ADAPTATION OF TESTING PROCEDURES AND STABILIZATION OF RESULTS IN PRESCHOOL RHYTHMIC GYMNASTS

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Abstract

The aim of this study was to familiarize preschool rhythmic gymnasts with testing procedures and to determine the number of familiarization attempts needed to stabilize the test results. Thirty-six female rhythmic gymnasts aged 5.14±0.79 years (body height: 119.44±5.98 cm; body mass: 21.46±3.35 kg) volunteered for the study. All gymnasts were free of injury, trained regularly (two days per week, approximately 60 minutes per session), and participated in the individual B level competitions. The main findings indicated a statistically significant difference between the variables of spine and leg flexibility (p<0.00), standing long jump (p<0.00), balance (p<0.00), and shoulder flexion and extension (p<0.00). According to the results obtained in this research, familiarization can significantly improve scores in motor tests for all variables (spine and leg flexibility, balance, standing long jump, and shoulder flexion and extension) in preschool rhythmic gymnasts. These findings suggest several possibilities for further research, such as investigating the long-term effects of familiarization on motor skill development, the specific mechanisms through which familiarization enhances performance, and its impact across different age groups and skill levels in rhythmic gymnastics. Rhythmic gymnastics trainers and other coaches of aesthetic sports should adapt and introduce participants to test protocols to avoid errors in testing.

Keywords: *flexibility; balance; explosive power; children; movement development.*

INTRODUCTION

Rhythmic gymnastics (RG) is a technical-composite sport that includes elements of gymnastics, dance, ballet, and apparatus manipulation (rope, ball, clubs, and ribbon) (Despina et al., 2014; Douda, Toubekis, Avloniti, & Tokmakidis, 2008; Gateva, 2013; Laffranchi, 2005; Vernetta, Montosa, Beas-Jiménez, & López-Bedoya, 2017). It is associated with elegance, beauty, and excellence in body movement, often set to musical accompaniment (Batista Santos, Lemos, Lebre, & Ávila Carvalho, 2015). These characteristics distinguish RG from other branches of gymnastics. RG requires many hours of training, as selection begins at an early age, and success is only possible through continuous improvement of all the elements involved in the sport (Bobo-Arce & Méndez Rial, 2013; Rutkauskaitė & Skarbalius, 2012). A high level of development in motor skills, rhythm, coordination, agility, and endurance is necessary, with particular emphasis on the collaboration between balance, strength, and flexibility, which play key roles in RG (Batista Santos et al., 2015; Dobrijević, Moskovljević, & Dabović, 2016; Donti, Tsolakis, & Bogdanis, 2014; Laffranchi, 2005). Testing motor skills and monitoring their development is complex, especially when testing children's abilities. It requires a high level of precision, reliability, and objectivity (Tomac, Hraski, & Sporis, 2012). In artistic gymnastics, each gymnastics school has specific models for talent identification (Mkaouer, Hammoudi-Nassib, Amara, & Chaabène, 2018). However, there are limitations in the testing procedures used in rhythmic gymnastics. In many test batteries (Jastrjembskaia & Titov, 1999), the models for testing are specific to mature gymnasts, which preschool children are not familiar with. Determining the profile of a child gymnast and her level of fundamental motor skills could assist coaches in talent identification, as well as in her overall development through training (Šalaj, Milčić, & Šimunović, 2019).

The development of all motor skills mentioned earlier during early childhood provides the foundation for sports skills, as this is when children typically choose the sport whose training they will continue (Busquets, Aranda-Garcia, Ferrer-Uris, Marina, & Angulo-Barroso, 2018). Testing preschool children is necessary to track progress and identify talent for future high-level sports performance (di Cagno et al., 2014). One of the main components of coordinative abilities is balance, which is influenced by a complex interaction of factors, including sensory information (from the somatosensory, visual, and vestibular systems), joint range of motion (ROM), and strength (Ricotti, 2011). Balance is crucial for the correct execution of complex RG movements. Motor skills during early childhood are in a very intensive stage of development, and learning influence is critical (Barnett, Van Beurden, Morgan, Brooks, & Beard, 2008; Fisher et al., 2005). Specific motor skills can be improved with a sufficient level of movement repetition (Pediatrics, 1992). Therefore, it is important to assess the impact of familiarization through testing protocols, especially considering the uncertainties at the preschool age.

Studies on children's development and the improvement of motor skills aim to investigate learning new movement structures and skill proficiency. During the process of motor skill development, children rely on feedback from adults (Sullivan, Kantak, & Burtner, 2008). Some previous studies analyzing the influence of familiarization on sprint running test results have shown varied conclusions. Glaister et al. (2010), for example, demonstrated a positive impact of familiarization on multiple running speed test results, while others found that familiarization did not improve jumping and running test results (Moir, Button, Glaister, & Stone, 2004; Moir, Sanders, Button, & Glaister, 2005). Thomas & Nelson (1996) suggest that individual differences in familiarization with tests and performance situations may explain errors in measurement. Sullivan et al. (2008) studied the effect of different feedback frequencies during practice on the acquisition and retention of motor skills in children compared to adults. Preschoolers significantly improved their results (Međedović et al., 2018) in assessments of leg power, abdominal repetitive strength, running speed, and agility by the final measurement. It appears that feedback and proper instruction enhance children's ability to understand the mechanics of movement in these motor skills (Tomac et al., 2012).

Vrbik et al. (2017) showed significant improvements in polygon backwards and polygon with turn performances, while the vertical jump test, standing long jump, and toe touch test showed no significant improvement during familiarization sessions. The results from Tomac et al. (2012) indicate that, under the influence of familiarization and motor knowledge acquisition, children significantly improved their scores in motor tests of strength and balance.

To the best of our knowledge, research on familiarization with testing procedures in preschool rhythmic gymnasts is limited. Therefore, the aim of this study was to familiarize preschool rhythmic gymnasts with testing procedures and to determine the number of familiarization attempts needed to stabilize the test results.

METHODS

Thirty-six female rhythmic gymnasts aged 5.14±0.79 years (body height: 119.44±5.98 cm; body mass: 21.46±3.35 kg) volunteered for the study. All gymnasts were free of injury, trained regularly (two days per week, approximately 60 minutes per session), and participated at the individual B level. The gymnasts competed 5–6 times per year in national competitions, tournaments, and international cups, as scheduled in the national calendar. Parental consent and child assent were obtained. All tests were performed at the gymnastics club during regular session times. The study was approved by the Ethical Committee of the Faculty of Sport and Physical Education, University of Niš, in accordance with the revised Declaration of Helsinki.

Body mass was measured using an OMRON – BF511 (Omron, Japan), and body height was measured using a GPM Anthropometer (Siber Hegner, Zürich, Switzerland).

Test of *Spine and leg flexibility* is used to determine the degree of flexibility in the spine while bending forward. The gymnast stands on a gym bench, with her toes at the edge of the bench. Her legs should be straight (fully extended), and one hand should be placed on top of the other (overlapped). The tester then instructs the gymnast to lower her hands and slowly reach as far forward as possible. She should reach her maximum stretch and hold that position for two full seconds. A partner should ensure that the gymnast’s legs remain straight throughout the test by lightly holding back the knees. A bench and ruler were used for measurement. Each gymnast is allowed a warm-up trial and two test trials, with the best result being recorded. The tester must ensure the gymnast's toes are aligned with the edge of the bench and that her knees remain straight. The tester measures the distance between the tip of the gymnast’s third finger and the upper edge of the bench. Note: a partner is needed for this test (Jastrjembskaia & Titov, 1999). The gymnast repeats the test four times, and each attempt is measured.

Balance: Static balance was assessed using a sport-specific test for rhythmic gymnastics. The gymnast's goal was to remain on tiptoe ("releve") with arms held above the head (third position) and the free foot in a low passé (fondue) position for as long as possible. Four trials were allowed and recorded using a digital stopwatch (Kioumourtzoglou, Derri, Mertzanidou, & Tzetzis, 1997).

Standing long jump: The gymnast's standing reach height was measured with arms and hands fully extended overhead. The length of the jump was measured to the body part closest to the take-off line (including any fall or step backward) (Dias, Aleksandrova, Lebre, Bobo, & Fink, 2021). The gymnast repeated the test four times, with each attempt being measured.

Shoulder flexion and extension: This test was used to determine shoulder flexibility. The gymnast stood in a straddle position, holding a stick forward with both hands. The gymnast raised the stick upward and then brought it over her back without bending her elbows, keeping the arms fully stretched at all times. A meter stick with centimeter calibrations was used to measure performance (Jastrjembskaia & Titov, 1999). The gymnast repeated the test four times, and each attempt was measured. A reduction in the distance between the hands indicates improved shoulder flexibility. As the gymnast becomes more flexible, she is able to bring her hands closer together behind her back, demonstrating a greater range of motion in the shoulder joint. This metric directly measures shoulder flexibility and assesses the effectiveness of flexibility training exercises.

Physical fitness and body measurements were performed during an evening training session at around 6 p.m. in a bright, warm (19°C) hall. The technical execution of fitness tests was assessed by the same experienced International Gymnastics Federation (F.I.G.) judges and experienced coaches. During the training session, body measurements were taken first, followed by the assessment of physical fitness elements in the following order: balance, upper body flexibility, lower body flexibility, and explosive power. Twenty-four hours before the training session, the gymnasts were asked to avoid any strenuous activity. A standardized rhythmic gymnastics warm-up (including 3 minutes of jogging interspersed with general and specific movements of moderate intensity, 3 minutes of dynamic sport-specific stretching, and 20 minutes of specific warm-up exercises for rhythmic gymnastics) was performed prior to measuring.

Statistical analysis: Data are reported as means and standard deviations (SD). The normality of the distribution was estimated using the Kolmogorov-Smirnov test. For normally distributed results, ANOVA repeated measures were used to determine differences between repeats, while the Independent-Samples Kruskal-Wallis Test was used for non-normally distributed results. Bonferroni post-hoc analysis was also applied. Statistical significance was accepted at $p<0.05$. All analyses were performed using SPSS (version 20.0, SPSS Inc., Chicago, IL, USA).

Table 1
Descriptive parameters and repeated measures analysis

Variable (n=36)	**mean±SD**	**ANOVA repeated measures Kruskal-Wallis Test**
Spine and leg flexibility (cm)		**p-value**
Measurement 1	4.86±5.53	0.00
Measurement 2	7.79±6.12	
Measurement 3	7.72±6.16	
Measurement 4	9.02±6.02	
Balance (sec)		
Measurement 1	1.99±1.07	0.00
Measurement 2	2.33±1.52	
Measurement 3	3.31±2.41	
Measurement 4	3.93±1.98	
Standing long jump (cm)		
Measurement 1	98.55±14.72	0.00
Measurement 2	102.52±16.30	
Measurement 3	105.50±14.20	
Measurement 4	108.77±15.62	
Shoulder flexion and extension (cm)		
Measurement 1	58.13±8.33	0.00
Measurement 2	52.61±7.65	
Measurement 3	49.41±7.82	
Measurement 4	46.91±10.09	

Legend: p-value<0.05 statistical significance; **n-** number of participants.

RESULTS

The descriptive parameters were calculated for each variable (Table 1). ANOVA for repeated measures showed statistically significant differences in two variables: spine and leg flexibility (p<0.00) and standing long jump (p<0.00). The Kruskal-Wallis Test also revealed statistically significant differences in two variables: balance (p<0.00) and shoulder flexion and extension (p<0.00).

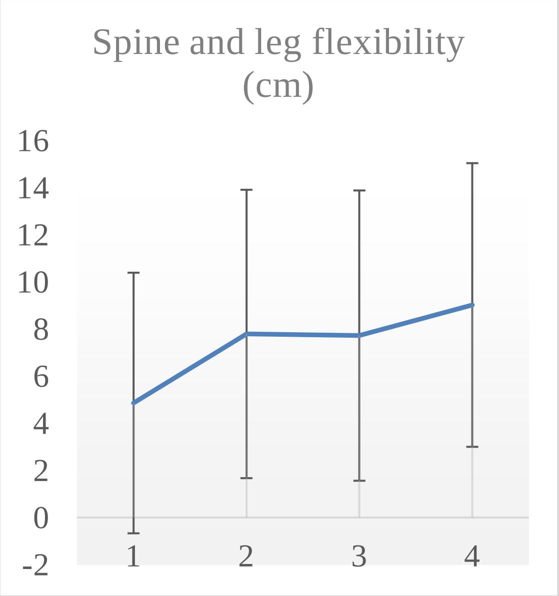

Figure 1. Results of spine and leg flexibility

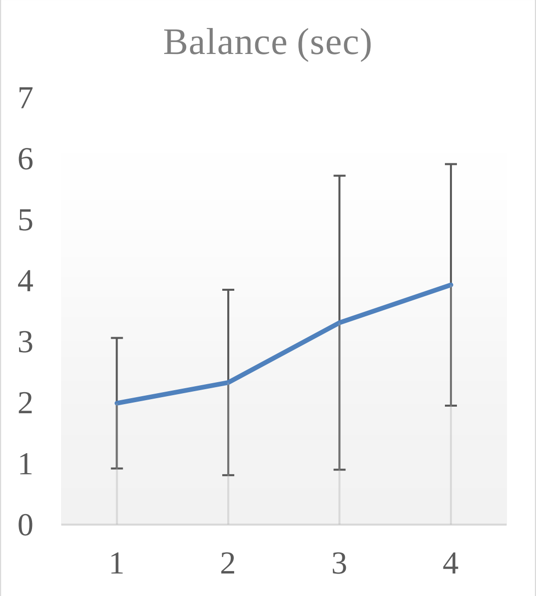

Figure 2. Results of balance

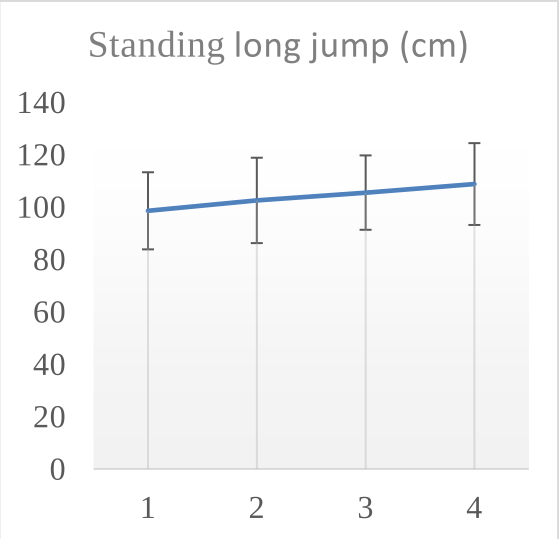

Figure 3. Results of standing long jump

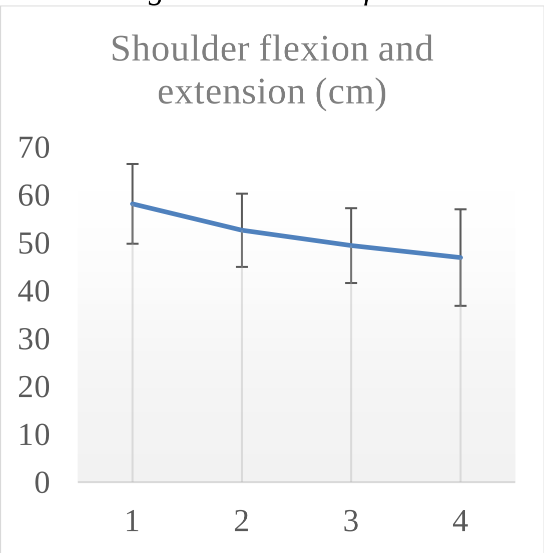

Figure 4. Results of shoulder flexion and extension

Spine and leg flexibility results (Figure 1) showed statistically significant differences between measurements 1 and 2 (p<0.00), 1 and 3 (p<0.00), 1 and 4 (p<0.00), and 3 and 4 (p<0.00). However, there were no statistically significant differences between measurements 2 and 3 (p<1.00), 2 and 4 (p<0.75), or 3 and 4 (p<0.76).

Balance results (Figure 2) showed statistically significant differences between measurements 1 and 3 (p<0.01), 1 and 4 (p<0.00), and 2 and 4 (p<0.00). No statistically significant differences were found between measurements 1 and 2 (p<1.00), 2 and 3 (p<0.23), or 3 and 4 (p<0.36).

Standing long jump results (Figure 3) showed statistically significant differences between measurements 1 and 3 (p<0.00), 1 and 4 (p<0.00), 2 and 4 (p<0.00), and 4 and 3 (p<0.00). However, there were no statistically significant differences between measurements 1 and 2 (p<0.13) or 2 and 3 (p<0.16).

Shoulder flexion and extension results (Figure 4) showed statistically significant differences between measurements 1 and 4 (p<0.00) and 1 and 3 (p<0.00). There were no statistically significant differences between measurements 1 and 2 (p<0.12), 2 and 3 (p<0.49), 3 and 4 (p<1.00), or 4 and 2 (p<0.06).

DISCUSSION

The aim of this study was to familiarize preschool rhythmic gymnasts with testing procedures and to determine the number of familiarization attempts required to stabilize the test results. The main findings indicated statistically significant differences between variables of spine and leg flexibility (p<0.00), standing long jump (p<0.00), balance (p<0.00), and shoulder flexion and extension (p<0.00). These results have several implications for the testing protocol and methodological approach in preschool rhythmic gymnasts, which will be discussed below.

It is recommended to focus on developing flexibility in female gymnasts aged 4-5 years during the elementary phase of training (Pechenevskaya, Kartashova, & Korichko YuV, 2015). The effectiveness of flexibility development techniques has been tested in educational experiments and proven to be effective. Based on our familiarization results (Figure 1), the test should be performed in two trials, as results stabilized in the second trial. Previous research (Vrbik et al., 2017), which investigated familiarization with this testing protocol, found that it could be performed without requiring familiarization trials. The difference in results may be attributed to the older age of the children (10.8 years) in Vrbik et al. (2017) study. The authors explained that the simplicity of the task and the older age of the children were favorable for developing new capabilities, which affected the number of testing attempts, recognition, and stability of the results.

Training younger categories regularly includes positions with both feet on tiptoe as an essential element of all movements in rhythmic gymnastics, as they are often the starting position (Dobrijević et al., 2016). Our study showed that the testing results for balance (Graph 2) were stabilized in the third trial. Research supports the effect of familiarization (Tomac & Hraski, 2016; Tomac et al., 2012; Vrbik et al., 2017) or improvement in balance results after repeated measurements (Dobrijević et al., 2016; Shigaki et al., 2013). Most authors attribute better results to improved coordination of movements and the response of the neuromuscular system (Dobrijević et al., 2016; Vrbik et al., 2017), as well as the activation of larger muscle groups such as the hip-trunk muscles (gluteus, hamstrings, and lower back) (Shigaki et al., 2013).

According to research (Douda et al., 2008), explosive strength is an important determinant of successful performance in rhythmic gymnastics (9.2%). Our study results showed familiarization with the testing protocol for the standing long jump and indicated that results stabilized after four trials (Graph 3). Other studies have reported different results and showed no familiarization effect with this test (Tomac & Hraski, 2016; Tomac et al., 2012; Vrbik et al., 2017). The divergence may be attributed to differences in participant age (Vrbik et al., 2017), as their study included older participants (10.8 years) compared to the current study's participants (5.9 years) (Tomac et al., 2012). Additionally, age groups of 6-7 year old rhythmic gymnasts have shown the lowest annual progress rates in explosive power, estimated at only 2-3% (Zagrevskiy & Beznosikova, 2017), which could be due to insufficiently developed strength at that age.

There is a recommendation for further research on flexibility tests, as well as for considering the use of this fitness component in schools and preschools (Pate, Oria, & Pillsbury, 2012). Shoulder flexibility significantly reduces the risk of injuries in gymnasts (Ling, Sleeper, & Casey, 2020); therefore, the shoulder girdle should be strengthened and tested regularly. Our research on shoulder flexion and extension indicates that familiarization had the most stable results in the third attempt. According to research (Çelik, 2017), shoulder flexibility increased with both cyclic and static stretching after the intervention, and internal rotation strength also improved with cyclic stretching.

The significant differences observed in spine and leg flexibility suggest that flexibility training should be tailored to the individual needs of preschool gymnasts. Familiarization with the testing protocol indicates that stability in flexibility results can be achieved with two trials, underscoring the importance of repetitive practice in enhancing flexibility at an early age. The results regarding balance tests, which stabilized after three trials, highlight the necessity of incorporating regular balance training into preschool gymnastics programs. This is consistent with existing literature that emphasizes the role of neuromuscular coordination and muscle group activation in improving balance (Dobrijević et al., 2016; Shigaki et al., 2013). Regular balance exercises can help young gymnasts achieve the stability required for more complex movements in rhythmic gymnastics.

The familiarization with the standing long jump test and the need for four trials to achieve stable results imply that explosive strength training should be gradually introduced and regularly practiced. The divergence from other studies, which found no need for familiarization, suggests that the age and developmental stage of the gymnasts are critical factors. Younger gymnasts may require more frequent practice to develop the explosive strength needed for successful performance in rhythmic gymnastics.

The stabilization of shoulder flexion and extension results after three attempts indicates the importance of regular flexibility and strength training for the shoulder girdle. This aligns with research suggesting that shoulder flexibility reduces injury risk (Ling, Sleeper, & Casey, 2020). Implementing regular shoulder flexibility assessments and targeted training can help prevent injuries and enhance overall performance.

The implications of this study extend to educational programs and policy recommendations for preschool physical education. The evidence supporting the importance of flexibility, balance, and explosive strength training in young children underscores the need for incorporating these components into school and preschool curricula (Pate, Oria, & Pillsbury, 2012). This can contribute to the overall physical development and well-being of children, promoting lifelong fitness habits.

The limitations of this study include the sample selection, specifically the insufficient number of respondents and the lack of more specific tests for rhythmic gymnastics and the assessment of motor skills in preschoolers. With the help of these specific tests, we could more accurately determine the impact of familiarization on other motor skills, which would aid in the development of future testing protocols.

Further studies should be longitudinal to determine whether the training process affects the familiarization of movements and testing protocols.

CONCLUSION

According to the results obtained in this research, familiarization can significantly improve scores in motor tests across all variables (spine and leg flexibility, balance, standing long jump, and shoulder flexion and extension) for preschool rhythmic gymnasts. These findings suggest several possibilities for further research, such as investigating the long-term effects of familiarization on motor skill development, the specific mechanisms through which familiarization enhances performance, and its impact across different age groups and skill levels in rhythmic gymnastics. An important factor in improving performance quality is understanding the task. Rhythmic gymnastics trainers and other coaches of aesthetic sports should adapt and introduce participants to test protocols to avoid errors in testing. Feedback information and adequate instructions increase gymnasts' ability to better understand the mechanics of movement in the mentioned motor skills. As in previous research, this study confirmed that the process of familiarization with testing procedures and the feedback provided is an important factor in the motor evaluation of preschool rhythmic gymnasts.

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