THE INVERTED RELATIVE AGE EFFECT IN KOREAN GYMNASTS

Jiwun Yoon and Jae-Hyeon Park

Korea National Sport University, Seoul, South Korea

Original article *DOI:10.52165/sgj.14.2.249-256*

Abstract

Students born in earlier months likely have higher academic achievement than those born later even though they are in the same grade (relative age effect, RAE). Some studies reported no RAE in gymnastics. This study aimed to determine the RAE in Korean gymnasts. Data were collected on the birth month of 806 Korean gymnasts: 482 elementary (181 men; 301 women) and 324 middle-high (189 men; 135 women) school gymnasts registered by the Korea Gymnastics Association. Four quarters were used: Q1 (January–March), Q2 (April–June), Q3 (July–September), and Q4 (October–December). The χ^2 test and its probability were applied for hypothesis testing. Overall, 164 (20.3%) gymnasts were born in Q1, 191 (23.7%) in Q2, 220 (27.3%) in Q3, and 231 (28.7%) in Q4. We could not confirm the birth frequency of Q1 as high. Descriptive data of RAE showed that the frequency of Q1 was the lowest among the quarters of participants. Contrary to RAE expectations, Q4 showed the highest frequency in both elementary and middle-high (χ^2 elementary=2.431, p-value=0.487; χ^2 middle high=17.827, p-value=0.001) school gymnasts, and this appeared like an 'inverted relative age effect'. The inverted RAE was more pronounced in middle and high school gymnasts.

Keywords: *inverted relative age effect, Korean gymnasts, RAE, birth month.*

INTRODUCTION

In school systems used in most countries, academic years are divided on the basis of chronological age of students. In some countries, a new school year begins in March (e.g., Korea), whereas in others it begins in September (e.g., United States). Since each academic year covers one year, students attending the same academic year may be born in different months. Students born in earlier months are likely to be more advanced in physical and cognitive development compared to those born in later months; therefore, it is well known that they have advantages in academic performance (Armstrong, 1966; Freyman, 1965). In the same academic year, students born in earlier months often have an advantage over those born in later months, and this effect is referred to as the relative age effect (RAE) (Baker, Schorer, & Cobley, 2010).

RAE is especially prominent in competitive environments that require physical development, such as sports. Barnsley, Thompson, and Barnsley (1985) and Grondin, Deshaies, and Nault (1984) made the first reports of RAE in sports, focusing on Canadian ice hockey players and volleyball players. Subsequently, many researchers have confirmed RAE in athletes (Delorme & Raspaud, 2009; Hollings, Hume, & Hopkins, 2014; Votteler & Honer, 2014). Previous studies (Helsen, Hodges, Van Winckel, & Starkes, 2000; Sherar, Baxter-Jones, Faulkner, & Russell, 2007) indicated that adolescent athletes may demonstrate different athletic performance depending on their physical maturation (i.e.

being relatively order) because of the RAE and argued that RAE should not be mistaken for superior talent of some athletes. In other words, there is a need to devise specific methods to decrease or eliminate RAE for each type of sports (Baker et al., 2010).

Baker, Janning, Wong, Cobley, and Schorer (2014) analysed RAE in athletes of individual sports and reported differences in RAE depending on the characteristics of each type of sports. Baker et al. (2014) reported that more skiers and figure skaters are born in earlier months (earlier than March) than those born in later months (later than October), thus confirming RAE in these sports. In other words, since skiers and figure skaters born in later months are at a disadvantage in comparison to those born in earlier months in terms of physical maturation they may drop out.

Although RAE has been confirmed in most group and individual sports, previous studies on gymnastics have not found that gymnasts born in earlier months are at an advantage compared to those born in later months (Baker et al., 2014). Baker et al. (2014) found that most gymnasts were born between April and September, denying the RAE hypothesis that relatively older and more mature gymnasts will have advantages.

Moreover, Hancock, Starkes, and Ste-Marie (2015) analysed RAE in female gymnasts and found the following interesting results: RAE could not be found in female gymnasts below the age of 15, but it was present in those older than 15. In particular, when female gymnasts above 15 were analysed, there was a high proportion of those born in later months, and this was referred to as the inverted RAE. Since women gymnastics is characterised by relatively earlier peak performance compared to other sports, Hancock et al. (2015) concluded that inverted RAE may be present. However, the inverted RAE in female gymnastics reported by Hancock et al. (2015) is limited to a Canadian group of gymnasts, so it is difficult to generalise the findings. Whether inverted RAE is a characteristic limited to Canadian female gymnasts or is a general characteristic that can also be seen in male and female gymnasts from other countries is an interesting theme. Therefore, this study aimed to confirm inverted RAE in male and female South Korean gymnasts.

METHODS

This study was planned to elucidate RAE in Korean gymnasts. For this purpose, the year and month of birth were investigated in all elementary (grades 1-6), middle (grades 7-9), and high school (grades 10-12) gymnasts registered with the Korea Gymnastics Association in 2018. The Korea Gymnastics Association as a national organization registers highly trained gymnasts to effectively manage gymnasts and teams, and all highly trained gymnasts seeking to participate in competitions are required to register with the Korea Gymnastics Association. In 2018, there were 806 elementary, middle, and high school gymnasts registered with the Korea Gymnastics Association. There were a total of 482 elementary school gymnasts (181 men and 301 women) and 324 middle-high school gymnasts (189 men and 135 women) (see Table 1). They were selected as gymnasts when they were around 7-8 years old and highly trained to achieve the highest level of performance.

To confirm RAE in gymnastics, those that entered elementary school earlier than other gymnasts and those that entered later should be separated. This is because age in months may differ in the same school grade depending on their age when entering elementary school. In the South Korean educational system, students born between March and February of subsequent year were previously grouped into the same school year. However, students born between January and December of one calendar year are now grouped together. Therefore, the birth months of those born before 2000 at which time the new system

was implemented (cohort A) and those born after 2000 (cohort B) are linked, as shown in Figure 1.

Most previous studies analyzing RAE in education and sports have investigated the difference between each quarter to confirm patterns of RAE (Arrieta, Torres-Unda, Gil, & Irazusta, 2016; Lavoie, Laurencelle, Grondin, & Trudeau, 2015; Nakata & Sakamoto, 2012). Therefore, we also categorised those born between January and March as Q1 (first quarter), those born between April and June as Q2 (second quarter), those born between July and September as Q3 (third quarter), and those born between October and December as Q4 (fourth quarter).

The expected and observed frequencies were calculated based on the collected data on all gymnasts using MS Excel. Frequency and percentage for all gymnasts as well as those for elementary and middle-high school gymnasts were calculated separately. χ^2 analysis was carried out to confirm differences between expected and observed frequencies, and the level of statistical significance was set as α=.05. χ^2 was calculated according to the following formula:

$$\chi^2 = \frac{\sum(\text{Observed} - \text{expected})^2}{\text{exp ected}}$$

(Formula 1)

RESULTS

With RAE, individuals born in earlier months are known to be at an advantage as they are relatively older and more mature physically and cognitively. In this study, 20.3% of male and female gymnasts belonged to Q1 (n=163), 23.7% to Q2 (n=191), 27.3% to Q3 (n=270), and 28.7% to Q4 (n=231). There was a higher frequency of male and female gymnasts born in later months than those born in earlier months (Figure 1). χ^2 was 13.53, so there was a statistically significant difference at the level of p=.003. In other words, there was a higher proportion of gymnasts born in later months than those born in earlier months (see Table 2).

Figure 2 shows the frequency and proportion of birth months in each quarter calculated separately for elementary and middle-high school gymnasts. For elementary school gymnasts, Q1 (n=106, 22.0%) had a relatively lower frequency than Q2 (n=123, 25.5%), Q3 (n=128, 26.6%), and Q4 (n=125, 25.9%); however, no significant difference was found (χ^2 = 2.43, p=.487). In contrast to elementary school gymnasts, for middle-high school gymnasts, there were significant differences between Q1 (n=58, 17.9%), Q2 (n=68, 21.0%), Q3 (n=92, 28.4%), and Q4 (n=106, 32.7%) (χ^2 = 17.83, p=.001). In particular, the following differences in the frequency of birth month were observed between elementary and middle-high school gymnasts (Figure 2): 48 for Q1, 55 for Q2, 36 for Q3, and 19 for Q4. The differences were greater for Q3 and Q4 than for Q1 and Q2, indicating that more middle-high school gymnasts are born in later months than elementary school gymnasts.

DISCUSSION AND CONCLUSIONS

Previous studies (Musch & Grondin, 2001; Helsen, Van Winckel, & Williams, 2005; Rađa, Padulo, Jelaska, Ardigo, & Fumarco, 2018; Ramos-Filho & Ferreira, 2021; Wattie, Schorer, & Baker, 2015) related to RAE claiming that later birth persons were disadvantaged in sports competitions do not apply to gymnastics in Korea. Contrary to RAE in earlier research, this study found that Q4 showed the highest frequency in both elementary and middle-high school gymnasts; thisappeared like an ‘inverted relative age effect’. In addition, this study identified that the inverted RAE appeared to be more pronounced in middle and high school than in elementary gymnasts.

According to previous literature on athletes, RAE is more prominent in groups that require high performance (Baker et al. 2010; Votteler & Höner, 2014; Werneck et al., 2016). RAE refers to the phenomenon

where those born in earlier months are more mature physically and cognitively and thus are at an advantage in comparison to those born in later months competing together in a group; this phenomenon is observed because more mature individuals are given more social opportunities.

Table 1
Number of male and female participants in each grade (N).

Grade	Quarter1	Quarter 2	Quarter 3	Quarter 4	total
Grade1	0	4	3	7	14
Grade2	9	11	13	11	44
Grade3	15	21	20	21	77
Grade4	36	25	46	34	141
Grade5	29	37	29	37	132
Grade6	17	25	17	15	74
Grade7	11	19	22	23	75
Grade8	13	14	14	17	58
Grade9	5	7	14	21	47
Grade10	13	12	15	19	59
Grade11	6	8	15	15	44
Grade12	10	8	12	11	41
total	164	191	220	231	806

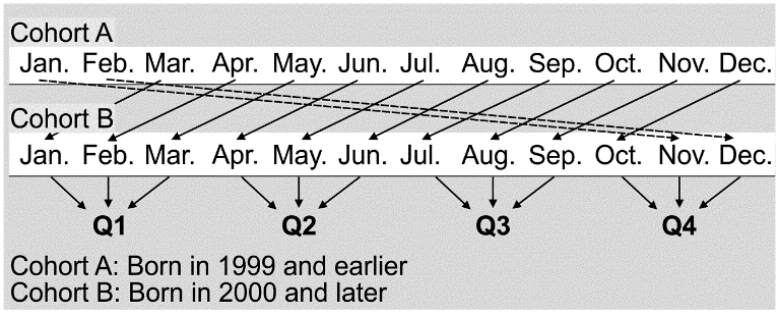

Figure 1. Linking the birth month of gymnasts born in 1999 and earlier and those born in 2000 and later, and the composition of quarters.

Table 2
Quarterly birth rate of highly trained Korean gymnasts.

Category	Q1	Q2	Q3	Q4	χ^2	*p*
Elementary male	36 (19.9%)	40 (22.1%)	53 (29.3%)	52 (28.7%)	4.834	0.184
Elementary female	70 (23.3%)	83 (27.6%)	75 (24.9%)	73 (24.3%)	1.232	0.745
Elementary total	106 (22.0%)	123 (25.5%)	128 (26.6%)	125 (25.9%)	2.430	0.488
Middle-high male	34 (18.0%)	41 (21.7%)	55 (29.1%)	59 (31.2%)	8.735	0.033
Middle-high female	24 (17.8%)	27 (20.0%)	37 (27.4%)	47 (34.8%)	9.681	0.021
Middle-high total	58 (17.9%)	68 (21.0%)	92 (28.4%)	106 (32.7%)	17.827	0.000

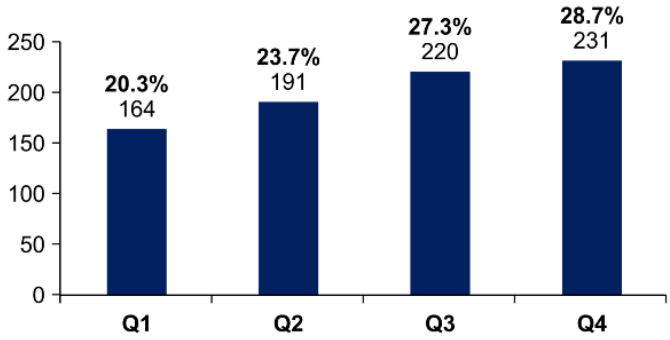

Figure 2. Distribution of birth month in each quarter for all gymnasts (elementary, middle, and high school gymnasts). Note: Difference in frequency between quarters for all gymnasts: χ^2=13.53, *p*=.003.

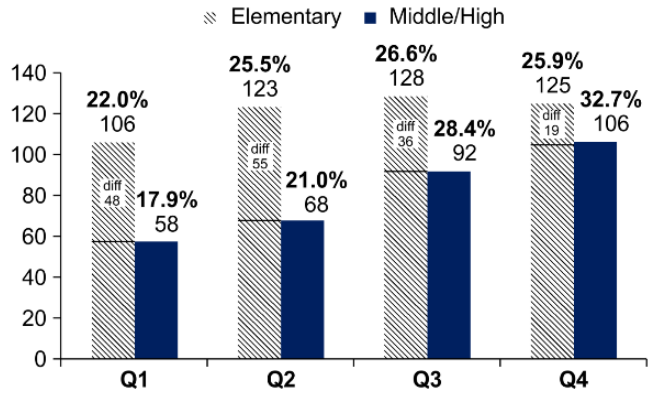

Figure 3. Distribution of birth month in each quarter for elementary and middle-high school gymnasts. Note: diff = frequency in elementary school gymnasts minus frequency in middle-high school gymnasts. Difference in frequency between quarters for elementary school gymnasts: χ^2 = 2.43, *p*=.487. Difference in frequency between quarters for middle-high school gymnasts: χ^2 = 17.83, *p*=.001.

Werneck et al. (2016) analysed RAE in Olympic basketball athletes according to sex, country, and continent and reported that the frequency was the highest for athletes born in months belonging to Q2. Baker et al. (2014) argued that RAE is more prominent in group sports than in individual sports and mentioned the Q2 effect for those born between April and June. Baker et al. (2014) reported an absence of significant RAE in athletes.

This study hypothesised that there would be factors contributing to or hindering social selection depending on the birth month and aimed to elucidate RAE in gymnasts, which was previously reported to be absent. Previous studies analysing RAE in athletes did not reflect the fact that academic years begin at different times in different countries. RAE assumes that students born in January will be at an advantage. However, depending on the definition of academic year, students at an advantage in different countries may be born in different months. For instance, in the United States, one academic year comprises those born between September and August of the subsequent year. In contrast, South Korea sets an academic year to comprise students born between January

and December of one calendar year. In Japan, one academic year includes students born between April and March of the subsequent year. Herein, students born in September are at an advantage in the US, whereas those born in April and those born in January are at an advantage in Japan and South Korea, respectively.

Therefore, this study calculated relative ages considering gymnasts' birth month and the month of entrance into the educational system (Figure 1). In the past, the South Korean educational system grouped those born between March and February of the subsequent year into one academic year. In contrast, one academic year now includes those born between January and December of one calendar year. This system was first applied to those born in 2000, so months between March and June for those born in 1999 and earlier, and months between January and March for those born in 2000 and later comprise Q1. Q2 may have had high frequencies in the studies of Baker et al. (2014) and Wemeck et al. (2016) since the authors did consider the different educational systems in different countries.

Hancock et al. (2015) reported an absence of RAE in gymnasts aged under 15 and an inverted RAE in those above 15. In addition, the relative age effect performed on male and female gymnasts who participated in the Olympic Games reported by Delaš Kalinski, Mandić Jelaska, & Atiković, (2018) did not confirm that athletes with an earlier birth month were advantaged. This study supports the findings of Hancock et al. (2015) and Delaš Kalinski et al. (2018). The inverted RAE seen in gymnasts could be interpreted as a general phenomenon observed in Canadian female and Olympian gymnasts as well as male and female South Korean gymnasts. In general, the effects of relative age that favour athletes born in earlier months act in an inverse manner in gymnasts; in other words, there is an inverted RAE.

Interestingly, RAE is weaker and statistically non-significant in elementary school gymnasts and is very prominent in middle-high school gymnasts. This indicates that the inverted RAE is not reflected when gymnasts are initially selected. However, as gymnasts progress to middle-high school, those born in earlier months may be more likely to drop out than those born in later months. It could be because later physical maturation is more advantageous in gymnastics. This supports the findings of Jelaska, Delaš Kalinski, & Crnjak (2017) that simple chronological age does not affect the best performance of gymnasts.

As the present study did not longitudinally investigate the proportion of South Korean elementary, middle, and high school gymnasts who drop out, it is difficult to conclude that students born in earlier months drop out as they progress to middle-high school. This is because this study is a cross-sectional study conducted on athletes registered with the Korea Gymnastics Association in 2017. However, since this study analysed the birth month of all gymnasts registered with the Korea Gymnastics Association in 2017, there is no logical fault in deducing the inverted RAE in gymnastics. If future studies can analyse the inverted RAE in gymnasts based on longitudinal data, they are expected to yield interesting findings of physical and social advantages of birth month.

ACKNOWLEDGMENTS

We specially thank Mr. Jung Ho So, the Secretary General, and Prof. Choong Sik Han, the Executive Director, of the Korea Gymnastics Association for their cooperation in the data collection of this study.

REFERENCES

Armstrong, H.G. (1966). A comparison of the performance of summer and autumn-born children at eleven and sixteen. *British Journal of Educational*

Psychology, *36*, 72–76.

Arrieta, H., Torres-Unda, J., Gil, S.M., & Irazusta, J. (2016). Relative age effect and performance in the U16, U18 and U20 European Basketball Championships. *Journal of Sports Sciences, 34*(16), 1530–1534.

Baker, J., Schorer, J., & Cobley, S. (2010). Relative age effects: An inevitable consequence of elite sport? *Sportwissenschaft, 40*(1), 26–30.

Baker, J., Janning, C., Wong, H., Cobley, S., & Schorer, J. (2014). Variations in relative age effecits in individual sports: Skiing, figure skating and gymnastics. *European Journal of Sport Science, 14*(S1), S183–S190.

Barnsley, R.H., Thompson, A.H., & Barnsley, P.E. (1985). Hockey success and birthdate. *Canadian Association for Health, Physical Education, and Recreation, 51*, 23–28.

Delaš Kalinski, S., Mandić Jelaska, P., & Atiković, A. (2018). Relative age effect among olympian gymnasts. *Science of Gymnastics Journal, 10*(3), 493-507.

Delorme, N., & Raspaud, M. (2009). The relative age effect in young French basketball players: a study on the whole population. *Scandinavian Journal of Medicine and Science in Sport, 19*, 235–242.

Freyman, R. (1965). Further evidence on the effect of date of birth on subsequent school performance. *Educational Research, 8*, 58-64.

Grondin, S., Deshaies, P., & Nault, L.P. (1984). Trimestres de naissance et participation au hockey et au volleyball [Trimester of birth and participation in hockey and volleyball]. *La Revue Québécoise de l'Activité Physique, 2*, 97–103.

Hancock, D.J., Starkes, J.L., & Ste-Marie, D.M. (2015). The relative age effect in female gymnastics: A flip-flop phenomenon. *International Journal of Sport Psychology, 46*, 714–725.

Helsen, W.F., Starkes, J.L. & Van Winckel, J. (2000). Effect of a change in selection year on success in male soccer players. *American Journal of Human Biology, 12*, 729–735.

Helsen, W.F., Van Winckel, J., & Williams, A.M. (2005). The relative age effect in youth soccer across Europe. *Journal of sports sciences, 23*(6), 629-636.

Hollings, S.C., Hume, P.A., & Hopkins, W. (2014). Relative-age effect on competition outcomes at the World Youth and World Junior Athletics Championships. *European Journal of Sport Science, 14*(S1), S456–S461.

Jelaska, I., Delaš Kalinski, S., & Crnjak, T. (2017). Chronological age among Olympic women's artistic gymnastics: Does it really matter? *Acta Kinesiologica, 11*(2), 108-116.

Lavoie, F., Laurencelle, L., Grondin, S., & Trudeau, F. (2015). Temporal plasticity of the relative age effect in ice hockey: The case of elite minor players in Quebec. *International Journal of Applied Sports Sciences, 27*(1), 14–25.

Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental review, 21*(2), 147-167.

Nakata, H., & Sakamoto, K. (2012). Sex differences in relative age effects among Japanese athletes. *Perceptual and motor skills, 115*(1), 179–186.

Rađa, A., Padulo, J., Jelaska, I., Ardigo, L. P., & Fumarco, L. (2018). Relative age effect and second-tiers: No second chance for later-born players. *PloS one*, *13*(8), e0201795.

Ramos-Filho, L., & Ferreira, M.P. (2021). The reverse relative age effect in professional soccer: an analysis of the Brazilian National League of 2015. *European Sport Management Quarterly*, *21*(1), 78-93.

Sherar, L.B., Baxter-Jones, A.D.G., Faulkner, R.A., & Russell, K.W. (2007). Do physical maturity and birth date predict talent in male youth ice hockey players? *Journal of Sports Sciences, 25*, 879–886.

Votteler, A. & Höner, O. (2014). The relative age effect in the German Football TID Programme: Biases in motor performance diagnostics and effects on single motor abilities and skills in groups of selected players. *European Journal of Sport Science*, *14*(5), 433–442.

Wattie, N., Schorer, J., & Baker, J. (2015). The relative age effect in sport: A developmental systems model. *Sports Medicine*, *45*(1), 83-94.

Werneck, F.Z., Coelho, E.F., de Oliveira, H.Z., Júnior, D.R., Almas, S.P., de Lima, J.R.P.,...Figueiredo, A.J. (2016). Relative age effect in Olympic basketball athletes. *Science & Sports*, *31*(3), 158–161.

Corresponding author:

Jae-Hyeon Park
Korea National Sport University
1239 Yangjae-daero, Bangi-dong, Songpa-gu
Seoul, South Korea
Email: jhpark@knsu.ac.kr
Tel: 82-10-5410-3728
Fax: 82-2-418-1877

Article received: 14.2.2022
Article accepted: 10.4.2022