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# Construction of a Specific Test for Flexibility Assessment in Rhythmic Gymnastics

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**Abstract**

Rhythmic gymnastics is a combination of sport and art, in which flexibility is one of the most important abilities and plays an important role in the performance specification equation. However, there is limited systematic research on specific tests of flexibility in rhythmic gymnastics for recognising children's potential and tracking the training process. The primary purpose of this research was to construct a measurement instrument for evaluating flexibility that would be applied specifically to rhythmic gymnastics. The sample consisted of 41 female rhythmic gymnasts aged 10-12 (X=11.05, SD=0.84). All of them are members of two rhythmic gymnastics clubs from Croatia and registered with the Croatian Gymnastics Federation. We used three familiar flexibility tests: - forward bend on a bench, frontal split with hand support, split in a supine position - and one new test – frontal split on an elevated surface. Results of the statistical analyses have shown that the new test measures flexibility, which is required for success in rhythmic gymnastics. There is a significant correlation between individual measurements ($p<0.001$), so this test is considered reliable. It would be good to implement the new test when selecting children for rhythmic gymnastics as well as during transitive measurements in the training process.

***Keywords:*** *ability, performance, newly developed test, success, rhythmic gymnasts*

## Introduction

Rhythmic gymnastics is a sport that contains its own artistic component. In addition to the five apparatuses that the gymnasts use, the body performs natural forms of movement following the rhythm and tempo of music. Body movements, apparatus work and music all come together in the beauty of performance. Countless different movements and combinations classify rhythmic gymnastics as one of complex acyclic sports (Wolf-Cvitak, 2004). It affects the development and improvement of a range of motor skills and the ability to follow the rhythm and tempo of music (Furjan-Mandic et al., 2010). Motor abilities affect the efficiency of human movement. Various studies have shown that motor skills cannot be defined by a single, universal feature, but rather, an analysis of human mobility requires division into several quantitative and qualitative motor skills (Cvenic, 2007). One of the most important motor skills in rhythmic gymnastics is flexibility (Laffranchi, 2005). It is the ability to perform the maximum amplitude of movement in a particular joint. Not all joints are equally flexible, which is conditioned by the structure of the articular bodies and the elasticity of the ligaments, tendons and muscles that perform the movement (Benjamin et al., 2006). Flexibility also depends on age, gender, room and body temperature (Breslauer et al., 2014). The ability to efficiently perform various elements of different techniques is very important in many sports, especially in rhythmic gymnastics. According to Ljevakovic (1982), a reduced range of motion can cause injuries in case of sudden movements and lead to excessive energy expenditure in movements that are difficult to perform due to inelasticity of antagonists or excessive muscle tone in agonists. Performance of each element requires certain flexibility which is often crucial in the selection of children for this sport (Hume et al., 1993). Due to early specialization, flexibility training begins at the age of 4-5, which is essential in addition to developing other abilities such as proper muscle activation and movement control that can prevent many injuries (Kristicevic et al., 2017). There are three types of flexibility: static, dynamic and passive (Kos, 1966). Static flexibility refers to the maximum range of motion

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without an emphasis on speed, for example a split. On the other hand, passive flexibility is a measure of the maximum range of motion without voluntary muscle contraction with the help of a trainee (Alter, 2004). According to Kos (1966), dynamic flexibility is the ability to perform the maximum range of motion in fast - moving activities, such as various jumps. Donti, Tsolakis and Bogdanis (2014) indicate that this sport requires high level of flexibility and good compromise between strength and flexibility, proving that in their study which examined the effects of baseline flexibility and vertical jump ability on straight leg raise range of motion (ROM) and counter-movement jump performance (CMJ) following different volumes of stretching and potentiating exercises. According to Laffranchi (2005), these performances are reached through a detailed planning and training organization. Santos et al. (2015) concluded that the best suggestion for the flexibility training is the implementation of symmetrical work to accomplish the correct and balanced development the gymnasts. However, participants in the study were high level Portuguese juniors and it does not include the rest of gymnasts. Also, the tests applied in the study had as limitation the type of evaluation with comparison of images and an assessment chart, but they are the FIG suggested tests, and they are close to rhythmic gymnastics reality. Since there is no adequate specific test for assessing the static flexibility in rhythmic gymnastics and the need for it can be seen from the given literature, in this research we will propose a new one. The aim was to construct a measurement instrument for evaluating flexibility that would be applied specifically to rhythmic gymnastics. The test could serve not only to facilitate the assessment of flexibility in the selection of children as successful rhythmic gymnasts in the future, but also to control the training progress and provide an insight into the current state of a gymnast's flexibility.

## Methods

*Participants*

The sample consisted of 41 female rhythmic gymnasts aged 10-12 (X=11.05, SD=0.84) who are registered with the Croatian Gymnastics Federation. The gymnasts are members of two rhythmic gymnastics clubs from Zagreb (GK Aura) and Osijek (KRSG Rondo). The participants were measured voluntarily and the parents of the gymnasts gave their written consent for the study. It should be pointed out that the gymnasts were free of injuries, warmed up before the testing and were familiar with the protocol of this research. All participants are competitors in rhythmic gymnastics and they started participating in the research the same level of learning. The Ethics Committee of the Faculty of Kinesiology concluded that the research respects ethical and professional principles and approved it on December 1, 2020, with decision 101/2020.

*Measurements*

To test flexibility, three familiar tests with verified metric characteristics were used – forward bend on a bench, split in a supine position (Metikos et al., 1989) and frontal split with hand support (Santos et al., 2015). Another new test – frontal split on an elevated surface was used as well. These tests measure flexibility and involve holding a static position for a minimum of 30 seconds, with measurements made in centimeters.

*Protocol of the research*

Tests were performed twice in the same way at two-month intervals, from the beginning of January to the end of February 2022. The study was conducted at the sports hall of St. Anne's Elementary School in Osijek and at the Arena Sports Hall in Zagreb.

*Forward bend on a bench*

The forward bend on a bench (FBB) test evaluates the flexibility of the lower back and back of the legs. Validity and reliability are described in the book "Measurement of Basic Motor Dimensions of Athletes" by Metikos et al. (1989). The duration of testing is up to 15 seconds per gymnast. To perform the test, a 40-cm-high bench is needed, on which a board with an 80-cm-long centimeter strip is attached to the front. The fortieth centimeter of the strip is at the level of the upper surface of the bench. In the starting position the gymnast is standing barefoot on a bench with her feet together. Her legs are fully extended and the tips of her feet are placed to the edge of the bench. The gymnast stretches out her arms and places the palm of the right hand on the back of the left one so the middle fingers overlap. She performs the maximum forward bend by slow descent (Figure1). The task is completed when the gymnast touches the maximum possible value on the centimeter tape with her fingertips and maintains the position until the result is read.

FIGURE 1. Forward bend on a bench test

*Frontal split with hand support*

The test evaluates the maximum passive and active flexibility through the dimensionless method which compares the gymnast's joint range of motion against an assessment chart. Validity and reliability are described in the paper "Active and Passive Lower Limb Flexibility in High Level Rhythmic Gymnastics"by Santos et al. (2015). The limb which effectively performs the task is considered the preferred lower limb (PLL) and the one which functions as support is considered the non-preferred lower limb (NPLL). There are five classification values attributed to each movement, referring to the maximum possible range of motion and on the scale from 0 to 4 points, in which 0 = very poor, 1 = poor, 2 = average, 3 = good and 4 = excellent. Only whole numbers are attributed to the results. For movements with a range of motion between two points of the assessment chart, the next lower value is registered (Santos et al., 2015). The test is presented in Figure 2.

FIGURE 2. Frontal split with hand support test

*Split in supine position*

The test was performed in a hall on a flat surface. Two mats were placed in the middle so that the longer sides touched. An adhesive tape was placed along the width of one mat and a protractor was placed on it so that its straight edge was to the edge of the mat. The 90° mark was on the "drawn" line. The scale was numbered so that the 0° mark is on the line that divides the mat into two equal parts. The task was performed so that the gymnast lay on her back on the line that divided the mats. The arms were spread and the legs parallel and fully extended. The gymnast stretched to the maximum and maintained in this position until the meter read degrees that the gymnast achieved with maximum stretching (Figure 3). Validity and reliability are described in the book "Measurement of Basic Motor Dimensions of Athletes" by Metikos et al. (1989).

FIGURE 3. Split in supine position

*Frontal split on an elevated surface*

The gymnast assumes the front split position with the extended front leg elevated at 40 cm and the other leg extended

FIGURE 4. Frontal split on an elevated surface

backwards on the floor. The distance between the pubic bone and the floor is measured with a centimeter tape. The measurement is made by performing a split on the dominant and non-dominant leg (Figure 4).

*Statistical analysis*

Microsoft Excel 365 was used for data entry and preparation and visualization of measurements collected. The statistical analysis was performed on all data using SPSS Statistics 14.0 (Dizdar, 2006, p. 63-145). This included examining percentage changes from pre-to post-tests for both groups in terms of all outcome measures. Kruskal-Wallis was used to determine the normality of the distribution, on the basis of which the use of parametric or nonparametric tests was determined in the further processing of the results. All the tests were conducted at the significance level of p=0.05. Reliability of the frontal split on an elevated surface test was assessed using Fleiss' kappa (Fleiss, 1971) for ordinal data. Additionally, the correlation between individual measurements was assessed using Spearman's Rank correlation coefficient (Daniel, 1990).

## Results

The simplest way to determine whether the distribution of results was normal was analysing normality using the Kruskal-Wallis test. The results indicate that the distribution of none variable deviated statistically significantly from the normal distribution. Table 1 shows descriptive indica-

**Table 1.** Descriptive statistics

| | Mean | Std. Dev. |
|---|---|---|
| R Frontal split on elevated surface1 | 9.95 | 7.60 |
| L Frontal split on elevated surface1 | 11.60 | 6.20 |
| Split in supine position1 | 159.75 | 15.40 |
| Forward bend on a bench1 | 58.89 | 4.66 |
| R Frontal split with hand support1 | 2.25 | 1.50 |
| L Frontal split with hand support1 | 2.08 | 1.25 |
| R Frontal split on elevated surface2 | 9.36 | 7.61 |
| L Frontal split on elevated surface2 | 11.07 | 6.23 |
| Split in supine position2 | 163.70 | 14.71 |
| Forward bend on a bench2 | 59.87 | 4.65 |
| R Frontal split with hand support2 | 2.70 | 1.32 |
| L Frontal split with hand support2 | 2.75 | 1.03 |

**Table 2.** Connectivity and reliability of individual test measurements - Frontal split on an elevated surface

| | Frontal split on a elevated surface | | Reliability | |
|---|---|---|---|---|
| Spearman's Rank Correlation | 1.Measurement | 2.Measurement | Fleiss Kappa | p- value |
| 1. Measurement | 0.025 | 0.034 | | |
| 2. Measurement | 0.034 | 0.025 | 0.870 | <0.001 |

tors, where the arithmetic mean and standard deviation of the sample is visible.

There is a statistically significant correlation between individual measurements ($p<0.001$), so this test is considered reliable. For the test to be reliable, the expected Fleiss Kappe value should be above 0.810 (Landis & Koch, 1977) and in this test it was 0.870 (Table 2).

## Discussion

The problem of measuring flexibility with an object is the topic of numerous kinesiological and medical studies. In this study, the possibilities of the maximum range of motion were analyzed and the results showed that the test is reliable, so it should be implemented in future studies, since, according to Laffranchi (2005) flexibility is the main motor ability in rhythmic gymnastics. Lebre (1993) pointed out the importance of coaches devoting great attention to the training of motor abilities. Numerous measurement procedures have been developed where the amplitude of the movement is measured either by a linear scale or by angular degrees. Gymnasts are mainly characterized by their flexible joints and compliant muscles (Donti et al., 2014). Due to the changes made in the Code of Points in the last three decades, flexibility has become the most required physical ability and currently makes up the framework of fundamental rhythmic gymnastics movements (Laffranchi, 2001). That is the reason why it is necessary to work on developing specific tests for this motor ability in rhythmic gymnasts. During training, knowing each gymnast individually is crucial for drawing up and planning a training program focused on their needs and physical and technical shortcomings, while also respecting their limits. The „frontal split on an elevated surface" test showed high reliability, which is in line with other test that assess the flexibility in rhythmic gymnastics, for example frontal split with hand support which compares the gymnast's range of motion against an assessment chart.

It would be interesting to construct specific tests for measuring flexibility of the upper and lower dominant and nondominant extremities. In addition to the previously mentioned indicators, a greater number of researches on the considered issue should certainly be carried out. Every research has its limitations and so does this one. There is a time gap of two months between measuring and the longer the time interval between tests, the lower reliability of the measurment will be, because during this time period many changes in variables can occur.

It would be even more complete if it included larger number of participants and tests specifically for each topological region. Therefore, for future studies it is necessary to construct a larger battery of tests which would measure the flexibility of the shoulders, back and other body extremities. The review of previous research that is offered in this study with guidelines for further research could, at least in part, provide help in the work and selection of children for rhythmic gymnastics.

## Conclusion

These results confirm the hypothesis that the newly developed test measures flexibility, but only in the observed sample, in this case rhythmic gymnasts, because the test includes specific movements that would be difficult to perform correctly with other athletes. It would be good to implement this newly developed test when selecting children for rhythmic gymnastics as well as during transitive measurements in the training process. For future research, it is recommended to include a larger number of participants from all Croatian clubs and especially for every level of competition.

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**Conflicts of interest**
The author declares that there is no conflict of interest.

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