Combined with the popularization of a gymnastic culture of the body, according to Hata and Sekine (2010), Physical Education and Sports were introduced in the curriculum of primary and secondary schools at the same time. Within regular Physical Education classes, gymnastics was also incorporated and became both the most used method of conditioning the body and the basis of conditioning for other sports (ibiden).

The occurrence of Bukh gymnastics in Japanese school gymnastics during the 1930-1940 period can be seen in connection with the fact that the regime considers it an effective form of gymnastics for ongoing militarization" (Bonde, 2004).

Until the end of World War II, physical education was recognized as fundamental in the transformation of the body, in order to make the nation stronger and, after physical education became a tool for "improving health and character formation" (Hata, Sekine, 2010). It is during this period, in the 1940s, that we see the so-called “Toshu group gymnastics” or group gymnastics without apparatus (Hideki, Japan). According to the author further stated that, as a benefit to Japan, the Danes advertised in the Danish media reporting the Japanese view of the political conflict.

Korea, Japan and the USA... During the 1930s, there were on a tour in Danzig, the Soviet Union, China, Korea, Japan and the USA. During the 1930s, there was a strong nationalist feeling among Japanese authorities. With this nationalist attitude, they showed aversion to foreign sports, such as baseball. Despite this, this aversion did not seem to match Denmark, a small and friendly European country that apparently had nothing to do with the political struggles of the great Asian powers at that time (Bonde, 2004). The author further stated that, as a benefit to Japan, the Danes advertised in the Danish media reporting the Japanese view of the political conflict.
which is currently called Danshi Shintaisou (MRG). It was an extension of the training of the military ... in terms of conditioning, body function and things like that ... so they managed to maintain this base much better than other countries ... they really developed it in places of presentation, and this became the MRG (Marco, Canada, p.03).

The first group performance took place at the National Sports Festival in 1946 in Kyoto as a demonstration (Nakata, 2008). In 1948, the 1st All Japan Rhythmic Gymnastics Championship took place, which is currently in its 72nd edition. In 1949, Japan’s first Inter-College Rhythmic Gymnastics Championship had its first edition and the 71st edition occurred in 2019. Thereafter, events began to occur every two or three years on a regular basis, organized by the Japan Gymnastics Association (JGA) and were even broadcasted (Nakata, 2008). The group composed by six man and another by six women performed a free-hand routine. The competitions continued until 1967 and, when RG started to be called Modern Gymnastics and later, Rhythmic Gymnastics, Japan also adopted the name of the sport practiced by men and the first championship took place in 1968, using this new nomenclature (Nakata, 2008) and which has not undergone further changes.

The Japan Gymnastics Association sent people to check out the world championships in 1967 and brought the RG back to Japan. In 1968, the Japan Gymnastics Association changed the names of the male and female Groups Toshu Gymnastics to Rhythmic Gymnastics. This was the beginning of Men’s Rhythmic Gymnastics, but after that ... Women’s RG felt into the international standard ... and Men’s Rhythmic Gymnastics, they are not in the international context ... because ... because world championships are just for women (Hideki, Japan, p.03).

In 1969 the free hands individual routines were added and, in 1970, the rope and the stick. In 1974, they added the clubs as apparatus, and in 1989, they removed the free hands exercise to add the two small hoops, in order to create four individual routines with different apparatus (Nakata, 2008). Still in 1974, they created the official competition regulations, with mandatory exercises. The MRG in Japan, in its current form, consists of individual and group competition. Group competitions consist of six gymnasts who perform free hands exercises, according to the Code of Points (CoP). In 2002, in Japan, there were an average of 1000 gymnasts, from schoolchildren to adults (Nakata, 2008) and currently, in 2020, we find around 2000 gymnasts (Hodge, 2017). The main sports competitions in Japan are: Inter High School, National Athletics Meeting, All Japan Inter-Collegiate Competition, All Japan Junior Championship, All Japan Amateur Championship and All Japan Rhythmic Gymnastics Championship. In addition to these competitions, it is possible to find some RG cups such as the Sasaki Cup and Chacott Cup.

For the past 30 years, many university groups of MRG have participated in international events such as Festival Del Sole, in Italy, and World Gymnaestrada, every four years, and the public has always been very involved and impressed with gymnasts, as could be seen when watching the presentation videos. Through these appearances outside Japan of formal competitions, groups have achieved greater popularity of the sport internationally.

The regulations and rules remain almost unchanged until mid-2003, the year in which an international championship took place and the name of the apparatus changed in Japanese to be understood internationally. For example, instead of Wa (輪), the small hoops were called rings (リング) and Kajibō (槇棒) started to be called clubs (クラブ). Japan desired to host an international competition. Mainly from 1980s to 2000s the country invested in their coaches’ qualification and send them overseas in order to popularize the sport. This process of sending the coaches was called „internationalization” and will be covered in the following topic (Noda, Mikako, 2017).

The internationalization of MRG

We noticed that Japan’s effort to internationalize its practice ended around 2005 (Noda, Mikako, 2017). Before the year 2000, Japan sent some coaches around the world with the central objective of presenting its version of MRG and training new coaches in other countries and Brazil got to know the sport by the internationalization process. According to the aforementioned sources, in 1980, Prof. Jarbas Gonçalves of University of Sao Paulo (USP), then director of EEFE and Prof. Dr. Antônio Boaventura da Silva, head of the department of the School of Physical Education at the same university, were invited to visit the University of Kokushikan and learn more about the sport. Motivated by the teaching quality of RG, practiced by both men and women, USP decided to extend the invitation for the professors from this Japanese University to come to Brazil to teach courses. With that, the professors Asakura Masaaki and their assistants, Keiji Yamaguchi and Mikumo Yamaguchi, went to Brazil the following year. In 1982, these Japanese teaching staff offered a course at the Olympic Training and Research Center of the
city of São Paulo (COTP) and, in 1983 at USP itself, and collaborated with the RG subject of the University for another six months. After that, the teaching staff returned to Japan and, according to the participants’ reports, the subject continued to be taught for some time but nowadays it does not exist anymore. Carolina, while teaching at the Universidade Estadual Paulista (UNESP) also introduced the RG for men in the Japanese style (from 1984 to 1987) and, later, in a private under-graduation school in São Paulo until the following year of the interview (2019), provided many Physical Education teachers with knowledge in this sport. Despite the investment in introducing the sport, little is known and is found about the courses and how much they influenced the way we practice the sport in the country today. In mid-2000, Japan sent former RG practitioners and competitors to six other countries, in order to start sharing knowledge about the sport, creating a network of practitioners, and allowing the sport to build its foundations internationally. The idea was to enable the promotion of international competitions and, in the future, to be recognized by FIG (Noda et al, 2017; Noda, Hata, 2017; Noda, Hata, 2016).

Nakata (2008) stated that until mid-2008, Japan worked actively with the FIG to define new rules for series in groups with apparatus, in order to bring the routine closer to those performed by groups composed of women. The sending of coaches/gymnasts to other countries focused on creating groups to participate in a future international championship between countries. The championships took place twice, in 2003 and 2005 (Marco, Canada), and the participants came from Canada, United States, Japan, Malaysia, South Korea, Australia, Mexico, and Russia.

During the 2005 international championship, in Japan, a preparatory course for referees was conducted aiming at their preparation for future events. Michaela Pendleton, from Australia, Mario Lam, from Canada, Foong Kok Seng, from Malaysia, and Ramon Moore, from the United States, passed the test and won the sport’s referee brevet, hoping to accumulate knowledge and experience that could support the popularization of sport in their respective countries. We will briefly discuss the participation of some of these countries in the internationalization process of the sport and the choice of having an MRG program. In Australia, after the presentation of a Japanese RG group in the country, RG coach Michaela Pendleton was very interested in the sport. Joel Callen was Australia’s first gymnast, aged 16 in 2004, to train and compete in the country. The JGA sent a coach three weeks before a competition that would take place in New Zealand to better prepare Joel. To-moya Izumi brought some new equipment and went with the Australian team to New Zealand.

Two other gymnasts, Shaun Andrews and Rowan Yap started training in early 2005. The Japanese trainer remained in Australia to continue his work at Michaela’s club. In the 2005 international championship, they represented Australia.

Regarding the unfolding of the work done by the Japanese coach and Michaela, according to the comments from the research participants (Marco and Yama) there was no impact of the sport in the country. Recently, we found the news that the Japanese RG program was back in the country at another club. In Malaysia, two months after the presentation of a Japanese group of MRG, in 2001, a Japanese coach was sent to the country to prepare a group that could compete in the 2003 international championship. Athletes from other sports were included in the groups, such as kung fu and Artistic Gymnastics. We know that, currently, MRG no longer exists in Malaysia, as stated by research participants (Hideki, Japan, p.05; Marco, Canada, p.05). Korea started the practice of Japanese RG in 2001 and the gymnasts who participated in the competition in the international championship in Japan, in 2003 were students at Sung Kyun Kwan University. Keeping college-age athletes active in Korea would be a major challenge for the sport, as it coincides with the age of compulsory military service. For this reason, Professor Mario Lam says that many failed to participate in the 2005 international competition.

In Russia, we have found many training videos, competitions and interviews for Russian TV programs. Champion Alexander Buklov participated in the international competitions and is currently a RG coach and referee on the Japanese style in the country, with his own training gym. According to several news websites, Alexander was responsible for popularizing the sport in the country after the 2005 competition. The differential of RG in Russia is the existence of mixed double routine, in which a girl with a traditional RG apparatus performs a choreography in partnership with a boy who manipulates a Japanese MRG apparatus. Since 2016 the MRG of the Japanese style has been part of the disciplinary program of the Russian Federation and, as in Japan, competitions take place concurrently with those official aimed to girls in the country. Currently, Russia continues to promote the sport. In 2020, at the Open Championship of Karelia, the gymnast Gleb Galkovskiy was champion, and showed that the country continues to invest in the Japanese style for its practice.

In the United States of America (USA) RG for men
has developed only recently. Japanese groups from the University of Kokushikan made several tours around the country and, in 2018, on their last tour, they visited Boston. Previously, in mid-2016, they toured Atlanta and Boston, giving the idea of starting the program in the two American cities. Apparently, the issue regarding sending coaches and financial problems was resolved by one of the gymnasiats that presented the sport, in Boston. According to participant Vincent (United States), the partnership was made between universities, and Japanese gymnasts who traveled to the USA, used extra-class time to participate in the gym activities.

[...] We contacted the teams from Aomori and Kokushikan, Japan. [...] We were able to coordinate between Japan and the United States two very talented boys to come and do exchange programs to learn English and taking classes at the university and also helping us to develop the sport [...] and they really helped us to develop the series, choreographies, the technique, the musicality, the art behind it all, inspiring the boys with acrobatics, the very interesting skills that they know how to perform. (Vincent, United States, p. 2).

In Canada, several Japanese coaches have taught MRG since 2003 and, despite this, the sport has been transformed and it is now known as Martial Gym. After 2003 and 2005, the country no longer participated in competitions with the Japanese, and apart from the gym in Vancouver city, we could not find any other practice spots. For the participants it was very difficult to create a sports program due to the lack of organization and communication from the Japanese side. Since a presentation in the country in 2002, between May and June, there has been an interest in an alliance between the countries. A specific Japanese MRG teaching program was created. Our participant was present throughout the process and reported:

[...] I managed to get him to bring a group to Vancouver to perform. And in 2002 the possibility of an alliance appears, so [...] that provided them with a platform to present in several other countries, as well as on the local FOX broadcaster, BBC, and [...] so we made the right connections and uh [...] one of the coaches / gymnasts wanted to stay to actually help us create a team for 2003. So, we did it. The presentation took place in 2002, between May and June, and I didn't hear a word about whether a coach was coming or not. I needed to start a program, I needed to plan ahead. I can't just show up and... magic! (Marco, Canada, p.5). [...] what happened was that with two weeks' notice, he showed up, the coach, and that was in December and we should start the program in January, classes would start in January. So, you can see why it was so messy to make things happen. I had to do all the orders and things like that back in August (Marco, Canada, p.7).

Because of the knowledge brought by the professionals to the gym, participant Marco (Canada) believed in the inclusion of everyone in this practice. With that, the coach decided for a non-competitive version of gymnastics, linked to the experience with martial arts and gymnastics. He opted for creating a way of moving that was adapted to the context of the country.

So, it's martial art and gymnastics and... they all start with, for example, 5 years old, they start in the same basic type of class, and when they reach 8 to 12 years old, I start to allow a mixture of self-defense in class, if they want, or they can basically focus more on the performance side. So if they decide to focus on the performance side, the techniques they learn are related to the male GR, if they focus more on the self-defense side, they learn self-defense, but basically they use the methodology and techniques of teaching gymnastics to create a base, in a logical and scientific perspective (Mario, Canada, p.2).

Therefore, the Japanese coach was able to adapt the classes to an alternative method so that the GR program would remain active and attract students. In Canada, even girls practice the Martial Gym. Other coaches in the country were interested in the sport, but could not afford or did not have the facilities to start the program, and gave up the idea.

DISCUSSION
Japan created its own version of MRG decades ago, and the knowledge and contents related to the sport were restricted to the Japanese language, as well as to the coaches and gymnasts in the country. Nevertheless, an attempt to internationalize the practice has worked in some ways. Much effort has been made to make the sport popular, using the digital format, through social media such as Instagram, YouTube and Facebook. Therefore, added to the performances at international events, the sport started to become better known by the population outside Japan during the XXI century.

The main barriers faced by the Japanese in expanding and popularizing their MRG were: bad quality of communication between countries, lack of pedagogical preparation in the sport and knowledge of the language of the destination country or even English, as well as failures in the organization of funds for sending athletes and coaches abroad. Noda et al (2017, 2016) and Nakata (2008) indicated in their
research that the language barrier, the lack of experience in adapting people to the classes in the other cultures, as well as the lack of a master development plan for the sport in the international context, made the sport lose the investment opportunity made by Japan. The reflection of the Japanese pioneers who crossed the border was:

The biggest problem is that we have no connection. We have no connection between association and association... we only have connection between club and club [...] the other is payment, money, this is the big problem, yes [...] but, uh, the coach must pay everything [...] The Japanese side always pays... so this is very difficult. [...] if they want to continue with the Men’s Rhythmic Gymnastics program [...] they (the interested countries) need to help (Hideki, Japan, p.05).

One of the goals at that time (between 2003 and 2005) was to create a commission so that we could communicate and define these things, but, because of the language barrier, it becomes very difficult to make this happen. So now, basically, we have a side of the male RG that speaks English [...] Russia, we are on Facebook contacts, but uh... he doesn't speak English and I don't speak Russian [laughs] so... yes, these things are difficult, there is no consistency of work (Marco, Canada, p.08).

In short, the internationalization and the organization of the international championships have not brought many outcomes. For Marco (Canada), all this movement “became just like a special experience for one or a few people and, from the point of view of FIG, this is not enough to even think about making it official”. Despite the importance of FIG approval of the MRG, for now, making the Code of Points, books and papers available in English language, as the rules and opening the gymnastics practices for anyone who wants to learn more about the sport could be a starting point to a real internationalization of the sport.

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ASSOCIATIONS BETWEEN MOVEMENT CONTROL QUALITIES IN ELITE RHYTHMIC GYMNASTS

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ABSTRACT
A recently-developed skill test battery, RG Movement Screen (Darling et al. 2021), visually assesses biomechanical qualities of foundational movement control in various postures in rhythmic gymnasts. The purpose of this study was to identify the essential movement control qualities that are associated with major body difficulties and to quantify the improvements with feedback to elite gymnasts in one year by analyzing the screening grades. RG Movement Screen was conducted on the USA National Team gymnasts in 2019 (Version 1) and 2020 (Version 2) by the same physical therapists. They made a 3-point grading scale on biomechanical appropriateness and safety during 17 fundamental movements in Version 1 and 15 movements in Version 2. De-identified data were obtained for 26 national team gymnasts in 2019 and 20 gymnasts in 2020. The average screening grade of individual gymnasts was correlated with their Activities of Daily Living score ($r = .604$) in the Dance Functional Outcome Survey (Bronner et al. 2019). Screening grades on the penché balance with and without a ring position were both associated with various screening grades on controlling the pelvis and joints in biomechanically appropriate postures. With individualized feedback on screening results and recommended exercise, the gymnasts increased the average screening grade by 10% in one year, with a 9% improvement on the penché ring balance and the largest improvement on turnout-related posterior hip flexibility by 42%. The gymnasts increased an average symmetry index by 9% across postures and movements, with the largest improvement on hip-extension symmetry by 40%. These data with interpretation from the biomechanical perspectives provide new insights into focused training on specific fundamental neuromuscular control and demonstrate the usefulness of RG Movement Screen for improving rhythmic gymnastics skills.

Key words: Physical Preparation, Body Difficulty, Biomechanics, Motor Control, USA Gymnastics

INTRODUCTION
Many body difficulties in rhythmic gymnastics are possible only with appropriate posture and movement controls, which are the combinations of foundational movement controls. A recently-developed skill test battery, RG Movement Screen (Darling et al. 2021), visually assesses biomechanical qualities of foundational movement control in various postures in rhythmic gymnasts. This preliminary study aimed to identify the essential movement control qualities that are associated with major body difficulties and to quantify the improvements with feedback to elite gymnasts in one year by analyzing the assessment scores for specific control aspects and the final screening grades in RG Movement Screen.

METHODS
Details of RG Movement Screen are described elsewhere (Darling et al. 2021). Version 1 was composed of the assessment of 32 specific control aspects during 17 fundamental screened movements in terms of biomechanical appropriateness and safety. Some of the movements were replaced in Version 2, which was composed of the assessment on 37 specific control aspects during 15 movements. Twelve movements were common across Version 1 and Version 2. The detailed assessments on the satisfaction of specific control aspects were scored in a 3-point grading scale (0: Yes, -1: Intermediate, -2: No) (termed control score). Larger negative values in the control score indicated less satisfaction. In both versions, specific control assessments were integrated into a final 3-point grading scale (0: Pass/Green, -1: Warning/Yellow, and -2: Problem/Red) on the corresponding screened movements (termed screening grade). Larger negative values in the screening grade indicated greater problems in screened movements. RG Movement Screen was administered to the USA National Team gymnasts (both individual and group) in November 2019 on Version 1 and in October 2020 on Version 2 by the same physical therapists. Gymnasts received individualized feedback on their screening results and recommended exercise. In 2020, they rated their current capabilities on a 6-point scale on 6 activities of daily living and 8 dance techniques subjectively, using Dance Functional Outcome Survey (DFOS) (Bronner et al. 2019). The ratings in DFOS were scored into a maximum of 40 points for activities of daily living and a maximum of 50 points for dance technique, and the maximum of 90 points of these additions was converted to a maximum of 100% as a total score. Details of the
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development and administration of RG Movement Screen are described elsewhere (Darling et al. 2021). De-identified data of all these assessments were obtained for 26 (10 juniors and 16 seniors at the time of screening) and 20 (6 juniors and 14 seniors) USA National Team gymnasts in 2019 and 2020, respectively. There were 19 (5 juniors and 14 seniors) gymnasts who were screened in both 2019 and 2020.

To identify potential associations between fundamental movement assessments, the screening grades in 2019 were processed in the following manner. Within a gymnast, a deviation between one movement (e.g. Right Hip Extension) and another (e.g. Penché Balance on Left Leg) was calculated across movements and termed ScreenDev. The smaller absolute values of ScreenDev indicate smaller grade deviations between the pair of movements. If the grades are identical between movements, ScreenDev is 0 (i.e. no deviation). The pairs of movements that had small absolute values of mean ScreenDev (i.e. small deviation from 0) were regarded as the associated movements that share similar skill requirements.

To obtain more specific control aspects that are associated between movements, the control score in the specific assessments in 2019 was processed in a similar manner and termed ControlDev. The pair of specific control aspects that had smaller absolute values of mean ControlDev (i.e. small deviation from 0) were regarded as the associated skills that share similar control requirements.

To quantify the asymmetry between the right and left sides, deviation in the screening grade between the right- and left-sided movements was calculated across the movement pairs that had left- and right-sided postures. In each pair, the absolute value of the symmetry deviation was determined and termed ScreenRLDev. The smaller values of ScreenRLDev indicate less asymmetry (i.e. greater symmetry).

To examine the improvement in one year, the screening grade of 12 common movements in 2019 was subtracted from that in 2020 (ΔScreen) in 19 gymnasts who were screened in both years. The greater positive values in ΔScreen indicate the greater improvement in one year. Similar calculations were made on ScreenRLDev, the index of asymmetry.

To test the potential association in assessments between the RG Movement Screen grade and survey results of DFOS, correlation analysis was performed between the mean grade of RG Movement Screen and each score of the DFOS across 20 gymnasts in 2020. Pearson’s correlation coefficient was determined in each correlation analysis.

RESULTS

Screening Grades. In the screening grade, the larger negative (i.e. lower) grades indicate greater problems. Across gymnasts in 2019, the mean screening grade was -1.03 ± 0.30 (mean ± SD). The highest grade was recorded in Side Plank on Right (-0.31 ± 0.47) and Left (-0.38 ± 0.57) Elbow, followed by Penché Balance on Right Leg (-0.46 ± 0.81). The lowest grade was found in Penché Balance on Left Leg with Ring Shape (-1.69 ± 0.47), followed by Seated Lotus Position with Right (-1.54 ± 0.76) and Left (-1.54 ± 0.81) Leg on Top, indicating the weaknesses in this difficult form of balance and the turnout-related posterior hip flexibility.

Screening Grade Deviations from Penché Balances. To identify the associated movements that share similar skill requirements, ScreenDev between movements was averaged across gymnasts in 2019. The absolute value of mean ScreenDev ranged from 0.12 to 0.77 across movement pairs. The smallest absolute value was found between Relevé Balance on Right Leg with Left Leg in Front Passé and Penché Balance on Left Leg (0.12 ± 0.24). The second smallest absolute value was found between Right Hip Extension and Penché Balance on Right Leg with Ring Shape (0.19 ± 1.17).

These results indicate that the skill in Penché Balance on Left Leg (Figure 1J) was associated with the skill in Relevé Balance on Right Leg with Left Leg in Front Passé (Figure 1H), and the skill in Penché Balance on Right Leg with Ring Shape (Figure 1C) was associated with the skill in Right Hip Extension (Figure 1K & 1L).
Figure 1. Identified associations between the abilities for controlling screened movements in RG Movement Screen (Darling et al. 2021). Associations are connected with red arrows while the right (pink) and left (blue) legs are color-coded.

**Penché Balance without Ring Shape.** To further examine the associated specific controls, ControlDev between control scores was averaged across gymnasts in 2019. The absolute value of mean ControlDev ranged from 0.00 to 1.29 across control aspect pairs. The following comparisons showed relatively low absolute values in ControlDev. In reference to "Split ≥ 180°" in Penché Balance on Left Leg, the lowest value was found against “Able to Lift Leg without External Rotation” in Right Hip Extension (0.04 ± 1.40). Note in Right Hip Extension, ControlDev against just “Able to Lift off Ground” (green arrow in Figure 1L) was much higher (1.00 ± 1.27). Note also that the original control score for “Able to Lift Leg without External Rotation” (-1.38 ± 0.94) was lower than “Able to Lift off Ground” (-0.63 ± 0.93) in Right Hip Extension. Other low ControlDev values in reference to “Split ≥ 180°” in Penché Balance on Left Leg were found against “Good Foot-Ankle Position” (0.15 ± 1.29) in Relevé Balance on Left Leg with Right Leg in Front Passé as well as against “Good Foot-Ankle Position” (0.12 ± 1.51) and “Good LumboPelvic-Hip Position” (0.19 ± 1.33) in Relevé Balance on Right Leg with Left Leg in Front Passé. The results demonstrate that the split leg control of Penché Balance on Left Leg (Figure 1J) was associated with the right leg and pelvis control in Right Hip Extension (Figure 1K), the left foot-ankle control in Relevé Balance on Left Leg with Right Leg in Front Passé (Figure 1I), and the right foot-ankle and lumbopelvic-hip control in Relevé Balance on Right Leg with Left Leg in Front Passé (Figure 1H). Also, within Relevé Balance on Right Leg with Left Leg in Front Passé, ControlDev showed a very small value (0.08 ± 1.32) between “Good (right) Foot-Ankle Position” and “Good LumboPelvic-Hip Position”, indicating an association between these skills on different body parts within the same movement.

**Relevé Balance with Front Passé.** For relevé balance with passé, ControlDev in reference to “Good LumboPelvic-Hip Position” in Relevé Balance on Right Leg with Left Leg in Front Passé had low absolute values against “Good Foot-Ankle Position” in the same posture (0.08 ± 1.32), “Good Trunk Control” in Quick (0.00 ± 1.50) and Slow (0.08 ± 1.44) Jumps in First Position, and “Good Lumbar Position” (0.08 ± 1.44) and “Good Scapular Position” (0.15 ± 1.38) in Front Plank. Note ControlDev was also low between “Good Lumbar Position” and “Good Scapular Position” in Front Plank (0.26 ± 1.03). The results indicate that the trunk control in Relevé Balance on Right Leg with Left Leg in Front Passé (Figure 1H) was associated with the foot-ankle control in the same posture, the trunk control in Quick or Slow Jumps in First Position (Figure G), and the lumbar and scapular control in Front Plank (Figure 1F).

**Penché Balance with Ring Shape.** In examining the associations with Penché Balance with Ring Shape (Figure 1C), ControlDev in reference to “Foot Touches Head When Knee Bends” in Penché Balance on Right Leg with Ring Shape had low absolute values against “Left Leg Lower than Waist” in Seated Lotus Position with Left Leg on Top (0.02 ± 1.20), “Right Leg Lower than Waist” in Seated Lotus Position with Right Leg on Top (0.06 ±
1.13), and “Able to Lift Leg without External Rotation” in Right Hip Extension (0.25 ± 1.24). The results indicate that the control of Penché Balance on Right Leg with Ring Shape (Figure 1C) was associated with the turnout-related flexibility of the posterior hip in Seated Lotus Position (Figures 1D & 1E) as well as the leg and pelvis control in Right Hip Extension (Figure 1K).

Développé à la Seconde. Développé à la Seconde (i.e. hold the leg at 90° to the side) was added to the screened movements in Version 2. The mean screening grade was -0.95 ± 0.60 on Left Leg and -1.00 ± 0.56 on Right Leg across gymnasts in 2020. In reference to Développé à la Seconde on Right Leg with Left Leg in Front Passé (0.00 ± 0.86) and against Relevé Balance on Left Leg with Right Leg in Front Passé (0.05 ± 0.89). Similarly, in comparison to Développé à la Seconde on Left Leg, the lowest absolute value was found against Relevé Balance on Right Leg with Left Leg in Front Passé (0.05 ± 0.83) and against Relevé Balance on Left Leg with Right Leg in Front Passé (0.10 ± 0.91). These results indicate that the skill for Développé à la Seconde (Figure 1B) was associated with Relevé Balance in Front Passé (Figure 1H). To examine the associated control aspects with other movements, ControlDev was averaged across gymnasts in 2020. The lowest absolute value in mean ControlDev was found, in reference to “Good LumboPelvic Position” in Développé à la Seconde on Right Leg, in the deviations against “Good LumboPelvic-Hip Position” in Relevé Balance on Right Leg with Left Leg in Front Passé (0.06 ± 1.01) and against “Good Pelvic Position” in Side Plank on Right Elbow (0.09 ± 0.67). These results indicate that the ability for the lumbopelvic control in Développé à la Seconde on Right Leg (Figure 1B) was associated with the lumbopelvic control in Relevé Balance on Right Leg with Left Leg in Front Passé (Figure 1H) and Side Plank on Right Elbow (Figure 1A).

Asymmetry. Mean ScreenRLDev, an index of asymmetry, ranged from 0.15 to 1.04 across pairs of movements. The highest value was in Penché Balance on Right/Left Leg (1.04 ± 0.96), followed by Penché Balance on Right/Left Leg with Ring Shape (0.54 ± 0.71). The large difference between the forms of penché balance corresponded to much better ScreenDev on the right leg in the former (-0.46 ± 0.81 on right vs. -1.35 ± 0.94 left legs) than the latter (ring-shaped) form (-1.23 ± 0.71 on right vs. -1.69 ± 0.47 left legs). These large ScreenRLDevs were followed by Relevé Balance on Right/Left Leg with Left/Right Leg in Front Passé (0.38 ± 0.70) and Right/Left Hip Extension (0.32 ± 0.38). The mean ScreenRLDev in Développé à la Seconde on Right/Left Leg (screened only in Version 2) was in a similar range (0.35 ± 0.67). The results indicate that large or substantial asymmetry was present in balances and hip extension. In hip extension, however, the mean screening grade across gymnasts was comparable across the right (-1.04 ± 0.82) and left (-1.08 ± 0.86) legs. The substantial asymmetry index despite the comparable mean screening grade between sides for hip extension indicates that the asymmetry toward the right or left sides was not consistent across gymnasts but variable depending on gymnasts.

1-Year Improvement. As a measure of improvement in screening grade in one year, ΔScreen from 2019 to 2020 was calculated in 19 gymnasts who were screened in both years. Note a higher ΔScreen indicates greater improvement. Mean ΔScreen across movements was 0.11 ± 0.27, which corresponded to a 10% improvement from 2019 to 2020. The highest ΔScreen was found in Seated Lotus Position with Left Leg on Top (0.68 ± 0.67, by 43%) and Right Leg on Top (0.68 ± 0.75, by 42%) (Figures 1D & 1E). The next highest ΔScreens were Slow Jumps in First Position (0.11 ± 0.83, by 12%) (Figure 1G), Left Hip Extension (-0.11 ± 0.74, by 9%), and Penché Balance on Left Leg with Ring Shape (0.16 ± 0.60, by 9%). These changes highlight the greater improvement in turnout-related posterior hip flexibility on both sides and the left-side improvement in hip extension and a left-legged balance.

For asymmetry, mean ScreenRLDev decreased by 9% (i.e. improved symmetry) from 0.33 ± 0.24 in 2019 to 0.25 ± 0.17 in 2020 across movement pairs. The largest change was recorded as a 40% improvement on Right/Left Hip Extension (0.26 ± 0.44 in 2019, 0.16 ± 0.17 in 2020). This was followed by a 30% improvement on Relevé Balance on Right/Left Leg with Left/Right Leg in Front Passé (0.56 ± 0.76 in 2019, 0.39 ± 0.59 in 2020) and 15% improvement in Penché Balance on Right/Left Leg with Ring Shape (0.68 ± 0.73 in 2019, 0.58 ± 0.59 in 2020). These results indicate large improvements in symmetry in hip extension and balances.

Self-Administered Survey (DFOS). A correlation analysis was performed between the total screening grade in RG Movement Screen and each of self-administered DFOS (Activities of Daily Living, Technique, and Total) across 19 gymnasts in 2020. Pearson's correlation coefficient with the total screening grade was highest with the score in activities of daily living (r = .604, p < 0.01), followed by the total score (r = .542, p < 0.05) and the technique score (r = .476, p < 0.05) in DFOS. No higher correlation was found. They indicate that the self-assessment on dance techniques had a significant but limited correlation with RG Movement Screen grade, which was less significant than the self-assessment on activities of daily living.
DISCUSSION
This analysis of data from RG Movement Screen assessments in the USA National Team gymnasts helped detect associations between fundamental movement control qualities, quantify asymmetries, and identify the 1-year improvements in elite rhythmic gymnasts. The initial analysis of the deviations between the screening grades (ScreenDev) detected major associated movements. *Penché Balance on Left Leg* (Figure 1J) was associated with *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 1H), and *Penché Balance on Right Leg with Ring Shape* (Figure 1C) was associated with *Right Hip Extension* (Figure 1K). The subsequent analysis of deviations between the control scores (ControlDev) further clarified what specific control aspects were associated among movements.

**Associations with Penché Balance.** Penché balance (without ring shape) is one of the advanced body difficulties in rhythmic gymnastics. According to the ControlDev analysis, the control skill for making and maintaining the split ≥ 180° in *Penché Balance on Left Leg* (Figure 1I) was most associated with the ability to lift the right leg without external rotation of the pelvis in *Right Hip Extension* (Figure 1K), but not much with the capability to just lift the right leg during the hip extension (Figure 1L). In this form of penché balance, the hip extension of the right leg is used for producing a large split with the lifted right leg. The findings indicate that it is not the capability for just producing hip extension force, but for controlling hip extension force while maintaining the neutral position of the pelvis without external rotation.

The testing posture for hip extension was chosen to focus on the ability for controlling the gluteus maximus and hamstring muscles against the stiffness of the anterior hip flexors without anterior tilt of the pelvis. The lower control score for "Able to Lift Leg without External Rotation" (-1.38) than for just "Able to Lift off Ground" (-0.63) in *Right Hip Extension* indicates that, while gymnasts possess enough hip extensor force production capability as well as hip flexor flexibility for just lifting the leg, some gymnasts do not have good ability for doing so without external rotation of the hip. There are two potential causes for this problem. One potential cause is the limited hip flexor flexibility in the neutral pelvis position (aka “squared-hip flexibility”). For creating a large split appearance, gymnasts tend to externally rotate the pelvis (aka “twisted hips”) of the posterior-leg side during gymnastics movements including flexibility exercises. Those gymnasts do not develop enough hip flexor flexibility in the neutral pelvis posture. Another potential cause is the limited ability for activating the gluteus maximus and hamstring muscles in a neutral hip position. In various gymnastics movements such as battement derrière and arabesque balance, some gymnasts tend to anteriorly tilt the pelvis (causing lumbar extension) for creating a lifted appearance of the posterior leg without fully extending the hip joint. Such movements cause overuse of lumbar extensors, with less activation of the gluteus maximus and hamstrings. Those gymnasts would not develop enough neural ability for activating the hip extensor muscles, and likely their mass is less developed.

![Figure 2](image1.png)

**Figure 2.** Associations between “Good Foot-Ankle Position” and “Good Lumbopelvic-Hip Position” in *Relevé Balance on Right Leg with Left Leg in Front Passé* (A, B) and “Split ≥ 180°” in *Penché Balance on Left Leg* (C, D). Panel B is the side view of panel A. Panel D is rotated by 90° anticlockwise to make panel C. The left hip joint is flexed in both balances.

The observed association between “Split ≥ 180°” in *Penché Balance on Left Leg* (Figure 1I) and “Good Foot-Ankle Position” in *Relevé Balance on Left Leg with Right Leg in Front Passé* (Figure 1I) is intuitive because both use the left leg as the supporting leg. In contrast, the identified association between “Split ≥ 180°” in *Penché Balance on Left Leg* (Figure 2D) and “Good Foot-Ankle Position” (of Right Leg) and “Good Lumbopelvic-Hip Position” in *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 2A) may seem
perplexing because the supporting legs are opposite. It can be interpreted, however, if we rotate the picture of *Penché Balance on Left Leg* (Figure 2D) by 90° anticlockwise so the trunk artificially appears in an upright position (Figure 2C). In this rotated view, it becomes apparent that the left hip joint in *Penché Balance on Left Leg* is in the similarly ~90° flexed position relative to the trunk as in *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 2B). Hence, with the common posture of the left hip joint flexed to ~90° (blue arrows in Figure 2), the ability for creating and maintaining split ≥ 180° in *Penché Balance on Left Leg* (while controlling the lumbopelvic-hip complex) is associated with the control of the lumbopelvic-hip complex as well as the foot and ankle in *Relevé Balance on Right Leg with Left Leg in Front Passé*. For an association between “Good Lumbopelvic-Hip Position” and “Good Foot-Ankle Position” in the same *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 2A), the underlying interaction would be that the inability to control the appropriate foot-ankle position likely originates from the inability to control the lumbopelvic-hip complex in a good neutral position. Collectively, “Split ≥ 180°” in *Penché Balance on Left Leg* and “Good Foot-Ankle Position” in *Relevé Balance on Right Leg with Left Leg in Front Passé* are likely not directly associated. Rather, both are associated with the same ability to control the lumbopelvic-hip complex in a good neutral position when the left hip joint is flexed to ~90°.

**Associations with Relevé Balance with Front Passé.**

The control of the lumbopelvic-hip complex in *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 1H) was also associated with the trunk control in *Quick or Slow Jumps in First Position* (Figure G) as well as the lumbar and scapular control in *Front Plank* (Figure 1F). These associations are reasonable because most of them are on the ability to control the lumbopelvic-hip complex. The involvement of the scapular control in *Front Plank* among these associations is likely not due to a direct association with the lumbopelvic-hip control in *Relevé Balance* but an indirect association due to its presumed association with the lumbar control in *Front Plank*. The association between the control of the lumbopelvic-hip complex in *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 1H) and the lumbopelvic control in *Développé à la Seconde on Right Leg* (Figure 1B) is reasonable because both involve the lumbopelvic control during balances with the comparable supporting and lifted legs. The association between the lumbopelvic control in *Développé à la Seconde on Right Leg* (Figure 1B) and the pelvic control in *Side Plank on Right Elbow* (Figure 1A) is also reasonable because both involve the pelvic control in postures with the common supporting leg (right leg).

**Associations with Penché Balance with Ring Shape.**

The ability of the left foot to touch the head in *Penché Balance on Right Leg with Ring Shape* (Figure 1C) was most associated with the turnout-related flexibility of the posterior hip in *Seated Lotus Position* (Figures 1D & 1E). The functional association between these abilities is unclear and requires further examination. Nonetheless, limited posterior hip flexibility restricts the glide of the femoral head posteriorly with hip flexion, so it increases the risk of anterior hip impingement. The association between the ability of the left foot to touch the head in *Penché Balance on Right Leg with Ring Shape* (Figure 1C) and the ability to lift the right leg without external rotation in *Right Hip Extension* (Figure 1K) is not intuitive because the lifted and hip-extended legs are opposite. This association may be understood if we pay attention to the force (torque) components for maintaining the horizontal trunk posture in this penché balance. In Figure 1C, the hip extension motion of the left leg along the blue arrow produces rotational torque about the right hip joint in the direction of the arrow. Since the right leg is vertically stabilized on the floor, this torque corresponds to hip flexion torque (i.e. to narrow the space between the trunk and the thigh) for the right leg. For maintaining the horizontal trunk posture, gymnasts activate the right hip extensors against lengthening force to counteract the right hip flexion torque. If gymnasts have limited ability for activating the right extensors and creating extension torque about the right hip joint (pink arrow) in the appropriate pelvic posture, they cannot resist the hip flexion torque, lose the horizontal trunk posture, and thus the balance.

**Associations with Développé à la Seconde.**

The association between the lumbopelvic control in *Développé à la Seconde on Right Leg* (Figure 1B) and the lumbopelvic control in *Relevé Balance on Right Leg with Left Leg in Front Passé* (Figure 1H) is reasonable because they are both about lumbopelvic control during right-legged balances. The association with the lumbopelvic control in *Side Plank on Right Elbow* (Figure 1A) is also reasonable because these are both about lumbopelvic control when the supporting leg is the right leg. Collectively, these associations highlight the important associations in lumbopelvic control during movements with the common supporting leg.

**Asymmetry.** The greatest asymmetry found in penché balances is not surprising because they are the most difficult movements among the screened movements. Gymnasts tend to focus on a better side (often the
right side for the supporting leg) for mastering these difficult balances. The greater asymmetry in a more difficult form of penché balance (with ring shape) than a less difficult one (without ring shape) substantiates this interpretation. The substantial asymmetry in hip extension with variable side-dependence across gymnasts may suggest that hip extension asymmetry may have resulted not from a general preference on one side across gymnasts but specific characteristics or preference of training in individual gymnasts.

1-Year Improvement. The largest improvement (by 42-43%) in turnout-related posterior hip flexibility in Seated Lotus Position is due to the low initial screening grade, most likely because exercise in this position is not common in rhythmic gymnastics. Through feedback, the awareness of this limitation and suggestions on associated exercise appear to have led to the improvement. The comparable improvements (by 9%) across Left Hip Extension and Penché Balance on Left Leg with Ring Shape may imply that the improvement of the latter was owing to the improvement of hip extension based on the previous discussion on such a relationship in the opposite leg combination. For asymmetry, the large improvement in Hip Extension symmetry (by 40%) was due to the improvement on the left leg in 19 gymnasts who were screened in both years. The improvements of symmetry in the balances were also due to the improvements in the posture of the left leg being the supporting leg.

Associations with Survey. The absence of a strong correlation between the self-administered survey and the screening score administered by physical therapists indicates that even elite gymnasts have limited capability for self-assessing their technical capabilities accurately. It emphasizes the need for movement control assessments by a professional.

Essential Control Skills. The data analysis revealed associations between motion control skills in elite rhythmic gymnasts. Among others, there appear to be specific control abilities that are the basis for multiple fundamental movements and body difficulty skills. First, the ability for controlling the leg without external rotation during hip extension appears to contribute to the skill of penché balances in different forms. In particular, hip extension control of the leg that is used as a supporting leg in penché balances appears to play an important role. Second, the ability for controlling the trunk (part of all of the lumbopelvic-hip complex) in an appropriate neutral position during the front and side planks as well as during jumps (landings) appear to contribute to the ability for controlling the trunk during one-legged upright balances (Relevé Balance with Front Passé, Développé à la Seco, and consequently to penché balance. These essential control skills are related and can be improved with appropriate focused exercises: 1) correction of frequently-observed “twisted hips” into “squared hips” (neutral pelvis position) during over split stretching to create a split amplitude in the neutral pelvis position, 2) sustained activation of “core muscles” (i.e., transverse abdominis, multifidus, and pelvic floor muscles) in the neutral pelvis position to stabilize the core, and 3) isolated hip extensor activation without compensatory anterior pelvic tilt or back arching. Since these control skills are basically in the direction of using the musculoskeletal system in biomechanically appropriate manners, improvements of these specific skills with focused training would lead to the improvement of both gymnastics skill performance and safety. In conclusion, these data with interpretation from the biomechanical and technical point of view provide new insights into focused training on specific fundamental neuromuscular control and demonstrate the usefulness of RG Movement Screen for improving rhythmic gymnastics skills.

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REQUIREMENTS FOR THE TEACHING OF RHYTHMIC GYMNASTICS: PAULO FREIRE PERSPECTIVES

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ABSTRACT
The pedagogical aspects of Rhythmic Gymnastics have been enhanced in recent decades from the theories of Pedagogy, Physical Education and Sport Sciences. The aim of this study was to bring possibilities to teach RG, based on the book “Pedagogy of Autonomy”, by the Brazilian pedagogue Paulo Freire (translated into more than 20 languages). The book indicates several “requirements to “teach”, and, in this study the proposal is to link some of them to the reality of RG, using a bibliographic research, with thematic analysis. One of the requirements refers to the safety, professional competence and generosity of the educator (teacher or coach), a condition that seems obvious, but that often triggers the fragility in the educator's technical, pedagogical, and/or human formation; or that triggers a process historically constructed and difficult to transform. As an educator who has a lot of technical knowledge but who does not know how to teach; or that does not offer technical or emotional security to their students/gymnasts. Another requirement is the commitment, not only with the profession and the discipline, but with the educational principles of a critical and citizen formation. Another requirement is freedom and authority, which refers to strengthening leadership, knowing when and how to provide freedom, and how to have authority, without being authoritarian. And finally, a fundamental requirement, which is the availability for dialogue, something that is still unusual in gyms and schools. An ethical, sincere and humble posture, which sustains the relationship between the educator and the student/gymnast provides an exchange of experiences and knowledge, strengthens confidence in the process and bonds (personal and institutional). It is concluded that this celebrated book of the author can bring subsidies and a paradigm break for the teaching of GR (in schools, gyms etc), from initiation to high performance.

Key words: Formação Profissional, Teaching, Coaching, Autonomy

INTRODUCTION
This study is based on the author's production in three publications that relate Gymnastics to the author Paulo Freire, two of them related to gymnastics for all (Toledo, 2005; 2007) and one book chapter related to rhythmic gymnastics (Toledo, 2014), and brings advances in these proposals practically five years later.
Thus, we aim to present some pedagogical aspects that we consider relevant to the teaching of rhythmic gymnastics (RG), anchored in Paulo Freire's proposal for an Education for autonomy (1996).
To have chosen Paulo Freire as the main theoretical reference of this study is to envision another pedagogical practice for GR, in different teaching contexts (formal and non-formal), from basic level to high performance, aiming at breaking or reframing classic practices of this modality or of these contexts (usually imbued with principles and actions traditionally reproduced without questioning or reflections in gyms). And as Padilha (2002) rightly mentions, opting for this framework is opting for a transformative and citizen education.
It is therefore a qualitative research of the bibliographic type, having as primary source the book “Pedagogia da Autonomia”, and having as a secondary source books that dialogue with it (in books, articles and abstracts of congresses). And that is justified by the fact that we still identify it by other productions, and by the experience lived in the modality. This theme is still necessary to be studied and mainly applied in the gymnasia.
The pedagogical aspects of sport have been the object of study in Physical Education and Sport Sciences, which outline the specificities that our area has in this context (Soares et al, 1996; Paes & Balbino, 2005; Scaglia, 2012; Bento, 1995; 1998; 2013; Bento & Marques, 1999; Armor, 2011; Light & Harvey, 2019; Cassidy et al, 2016).
Various approaches to teaching and practicing rhythmic gymnastics have been viewed with a focus on a sporting and competitive perspective (Peuker, 1973; Guérions, 1974; Vieira, 1982; Volpi, 1983; Mendizábal & Mendizábal, 1985; Bodo-Schmid, 1985; Bizzochi & Guimarães, 1985; Boot, 1986; Lisitskaya, 1995). These authors brought valuable contributions to a pedagogical perspective of teaching Rhythmic Gymnastics, with some of them having proposals that are still applicable today.
The twentieth century brought other productions, mostly in books, which also valued these pedagogical aspects, bringing more current dialogues and ref-
erences (Laffranchi, 2001; Govea, 2003; Bobo & Sierra, 2009; Paoliello & Toledo, 2010). The most recent work in this area was done by Viner-Usmanova et al (2014) and Jastrjembskaia & Titov (2016).

The production in abstracts (congresses) and papers that focus on the pedagogical aspects are still incipient. And more recently we had the important, but still small, collaboration of authors for a pedagogical approach to RG in papers, such as Gantcheva et al (2008), and Loquet, Gantcheva & Halilova (2009).

These bring an indirect pedagogical approach, since they are more focused on the technical aspects of the discipline, such as teaching of a specific element (illusion) and a proposal to classify the technical difficulties and optimization of training in high performance. Thus, they have important contributions, but they do not, in fact, emphasize on the pedagogical aspects in the teaching-learning relationship of RG.

We still have some more recent examples of this incipient production, when we analyze an international event that addresses RG, and the only journal specialized in gymnastics disciplines (which also involves RG). For example, in the last edition of SIGARC – International Seminar of Artistic and Rhythmic Gymnastics (2017), we had 4 specific researches of RG, but none of them addressed the pedagogical aspects of teaching the discipline. Another example of this is reflected in the analysis of the 3 editions published in the year 2020 in the SCGYM - Science of Gymnastics Journal (2020), which did not bring any paper with an emphasis on the pedagogical aspects of RG.

These data strengthen the purpose of this research, which aims to identify the pedagogical aspects that propitiate a more dialogical and emancipatory proposal are seldom found in these productions, or in them little prioritized, further justifying the proposal of this study.

PEDAGOGICAL ASPECTS OF TEACHING IN RHYTHMIC GYM: DIALOGUES WITH PRINCIPLES OF PEDAGOGY OF AUTONOMY

The book “Pedagogia da Autonomia”, by Paulo Freire, is a work published in more than 20 countries, and has still guided many documents and works, especially those aimed at school. Just as it has guided many proposals for non-formal education, from many areas of knowledge, in the most diverse social contexts.

This work echoed a lot in our reflections and in our performance with RG, from what we experienced as gymnasts, coaches, referees, teachers and researchers. Precisely, viewing this author’s proposal, we can find a new possibility of practicing this modality, especially in the training of teachers and coaches, guiding their choices, mediations and sayings in their teaching environments.

This book consists of 3 chapters:

- Chapter 1 - There is no teaching without speech;
- Chapter 2 - Teaching is not transferring knowledge;
- Chapter 3 - Teaching is a human specificity.

For this study, with an essay character, we selected some principles from chapter 3, and with them we intend to outline some reflections, criticisms and ways of overcoming some themes that involve teaching of rhythmic gymnastics.

1. Teaching requires security, competence and generosity

In this part of the work, the author reinforces that professional incompetence disqualifies the teacher’s authority, that is, the teacher who is not qualified in principle, is not worthy of the respect of his students, nor of exercising teaching. In addition to educators being safe in their teaching, and gaining their authority by showing their professional competence, they must be endowed with an indispensable generosity regarding knowledge.

An ever-present effort to consistently practice democratic authority is what makes it almost a slave to a fundamental dream: that of persuading or convincing freedom and that it builds with itself, in itself, with materials that, although going outside itself, be reworked by it, its autonomy. It is with it, autonomy, painfully building, that freedom fills the "space" that was previously "inhabited" by its dependence. Its autonomy is based on the responsibility that is being assumed. (Freire, 1996, p.105 - author translation).

Although it seems an obvious condition, it often triggers the fragility in the technical, pedagogical, and / or human education of the educator (coach or teacher); or that triggers a process historically constructed and difficult to transform. And in the case of RG this is not uncommon, with an educator who has a lot of technical knowledge but who does not know how to teach; or that does not offer emotional security for their students. This requires, therefore, self-knowledge and self-criticism, to overcome some challenges or deficiencies in this training or professional performance.

2. Teaching requires commitment

At this moment, the author clarifies that contradictory postures of teachers in teaching are not acceptable,
that is, “[... if my option is democratic, progressive, I cannot have a reactionary, authoritarian and elitist practice ... The perception that the student has from me does not result exclusively from how I work but also from how the student understands how I work”. (Freire, 1996, p.109 - author translation).

So, how can an educator desire and ask his students what is not? How can students demand boldness and creativity in RG routines, if educators do not act in this way and do not set their own example, offering classes and training that are totally directed? How to ask for the participation of students if there is no commitment to listen in almost all other moments of classes and training? What is the view that students have about me and relate to me? In other words, the attitude assumed by educators says more than their words, therefore, directly impacting on the students' view of their little commitment to the students/gymnasts' teaching-learning process.

3. Teaching requires freedom and authority

It is by deciding that one learns to decide ... What is necessary, fundamentally, is that the child assumes ethically responsibly, his decision, the foundation of his autonomy. Nobody is autonomous first and then decides .... And nobody is subject to anyone's autonomy. Autonomy, as the being matures for itself, is a process, it is becoming. (Freire, 1996, p.120;121 - author translation).

There is no autonomy without freedom, a freedom that can be reflected and shared with those in the group and with those who have the authority.

We have heard many reports from students and gymnasts pointing out that they have no freedom to express their feelings, pain, creative proposals for routines, a view of what is happening with other colleagues/gymnasts, suggestions for changes in training cycles etc. Students/gymnasts feel like cattle in a herd, like robots, like mere reproducers of orders, like docile bodies (Foucault, 1987), with a total devaluation of health. Something that should be revisited by educators, especially in the understanding that granting freedom (mediated, respectful, ethical) does not mean losing authority, that is, it requires a change in the concept of what it means to be a good leader, with authority and not authoritarian.

4. Teaching requires availability for dialogue

Educators must be available for dialogue, even if it means telling the student, in a sincere, humble and ethical posture, that they do not master all knowledge, as this availability shows the student that “My security does not rest on the false assumption that I know everything, that I am the ‘greatest’. My security rests on the conviction that I know something and that I ignore something that adds to the certainty that I can know better what I already know and know what I don't yet know.” (Freire, 1996, p.153 - author translation). It is necessary to debate the actions of the world in the dialogue with the students.

According to the author himself, in another work, “Dialogue is the encounter between men, mediated by the world, to designate it ... Dialogue cannot exist without a deep love for the world and for men. Love is both the foundation of dialogue and dialogue itself.” (Freire, 1980, p.82;83 - author translation). The lack of dialogue in a gym can occur for a number of reasons, but it is usually related to the local / national culture, or the culture of gymnastics (and high-performance sport in general) of subservience, or the tradition in which the trainer was formed and reproduces. And this lack of dialogue is sometimes justified by the precepts of the sports environment, of facilitating or streamlining the teaching process, precepts consistent with a society with a neo-liberal foundation, end up precisely preventing the integral formation of the individual, saving him from experiencing reflection, respect for the other, the confrontation of ideas, creativity, the human and ethical relationship, provided by dialogue.

ON BREACHES OF PARADIGM IN RHYTHMIC GYMNASTICS

Teaching rhythmic gymnastics, as well as other gymnastics, should be constantly searched, in line with the pedagogical premises of the field of Pedagogy and Sport Sciences, in a perspective of continuous improvement, having seen the many traumatic processes that are being experienced and narrated by children at school or by high-performance gymnasts in clubs and training centers (Rubio, 2015; Boaventura, 2016).

Thus, these principles of Paulo Freire (and others in your productions) must be present in the first contact with the modality (in whatever teaching contexts - clubs, schools, associations, public programs etc.), and must be maintained as guidelines of the sport initiation to high performance (clubs and training centers).

There is another universe of possibilities to cover the pedagogical aspects in the teaching of rhythmic gymnastics, impossible to be measured in this text. There are aspects of the field of sensitivity, affectivity, values, passion for gymnastics and everything it can provide to the human experience, transforming lives. And in this context, the role of the educator is very
important to motivate this dance, because often “the problem” is not the RG, but the dance that was not done with it ... at school and/or in training professional, in sports and leisure contexts etc. Non-existen
tent experiences, either frustrated, or traumatizing, or surrounded by preconceptions that our culture has historically built (and that we have a duty to de-
construct, based on a pleasant and meaningful prac
tice).

For Velardi (1999, p.23 - author translation):

[...] RG is an always new activity, different for each composition, for each exploration of the aspects of time, space and form, of its principles and dimensions, enabling the most varied compositions and interpretations. There is always an attribution of symbolic values to the body movement, the manipulation of the devices and the music, fed by each one of them, always composing a new, original and creative content.

Its regulation, however, determined by the International Code of Points of the International Gymastics Federation, has often been responsible for the “forgetfulness” of these factors that differentiate it from other sports, especially in relation to the possi-
bilities of interpretation, natural and fluent expression by body movement, apparatus handling and musical accompaniment.

Thus, our invitation with this book, and especially in this chapter, is for teachers and technicians to DARE TO ALLOW themselves new ways of understanding and teaching rhythmics (whether at school, in public squares, in associations, at university or at club - da initiation to training), as well as, CHALLENGE to propose the teaching of this manifestation, if they do not already propose it. Understanding in this way that students will be building a new experience with gymnastics, and allowing themselves to live the in-
credible, unique and unforgettable possibilities that it can bring.

No true teacher training can be done apart from, on the one hand, the exercise of criticality that implies the promotion of naive curiosity to epistemological curiosi

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ATTITUDES OF SICHUAN PROVINCE (CHINA) UNIVERSITY STUDENTS TOWARD RG ONLINE TRAINING

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ABSTRACT
Due to the COVID-19 pandemic, 4 universities in Sichuan Province, China put their RG training class online. Purpose: This research was mainly to find out how RG teachers designed online training during the COVID-19 pandemic. Methods: The questionnaire regarding the attitudes toward RG training online contained 6 items, aiming at providing basic information about the students. Among them, 4 items had to be answered along a 1-3 Likert scale indicating the students' hardware competence, and 15 items had to be answered along a 1-3 Likert scale indicating the students' feelings and attitude (Cronbach α:0.71). Conclusion: We adopted descriptive statistics and frequency statistics with SPSS 22.0 program, indicating the utilization rate of Tencent cloud conference was as high as 60.19% and the proportion of smartphone used for online training reached up to 79.61%. In this sense, it is wise to choose multifunction application which also supported smartphone to join the course. 57.6% students found that the space during the online class affected their completion of actions as requested. To fix the space challenge, the students found a spacious place where the teachers could arrange small-range physical exercises. In addition, 59.6% classmates believed that the online classes had increased their learning burden while 43.6% students thought the online training had improved their learning ability. Therefore, teachers appropriately increased the proportion of video appreciation and theoretical learning. Compared with traditional training, 54.5% students believed that the online training was less sport-intense, 64.6% students found the lower rate of equipment use Teachers arranged equipment exercises in the form of video feedback on homework after class.

Key words: online training; rhythmic gymnastics; college course; students

INTRODUCTION
During the COVID-19 pandemic, only four universities in Sichuan Province provided the course of Rhythmic Gymnastics, respectively, Chengdu Sport University, Sichuan University, Southwest Jiaotong University, Southwest Petroleum University in the form of online training for the previous term. The flipped classroom may increase the times of knowledge internalization of students' learning process by transferring the traditional way of study and decomposing the study material (Zhao, 2014). The flipped classroom teaching mode can help change the traditional teaching situation, promote the students' enthusiasm to participate in the study and make reasonable use of practice before class (Strayer, 2012). There would be efficient flipped courses when the students' learning attitude becomes positive. The online courses can make classes more personalized by holding more discussion and utilizing homework time to finish the practice (Bergmann, 2013). Students involved in this survey came from different schools and majors. Different students' backgrounds varied their engagement in online learning, such as the level of previous education, the previous online learning experience and the level of competence using the Internet (Shin, 2004).

Purpose of study
During the COVID-19 pandemic, only four universities in Sichuan Province, China set up the course of Rhythmic Gymnastics, respectively, Chengdu Sport University, Sichuan University, Southwest Jiaotong University, Southwest Petroleum University. Research was carried out about the online curriculum of Rhythmic Gymnastics.

METHODS
Regarding the online training of Rhythmic Gymnastics provided by universities in Sichuan Province during the COVID-19 pandemic, an online questionnaire was designed to know about the students' attitudes and feelings. A total of 25 questions were listed thereof, including multiple choices and completion. The questionnaire survey was conducted at universities in Sichuan Province that provided the course of Rhythmic Gymnastics, including Chengdu Sport University, Sichuan University, Southwest Petroleum University, and Southwest Jiaotong University. A total of 103 questionnaires were distributed with 99 questionnaires recovered, a recovery rate of 96%. The results were statistically analyzed by SPSS 22.0. Reliability test: The reliability of the questionnaire required for this study was tested with the Cronbach's a reliability coefficient. Upon analysis, the result is α>0.7. Therefore, the questionnaire is considered reliable. The student questionnaire's reliability coefficient a equals to 0.718, indicating that the questionnaire can measure the content effectively.
RESULTS AND ANALYSIS
Chengdu Sport University is the only specialized sports university involved in this study. The number of students involved in this survey accounted for 21.2% on average, 42.4% for Sichuan University, which was the highest, 26.3% for Southwest Jiaotong University, and 10.1% for Southwest Petroleum University, which was the least. The average age of the students involved was 18.98 years old.

Female students taking the class of Rhythmic Gymnastics accounted for the majority, about 85.9% with only 14.1% male students, 12 male students for Southwest Jiaotong University, 2 male students for Southwest Petroleum University, and no male student for Chengdu Sports College because of the particularity of this class. Only female students in Sichuan University chosen this class.

Table 1. Distribution of students by schools and gender (%)

<table>
<thead>
<tr>
<th>School</th>
<th>Grade</th>
<th>Percentage</th>
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<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Chengdu Sport University</td>
<td>2017</td>
<td>3.0</td>
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<td>21</td>
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<tr>
<td>Sichuan University</td>
<td>2018</td>
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<tr>
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<td>2019</td>
<td>20.2</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Southwest Petroleum University</td>
<td>2020</td>
<td>51.5</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>14</td>
<td>85</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Students majoring in Sports Training in Chengdu Sport University must have a national Level-2 gymnast certificate to get the qualification for enrollment examination. Southwest Jiaotong University got 7 Level-2 gymnasts and 9 Level-3 gymnasts. Considering the enrollment rules for students majoring in Dance, these students/gymnasts should join in the dance team, and the teacher who charge in dance team was also an RG gymnast.

Table 2. Level of gymnasts

<table>
<thead>
<tr>
<th>School</th>
<th>Level-1</th>
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<th>Level-3</th>
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<td>Sichuan University</td>
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<td>7</td>
<td>9</td>
<td>26</td>
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</tbody>
</table>
21.2% students majored in rhythmic gymnastics training in Chengdu Sport University, with 8% students majoring in performance or music performance, and the remaining 72% majoring in other majors similar to those in general universities, such as civil engineering, law, communication, and engineering mechanics, translation, and liberal arts etc. All these applications listed in Table 3 originated from China, with their instructions listed herewith. WeChat is compatible with all kinds of platforms for their multiple functions such as group chat, availability of voice, photo, video, and messages etc. Tencent QQ is an instant messaging software service and web portal developed by Tencent, a Chinese tech giant. Its cloud conference has been widely used in business conferences, annual meetings, road shows, lectures, industry forums etc. Thanks to these favorable functions, the participants can simply use their phones to obtain all relevant conference information. Besides, Superstar and Zhidao are similar to MOOC, and DingTalk is a professional office tool.

The utilization rate of Tencent cloud conference is as high as 22.7%, followed by DingTalk and QQ with 18% and 17.2%, and WeChat, Zhidao, and Superstar with 13.1%, 10.9% and 12.1%.

The proportion of smart phones used in online training reached up to 44.6% with the laptops of 37.1%. Smart phones and laptops are portable and easy to use. Their popularity among students result in the abovementioned high usage rate. The online course of Rhythmic Gymnastics requires students to adjust their equipment in time for physical exercises. As the desktop computers are fixed and bulky, the popularity of desktop computers is low. As a result, the desktop computers only account for 4.6% while the tablet computers account for 13.7%.
Table 4. Category of Devices (%)

<table>
<thead>
<tr>
<th>Devices</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop computer</td>
<td>8</td>
<td>4.6%</td>
</tr>
<tr>
<td>Laptop</td>
<td>65</td>
<td>37.1%</td>
</tr>
<tr>
<td>Tablet computer</td>
<td>24</td>
<td>13.7%</td>
</tr>
<tr>
<td>Smart phones</td>
<td>78</td>
<td>44.6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>175</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

69.7% students have online classes in the bedroom, with 25.3% in the living room, and 5% in the balcony and garden. 57.6% students thought that the space they were in during the online course affected their completion of movements.

Table 5. Space chosen for online training

<table>
<thead>
<tr>
<th>Space</th>
<th>N</th>
<th>Percentage</th>
<th>Space effect body movements?</th>
<th>percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom</td>
<td>69</td>
<td>69.7%</td>
<td>Yes</td>
<td>57.6%</td>
</tr>
<tr>
<td>Living room</td>
<td>25</td>
<td>25.3%</td>
<td>Not clearly</td>
<td>14.1%</td>
</tr>
<tr>
<td>Balcony</td>
<td>4</td>
<td>4.0%</td>
<td>No</td>
<td>28.3%</td>
</tr>
<tr>
<td>Garden</td>
<td>1</td>
<td>1.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>99</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More than 6 lessons of Rhythmic Gymnastics were provided by Chengdu Sport University per week online, lasting for more than 15 weeks, in contrast to only 2 to 4 lessons provided by ordinary colleges and universities. Sichuan University only provided 2 lessons a week, Southwest Jiaotong University provided 2 to 4 lessons a week, and Southwest Petroleum University provided 2 lessons a week. The course of Rhythmic Gymnastics provided by Chengdu Sport University is a core professional course for students majoring in Sports Training, as a result, so many lessons were provided and lasted for many weeks. And the course of Rhythmic Gymnastics provided Southwest Jiaotong University is for students from the dance team. For Southwest Petroleum University and Sichuan University, the duration is 2 lessons/week to 4 lessons/week.

Table 6. Length of online training

<table>
<thead>
<tr>
<th>University</th>
<th>Less 5 weeks</th>
<th>5 weeks-15 weeks</th>
<th>More 15 weeks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengdu Sport University</td>
<td>2 lessons</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>6 lessons</td>
<td>3</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Sichuan University</td>
<td>2 lessons</td>
<td>19</td>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>4 lessons</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>20</td>
<td>42</td>
</tr>
<tr>
<td>Southwest Jiaotong</td>
<td>2 lessons</td>
<td>5</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>University</td>
<td></td>
<td>4</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>6 lessons</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Southwest Petroleum</td>
<td>2 lessons</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>University</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>6 lessons</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

Half of the students who preferred online classrooms maintained neutral, and 36% students favored the teaching methods of online classroom. 59.6% classmates believed that the online classes have increased their learning burden, and 43.4% students thought that the online courses have broadened their vision of knowledge. With the improvement of physical skills, the evaluation of students also tended to be parallel. 49.5% classmates believed that the online courses have improved their ability of reflection and evaluation. The advantages and disadvantages of home-based
courses mostly depend on the individual's willingness and interest of leaning. Perhaps half of the students gave a neutral evaluation. Compared with the physical exercises in traditional classrooms, the online theoretical assignments requested more time and energy. The students who chose Rhythmic Gymnastics felt slightly more interested in physical exercises than theoretical studies. In this sense, the online courses have increased their learning burden. When preparing for the lessons, the teachers would prepare some competition videos or dance videos regarding rhythmic gymnastics while leaving some appreciating and evaluation assignments. Such design may enable students to improve their own reflection and evaluation capabilities. The combination with advantages of theoretical learning in online classrooms can improve the students' teaching organization ability, oral expression ability, and reflective evaluation ability to a certain extent.

Table 7. Attitude toward online training

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Yes (N, %)</th>
<th>Not clearly (N, %)</th>
<th>No (N, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q13 Like it or not</td>
<td>36 (36.4%)</td>
<td>50 (50.5%)</td>
<td>13 (13%)</td>
</tr>
<tr>
<td>Q14 Learning burden</td>
<td>14 (14.1%)</td>
<td>26 (26.3%)</td>
<td>59 (59.6%)</td>
</tr>
<tr>
<td>Q15 clear goal</td>
<td>29 (29.3%)</td>
<td>43 (43.4%)</td>
<td>27 (27.3%)</td>
</tr>
<tr>
<td>Q16 Difficulties to master</td>
<td>27 (27.3%)</td>
<td>34 (34.3%)</td>
<td>38 (38.4%)</td>
</tr>
<tr>
<td>Q17 Broaden their vision of knowledge</td>
<td>43 (43.4%)</td>
<td>37 (37.4%)</td>
<td>19 (19.2%)</td>
</tr>
<tr>
<td>Q18 Physical skill improvement</td>
<td>34 (34.3%)</td>
<td>34 (34.3%)</td>
<td>31 (31.3%)</td>
</tr>
<tr>
<td>Q19 Teaching organization ability</td>
<td>40 (40.4%)</td>
<td>34 (34.3%)</td>
<td>25 (25.3%)</td>
</tr>
<tr>
<td>Q20 Oral skills</td>
<td>38 (38.4%)</td>
<td>37 (37.4%)</td>
<td>24 (24.2%)</td>
</tr>
<tr>
<td>Q21 Improved ability to reflect and evaluate</td>
<td>49 (49.5%)</td>
<td>35 (35.4%)</td>
<td>15 (15.2%)</td>
</tr>
<tr>
<td>Q22 Theoretical learning rate is more than physical exercise</td>
<td>33 (33.3%)</td>
<td>40 (40.4%)</td>
<td>26 (26.3%)</td>
</tr>
</tbody>
</table>

Compared with traditional training, 54.5% students believed that the online training was less sport-intense, 64.6% students found the lower rate of equipment use, and only 24.2% of students thought that online training was more interesting. For the hardware conditions, when asked whether the space would affect your own exercise practice in online classes at home, the majority students believed it was affected. Due to the environmental factors, the space at home is not as good as that at the school’s professional practice field. As a result, the exercise intensity was relatively smaller; moreover, the use of equipment at home was more likely to harsh things at home, so the equipment usage rate was much lower. For equipment, functioning as a major feature of Rhythmic Gymnastics, the exercises without equipment naturally decreased the interest.

Table 8. Attitude in comparison with traditional training

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Yes (N, %)</th>
<th>Not clearly (N, %)</th>
<th>Not (N, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q23 Less exercise intensity</td>
<td>54 (54.5%)</td>
<td>27 (27.3%)</td>
<td>18 (18.2%)</td>
</tr>
<tr>
<td>Q24 lower rate of equipment use</td>
<td>64 (64.6%)</td>
<td>26 (26.3%)</td>
<td>9 (9.1%)</td>
</tr>
<tr>
<td>Q25 More interesting</td>
<td>24 (24.2%)</td>
<td>41 (41.4%)</td>
<td>34 (34.3%)</td>
</tr>
</tbody>
</table>

DISCUSSION

Male/female ratio for the course of Rhythmic Gymnastics is 14% in ordinary universities. However, there’s still a small proportion of male students taking Rhythmic Gymnastics as their elective course, which is a good start to promote Rhythmic Gymnastics. In addition, the universities have issued related policies to attract more male students to participate in Rhythmic Gymnastics, and encourage teachers to add appropriate learning contents suitable for male students when designing classes.

Applications such as Zhidao and Superstar, mainly designed for teaching, are rich in online course resources and highlight specialized live-streaming course functions, which are comprehensive in function but complex in operation. WeChat, QQ and DingTalk all have corresponding online classroom functions, and they are simpler for operation in comparison with the said teaching platforms, but the functions are not complete enough and the online classes can only be carried out on the basis of adding friends or building groups. Ten-
cent Cloud Conference features comprehensive functions and easy operation, which can fulfill the needs of online classes. Therefore, most RG teachers have chosen Tencent Cloud Conferences for their teaching. Portable and popular smart phones are the top choices of hardware devices for the students' online learning.

Under the premise of ensuring the network quality of online classrooms, students shall practice rhythmic gymnastics physically in a spacious space and the teachers shall prepare small-range physical exercise assignments in line with the characteristics of rhythmic gymnastics.

Students believed that the online training, compared with traditional classes, has increased their learning burden when. Usually, the traditional classes of Rhythmic Gymnastics emphasize physical practice classes while the online physical training has more theoretical learning and the homework after class is mostly theory-related. Students have to change their mind of thinking that the theoretical study should be also deemed as an important part of rhythmic gymnastics and equivalent attentions should be paid to.

Teachers can increase the proportion of video appreciation and theoretical learning in their lesson preparation appropriately, so as to guide students to make more interactive evaluations and improve the students' skills of oral expression and teaching. Teachers may arrange equipment exercises in the form of video feedback on homework after class. Therefore, students can find more spacious space for equipment exercises after class to improve the equipment usage and the exercise intensity.

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