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**ORIGINAL ARTICLE**

# Is There a Relative Age Effect in the Competition Total Scores and Its Components of Junior Individual Rhythmic Gymnasts?

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## ABSTRACT

**Background:** Children born at the beginning of the year may be cognitively, emotionally, and physically more advantageous than those born at the end of the year.

**Aim:** This study aims to determine whether there is a relative age effect (RAE) on the total scores and its components of the gymnasts in their routines, competing in the 1st Rhythmic Gymnastics Junior World Championships Individual All-Around Ranking-Apparatus Qualification in 2019.

**Methods:** 138 gymnasts from 61 countries participated in this competition and 61 gymnasts competed in each apparatus. The total scores (TS) and its components in gymnasts' competition routines were analyzed according to gymnasts' age groups (13, 14, and 15 years old) and period of birth [Group I (those born in the first six months of the year), Group II (those born in the last six months of the year)]. Differences and percentages of change between the two periods were examined. A total of 732 scores (Difficulty, Execution, and Total Scores) were evaluated. Descriptive statistics and the One-Way Analysis of Variance (ANOVA) Test analysis were used for statistical evaluation.

**Results:** When the TS and its components were examined in all age groups and all routines, no significant difference was observed between Group I and Group II in terms of RAE.

**Conclusion:** It is thought that considering the RAE in talent selection and orientation programs, participation in sports activities and performance evaluation may be useful for athletes, coaches, and administrators.

**Keywords:** Rhythmic gymnastics, competition performance scores, relative age effect, gymnast

## INTRODUCTION

It is important to protect the general health of the athlete in every sport. Attention should be paid to features such as early, normal or late development, new-onset, and progress.[1] Motor development often does not develop at the same rate as physical development, and there is a wide structural variation among children of the same age.[2] When the physical and biological changes and developments in children and young people are examined, there can be significant differences even in those with the same chronological age.[3] To interpret biological maturity, it is very important to know that one calendar year is not the same as one maturity year. While each individual goes through the same stages of maturity, they can experience it at different rates. This results in the existence of physical, cognitive, and physiological differences as a result of changes in the maturity level of children of the same calendar age.[4] Athletes' performance is the result of a complex interaction between genetic and environmental factors.[5] However, it is stated that researchers have begun to focus more on the effects of secondary or indirect factors that affect the type, amount, and quality of an individual's education.[6] As a consistent and pervasive secondary factor influencing an athlete's likelihood of reaching peak skill levels; the age (ie relative age) of the athlete relative to their peers is revealed.[7] It has been revealed that the physical, cognitive, and motoric development levels of children born in the first months of a given year and who have not completed their development process are more advanced than those born in the last months of the year. The positive effects of the advantage brought by this development are called the Relative Age Effect (RAE).[3] The first study to examine RAE in sport was done by Grondin, Deschaies & Nault (1984).[8] The RAE, which describes the overall difference in age between individuals within each age group[9] can produce significant performance differences and is significant for children, although this effect is minor for adults.[10] Children born at the beginning of the year may be cognitive, emotionally[3, 11], and physically more advantageous than those born at the end of the year.[12] It is designed to divide the athletes into age groups during childhood and youth, to reduce their maturation differences, to provide and evaluate more balanced sports training.[13] Most sports systems group athletes by chronological age.[8] In the rhythmic gymnastics (RG) branch, gymnasts aged 13-14 and 15 are categorized as the junior category. Rhythmic gymnasts train intensely from a very young age. They continue these workouts through adolescence and early adulthood. During this period, significant changes occur in body size, and physiological and physical performance are affected.[14] Research results in this field can guide experts who plan talent screening, selection, and development studies in sports. In the literature, many studies are examining the effect of intense training and nutritional status, growth, and development in gymnasts. RG is one of the early specialized sports and can be affected by RAE. This study was carried out to examine whether there is a relative age effect on the competition result scores of individual junior rhythmic gymnasts.

## MATERIAL & METHODS

**Participants:** One hundred and thirty-eight elite gymnasts (13, 14, and 15 years old) from 61 countries participated in the individual apparatus qualifications of the 1st RG Junior World Championships (WCh) (organized for the first time

for the junior category) 2019, Moscow, Russian Federation. According to the competition program, not every gymnast competed in every apparatus, but sixty-one gymnasts competed in each apparatus. A total of 732 scores (Difficulty total scores, Execution total scores, and Total scores) were evaluated.

**Procedure:** The total scores and its components in gymnasts' competition routines analyzed according to gymnasts' age groups (13, 14, and 15 years of age and period of birth [Group I (those born in the first six months of the year, between January and June), Group II (those born in the last six months of the year, between January and June)].

The individual routines' official competition scores were reached from the results book of 1st RG Junior WCh that are published on the Fédération Internationale de Gymnastique (FIG) official web page.[15] The terms used in the RG' judges panels were taken into account in the definitions ($D_{1-2}$, $D_{3-4}$, $E_{1-2}$, $E_{3-4-5-6}$) of the score components. For each routine, body difficulty $D_{1-2}$ and $D_{3-4}$ are added and difficulty total score (DTS) is determined. Execution artistic ($E_{1-2}$) and execution technic' ($E_{3-4-5-6}$) deduction scores are added up and subtracted from 10.00 points, and execution total score (ETS) is determined. Total score (TS) is obtained by adding the DTS and ETS scores.[16]

**Statistical Analysis:** SPSS 23.0 (SPSS Inc., Chicago, IL) program was used for statistical analysis. According to the age groups of rhythmic gymnasts of the total scores mean ± standard deviation, minimum and maximum values were given as descriptive statistics. Differences and percentages of change between the two periods (between Group I and Group II) were examined. The One-Way Analysis of Variance (ANOVA) test was used to examine whether there was a difference in RAE between Group I and Group II in the total scores and the components of the total score in each age group, in each apparatus. A significant level was set at $p<0.05$.

## RESULTS

Descriptive statistical analyzes of difficulty total scores, execution total scores, and total scores of the rope, ball, clubs, and ribbon routines according to age groups are given in Table 1 and 2.

Table 1. Descriptive Statistics of the Rope and Ball Routines for Difficulty Total Scores, Execution Total Scores, and Total Scores.

| | | 13 years of age (n=10) | | | 14 years of age (n=19) | | | 15 years of age (n=32) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max |
| **Rope (n=61)** | **DTS** | 6.15 ± 1.19 | 3.70 | 8.10 | 6.77 ± 1.40 | 4.60 | 9.90 | 6.88 ± 1.50 | 4.00 | 10.90 |
| | **ETS** | 6.12 ± 0.61 | 5.05 | 6.95 | 6.49 ± 0.92 | 4.25 | 8.00 | 6.52 ± 0.98 | 3.95 | 8.90 |
| | **TS** | 12.30 ± 0.60 | 9.10 | 14.90 | 13.20 ± 2.20 | 8.85 | 17.90 | 13.60 ± 2.50 | 7.65 | 19.80 |
| | | **13 years of age (n=11)** | | | **14 years of age (n=10)** | | | **15 years of age (n=40)** | | |
| | | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max |
| **Ball (n=61)** | **DTS** | 7.05 ± 1.48 | 3.60 | 8.70 | 7.38 ± 1.44 | 4.90 | 9.80 | 8.00 ± 1.92 | 3.50 | 12.80 |
| | **ETS** | 6.08 ± 1.12 | 4.35 | 8.00 | 6.38 ± 1.12 | 4.50 | 8.30 | 6.63 ± 1.26 | 3.70 | 9.20 |
| | **TS** | 13.10 ± 2.40 | 7.90 | 16.50 | 13.70 ± 2.40 | 9.40 | 17.00 | 14.50 ± 3.10 | 7.65 | 22.00 |

*n; Number of routines, $\bar{x}$, and SD; Mean ± Standard Deviation, Min; Minimum values, Max; Maximum values, DTS; Difficulty total scores, ETS; Execution Total Scores, TS; Total Scores.*

Table 2. Descriptive Statistics of the Clubs and Ribbon Routines for Difficulty Total Scores, Execution Total Scores, and Total Scores.

| | | 13 years of age (n=12) | | | 14 years of age (n=11) | | | 15 years of age (n=38) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max |
| **Clubs (n=61)** | **DTS** | 7.69 ± 1.74 | 3.40 | 10.70 | 7.06 ± 1.70 | 3.80 | 9.60 | 7.87 ± 1.89 | 4.20 | 12.40 |
| | **ETS** | 6.59 ± 0.89 | 4.85 | 7.65 | 6.07 ± 1.66 | 1.55 | 7.70 | 6.66 ± 1.35 | 3.60 | 9.15 |
| | **TS** | 14.30 ± 2.50 | 8.25 | 18.35 | 13.10 ± 3.30 | 5.05 | 16.40 | 14.51 ± 3.20 | 7.90 | 21.55 |
| | | **13 years of age (n=11)** | | | **14 years of age (n=12)** | | | **15 years of age (n=38)** | | |
| | | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max | $\bar{X}$ - SD | Min | Max |
| **Ribbon (n=61)** | **DTS** | 6.11 ± 1.72 | 2.90 | 8.90 | 5.94 ± 1.62 | 3.60 | 9.00 | 6.86 ± 1.50 | 3.20 | 10.00 |
| | **ETS** | 5.86 ± 1.23 | 3.50 | 7.35 | 5.77 ± 1.51 | 2.30 | 7.52 | 6.47 ± 1.01 | 3.55 | 8.35 |
| | **TS** | 12.00 ± 2.80 | 6.40 | 16.20 | 11.70 ± 3.00 | 5.90 | 16.45 | 13.3 ± 2.40 | 7.25 | 18.25 |

*n; Number of routines, $\bar{x}$, and SD; Mean ± Standard Deviation, Min; Minimum values, Max; Maximum values, DTS; Difficulty total scores, ETS; Execution Total Scores, TS; Total Scores.*

ANOVA analyzes of Difficulty total score, Execution total score, and Total Scores of Rope and Ball Routines of rhythmic gymnasts by months of birth are given in Table 3 and 4.

Table 3. Differences in total scores of Groups (I - II) in rope and ball routines.

| | | | 13 years of age *(Gr I n=6, Gr II n=4)* $\bar{X}$ - SD | 14 years of age *(Gr I n=10, Gr II n=9)* $\bar{X}$ - SD | 15 years of age *(Gr I n=19, Gr II n=13)* $\bar{X}$ - SD | F | p |
|---|---|---|---|---|---|---|---|
| **Rope** *(n=61)* | **DTS** | **Gr I** | 6.12 ± 1.24 | 6.78 ± 1.47 | 6.72 ± 1.29 | 0.50 | 0.78 |
| | | **Gr II** | 6.20 ± 1.29 | 6.76 ± 1.40 | 7.11 ± 1.79 | | |
| | **ETS** | **Gr I** | 6.23 ± 0.55 | 6.52 ± 0.94 | 6.41 ± 0.97 | 0.48 | 0.79 |
| | | **Gr II** | 5.98 ± 0.75 | 6.46 ± 0.95 | 6.70 ± 1.02 | | |
| | **TS** | **Gr I** | 12.33 ± 1.74 | 13.29 ± 2.32 | 13.06 ± 2.28 | 0.51 | 0.77 |
| | | **Gr II** | 12.16 ± 1.96 | 13.22 ± 2.17 | 13.80 ± 2.74 | | |
| | | | **13 years of age** *(Gr I n=6, Gr II n=5)* $\bar{X}$ - SD | **14 years of age** *(Gr I n=7, Gr II n=3)* $\bar{X}$ - SD | **15 years of age** *(Gr I n=22, Gr II n=18)* $\bar{X}$ - SD | **F** | **p** |
| **Ball** *(n=61)* | **DTS** | **Gr I** | 7.43 ± 1.11 | 7.31 ± 1.71 | 8.33 ± 1.84 | 1.03 | 0.41 |
| | | **Gr II** | 6.60 ± 1.87 | 7.53 ± 0.72 | 7.59 ± 1.98 | | |
| | **ETS** | **Gr I** | 6.22 ± 1.33 | 6.13 ± 1.06 | 6.80 ± 1.11 | 0.77 | 0.58 |
| | | **Gr II** | 5.93 ± 0.95 | 6.97 ± 1.21 | 6.43 ± 1.44 | | |
| | **TS** | **Gr I** | 13.54 ± 2.29 | 13.39 ± 2.74 | 14.93 ± 2.77 | 0.81 | 0.55 |
| | | **Gr II** | 12.52 ± 2.68 | 14.48 ± 1.76 | 13.91 ± 3.42 | | |

*n; Number of routines, $\bar{X}$ and SD; Mean ± Standard Deviation, DTS; Difficulty Total Scores, ETS; Execution Total Scores, TS; Total Scores, Gr I; Group I Born between January and June, Gr II; Group II Born between July and December, p<0.05.*

Table 4. Differences in total scores of Groups (I - II) in clubs and ribbons routines.

| | | | 13 years of age *(Gr I n=6, Gr II n=6)* $\bar{X}$ - SD | 14 years of age *(Gr I n=5, Gr II n=6)* $\bar{X}$ - SD | 15 years of age *(Gr I n=21, Gr II n=17)* $\bar{X}$ - SD | F | p |
|---|---|---|---|---|---|---|---|
| **Clubs** *(n=61)* | **DTS** | **Gr I** | 8.05 ± 0.53 | 6.58 ± 1.78 | 7.96 ± 1.99 | 0.55 | 0.73 |
| | | **Gr II** | 7.33 ± 2.47 | 7.47 ± 1.68 | 7.76 ± 1.83 | | |
| | **ETS** | **Gr I** | 6.69 ± 0.72 | 5.70 ± 2.43 | 6.61 ± 1.36 | 0.48 | 0.79 |
| | | **Gr II** | 6.50 ± 1.09 | 6.38 ± 0.73 | 6.72 ± 1.38 | | |
| | **TS** | **Gr I** | 14.73 ± 1.15 | 12.22 ± 4.30 | 14.54 ± 3.27 | 0.54 | 0.74 |
| | | **Gr II** | 13.82 ± 3.53 | 13.85 ± 2.25 | 14.47 ± 3.14 | | |
| | | | **13 years of age** *(Gr I n=7, Gr II n=4)* $\bar{X}$ - SD | **14 years of age** *(Gr I n=6, Gr II n=6)* $\bar{X}$ - SD | **15 years of age** *(Gr I n=24, Gr II n=14)* $\bar{X}$ - SD | **F** | **p** |
| **Ribbon** *(n=61)* | **DTS** | **Gr I** | 6.17 ± 2.18 | 6.25 ± 2.04 | 7.27 ± 1.18 | 1.89 | 0.11 |
| | | **Gr II** | 6.00 ± 0.66 | 5.63 ± 1.19 | 6.16 ± 1.76 | | |
| | **ETS** | **Gr I** | 5.89 ± 1.47 | 5.90 ± 1.95 | 6.74 ± 0.68 | 1.72 | 0.15 |
| | | **Gr II** | 5.83 ± 0.85 | 5.63 ± 1.08 | 6.00 ± 1.30 | | |
| | **TS** | **Gr I** | 12.06 ± 3.56 | 12.15 ± 3.84 | 13.98 ± 1.73 | 1.94 | 0.10 |
| | | **Gr II** | 11.83 ± 1.47 | 11.27 ± 2.21 | 12.12 ± 2.97 | | |

*n; Number of routines, $\bar{X}$ and SD; Mean ± Standard Deviation, DTS; Difficulty total scores, ETS; Execution Total Scores, TS; Total Scores, Gr I; Group I Born between January and June, Gr II; Group II Born between July and December, p<0.05.*

## DISCUSSION

As a result of the categorizations, it is revealed that the physical, cognitive, and motoric developmental levels of children born in the first months of a certain year and who have not completed their development process are more developed than those born in the last months of the year. The positive effects of the advantage brought by this development are called the Relative Age Effect (RAE).[3] RG is one of the early-specialized sports and can be affected by RAE. It is thought that this study, which was conducted to examine whether there is a relative age effect on the competition result scores of individual junior rhythmic gymnasts, will contribute to the literature as it is the first. In this study, the mean scores of the total score (TS) and its components (DTS and ETS) of the routines (rope, ball, clubs, and ribbon) according to the age of the gymnasts were evaluated as descriptive analysis data. According to the descriptive analysis data, DTS, ETS, and TS means of 15-year-old rhythmic gymnasts were the highest in all age groups and all apparatuses (Table 1 and 2). According to the results of ANOVA analysis, no significant difference was observed between group 1 and group 2 of TS, DTS, and ETS of all apparatuses (Table 3 and 4; $p<0.05$). As a result of the evaluation made by dividing the year into quarters and a half slices, Pekel and Kamiş (2018) determined a statistically significant excess in the first quarter and first half slices in the distribution of U14 age group athletes participating in the competition. ($p<0.05$, $p<0.001$). In addition, they observed that the final participation rates of male and female athletes born in the first quarter of the year were higher ($p<0.05$, $p<0.001$). They emphasized that the findings of the study clearly showed the presence of RAE in athletes under the age of 14.[17] Genç (2020), in the study comparing the athletic performance of girls aged 10-14 according to the RAE, the participants according to their months of birth as 1st (January-March), 2nd (April-June), 3rd (July-September), 4th (October-December) are classified into 4 groups as those born in the quarter. No statistically significant difference was found between girls born in the first half of the year and girls born in the second half of the year in terms of height, body weight, body mass index (BMI),

vertical jump, standing long jump, medicine ball throwing and speed tests. The 20-meter shuttle run differed significantly between the two groups (p. >0.05). According to this result, it was determined that RAE may affect aerobic capacity in girls aged 10-14 years, but it did not have a significant effect on selected physical fitness and anthropometric parameters.[18] Romann and Fuchslocher (2014) examined RAE in female athletes (skiing, tennis, athletics, fencing, and snowboarding) between the ages of 10-20 who do individual sports. They found that RAE was found in female athletes born in the first months of the year in all branches except table tennis.[19] In our study, RAE was not observed in junior rhythmic gymnasts, dissimilar from the literature. [17, 18, 19] The reason for relative age, which is effective in the literature, suggests that children born in the first months of the year, who can provide physical superiority to others by showing early development compared to their peers, may be preferred in the selection of athletes for teams or athletes to achieve success. Buckler et al. (1977) found that the average age of puberty in British male gymnasts was significantly greater than the average age of the normal British population.[20] In a study of elite young British athletes [gymnastics, soccer, swimming, and tennis - Young Athletes Training (TOYA)] only male gymnasts' birthdates are year-round, while they were equally distributed (p> 0.05), the birth dates of all other branches were not evenly distributed (p< 0.001). About half of male swimmers, football, and tennis players were born in the first three months of the election year, and similar results were found for female tennis players (p< 0.001). Although the number of studies examining the relationship between gymnastics and RAE is quite low, our study is compatible with the mentioned literature. [20, 21, 22, 23, 24, 25, 26]

In some sports, such as swimming, the sexual and skeletal maturation of successful young swimmers is described as average or slightly above average.[27] One study found that in the 100 m freestyle, early-maturing swimmers performed better than late-maturing juniors.[28] On the contrary, late maturation has been observed in sports where advanced maturation is a disadvantage (such as gymnastics).[13, 29, 30] Rhythmic gymnastics is a multi-component discipline that should be started at an early age and includes athletic performance as well as aesthetic and artistic directions. To maximize gymnastic performance, it is emphasized that gymnasts in the growth and development period are exposed to the training stress created by their intense training, as well as various restrictions to maintain low-fat mass.[31] Sports that require high levels of performance can expose young athletes to physical, mental, and emotional stress. This may cause many disorders in the central mechanisms that activate the hypothalamic-pituitary-adrenal axis.[32, 33, 34] For this reason, it is emphasized that young female athletes may encounter situations such as delayed menarche[35] and studies are showing that intense physical activity is a factor delaying menarche. [33, 36, 37]

The absence of RAE in junior rhythmic gymnasts in our study suggests that late maturation and late puberty may also be effective. According to the results of this study, the TS, DTS, and ETS of the gymnasts participating in the 1st Rhythmic Gymnastics Junior World Championship held for the first time in 2019 were not different for the gymnasts born in the first and last 6 months of the year in terms of RAE for all routines (p<0.005). The results also show that gymnasts are correctly categorized according to their age groups. However, in RG, RAE can be seen in physical fitness tests, assessment of apparatus and body difficulties, expression of movements. Also, those working with children should always be aware of the importance of biological maturity its relationship to growth and physical performance.[38] However, we believe that the advantages of RAE will help the coaches and athletes in the selection processes and in determining the potential of the selected gymnasts.

## CONCLUSION

In this study, the highest mean values of DTS, ETS and TS scores were found at the age of 15. Naturally, 15-year-old gymnasts have two more years of sporting experience than 13-year-old gymnasts. Maybe 13-year-old gymnasts may not be in the junior category, but competitions are considered the best environments where a gymnast can improve herself, gain motivation and set goals. Competition atmospheres can promote gymnasts' development. It is thought that considering the relative age effect in talent selection and orientation programs, participation in sports activities, and performance evaluation may be useful for athletes, coaches, and administrators.

**Limitations:** In this study, only one competition was evaluated, if a few competitions with large participation were examined, different results could be obtained. It is thought that it would be beneficial to evaluate RAE both in major competitions (such as World and European Championships) and in all categories under the age of 15 (such as pre-junior, minors).

**Conflict of Interest:** The authors confirm that this article's content has no conflicts of interest.

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