AGE EFFECTS AMONG ELITE MALE GYMNASTS

Sunčica Delaš Kalinski, Igor Jelaska and Nikolina Knezević

Faculty of Kinesiology, University of Split, Croatia

Original scientific paper

Abstract

Chronological age is a discussable theme in artistic gymnastics for years; relative age effect is a worldwide phenomenon described as the consequences of age variations between individuals competing in the same cohort. Both factors become very complex when seen through the late maturation of male gymnasts and complexity and longevity of learning processes in artistic gymnastics. The study analyzed the impact of chronological age and relative age effect among the elite male gymnasts who participated in All-Around Finals and in Event Finals at all Olympic Games held from 1980 to 2016. Results determined how analyzed finalists were generally in their twenties. Still ring finalists have been identified as the oldest apparatus finalists; significantly older than the All-Around and floor finalists. A significant difference was found in the number of gymnast born in a particular month (most male finalists were born in January and September); significant differences were not found in percent of male gymnasts born in a certain quarter and half of the year. The conclusion was that RAE is not present in elite male gymnastics. Further, date of birth probably is not, but a year of birth could be, one of the criteria in the selection of potential top gymnasts.

Keywords: *men's artistic gymnastics, chronological age, relative age effect, all-around finalists, apparatus finalists.*

Introduction

Favoritism toward selecting athletes born early in the birth year has been termed the relative age effect (RAE; Kirkendall, 2014). Many research shows, that RAE in sport is a worldwide phenomenon and that it exists in many competitive sports. It was first identified in the Canadian hockey and was hypothesized to play a role in success in hockey (Grondin, Deshaies & Nault, 1984; Barnsley, Thompson & Barnsley, 1985). Authors gave a definition of relative age: „it refers to the subtle chronological age discrepancies between individuals within annually age-grouped cohorts. Numerous studies have been conducted from then. Cobley, Baker, Wattie and McKenna (2009) in review article analyzed 38 studies (spanning 1984-2007, containing 253 independent samples across 14 sports and 16 countries) that analyzed relative age effects. In general, they confirmed RAE, with few exceptions, for a variety of sports for both genders over a range of competition and development levels.RAE is based on systems that use January 1 as the cut-off date. Compared to a child born in December, a child born in January of the same year can have a benefit of up to 364 days in his/her cognitive and physical development, although these two children are in the same age category. Therefore, RAEs refer to the specific selection, participation, and attainment (dis)advantages occurring as a result of physical and cognitive variability (Musch & Grondin, 2001). In the sports system, probably the main reason for RAE is to attempt to minimize developmental differences between ages and ensure more equitable competition. The main difference between early and late maturers athletes is physical maturation (as height and mass) and the accompanying performance factors known to be influenced by muscle mass (sprinting, explosive power; Cobley, Baker, Wattie & McKenna, 2009). The presence of an RAE in individual sports is not as ubiquitous but is apparent in skiing (downhill and Nordic; Baker et al., 2014), tennis and archery (Baxter-Jones, 1995). Individual female aesthetic sports (dance, gymnastics, figure skating, diving) seem less prone to an RAE (Baker et al., 2014). Men's Artistic Gymnastics (MAG) is a sport designed to emphasize the gender natural qualities: endurance and strength. Together with low body fat, insane muscles, agility and flexibility gymnasts are "ripped" (in an aesthetic way) because of what MAG belong to a group of individual aesthetic sports. Generally, MAG is all about weight-to-strength ratio, especially of upper – body (4 of the 6 men's events are upper-body dominant; floor & vault are exceptions). However, this weight-to-strength ratio, or more precisely strength, boys can't develop without Testosterone (whose levels are not increased until male gymnasts reach puberty). The increase of muscle mass and development of the power and the strength, without significantly mobilizing the aerobic processes, enable male gymnasts to perform the most difficult elements (Dallas, Zacharogiannis & Paradisis, 2013). Like female gymnasts, male gymnasts are typically characterized with short statures, later maturation, and a slower rate of growth than the normal population (Malina, 2014). Male gymnasts, not like female gymnasts who start with deliberate practice and advanced levels of training usually around six years (Tofler, Stryer, Micheli, & Herman, 1996; Arkaev & Suchilin, 2004), typically do not experience intensive, rigorous training before 14 or 15. Accordingly, the coaches in men's artistic gymnastics have more time

(compared to coaches in Women's Artistic Gymnastics -WAG) to take their gymnast to the peak of their career. Pressure and rush in MAG are much less than in WAG. Chronological age in artistic gymnastics has been the subject of discussion for years and is mostly correlated with the minimum chronological age needed for participation in senior competitions sanctioned by the International Gymnastics Federation (FIG). Although the problem of minimum age it is far more contentious in WAG(because of a range of physical and psychological problems, correlated with female gymnasts early deliberate practice, that were determined in several studies; Malina, 1994; Ryan, 1995; Malina, Bouchard & Bar-Or, 2004; Claessens, Lefevre, Beunen & Malina, 2006; Kerr et al., 2006; Martindale, Collins, & Abraham 2007; Barker-Ruchti, 2009; Caine, Lewis, O'Connor, Howe & Bass, 2001; Cassas & Cassettari-Wayhs, 2006; Daly, Bass, & Finch 2001; Dresler, 1997; Lindholm, Hagenfeldt & Hagman, 1995; Tofler et al., 1996; Martinsen, Bratland-Sanda, Eriksson, & Sundgot-Borgen, 2010) the FIG through past three decades has increased the minimum for both genders.

Prior to 1981, the minimum required age for participation in senior competitions, sanctioned by the FIG, was 14 years; in 1981 it was increased on 15, while from 1997 both genders older than 16 can participate in World Championships additionally, female gymnasts who turn 16 and male who turn 18 in the current year can participate in the Olympic Games, but only as members of national team. Rare studies of RAE in artistic gymnastics were mostly conducted on female gymnasts and had pointed the following:

1) there is an atypical RAEs effect for the female gymnasts; athletes born in the second and third quartiles were more frequently represented on national teams than athletes born in the first and fourth quartiles(Baker et al., 2014); 2) relatively older female gymnasts, have been shown to drop out more frequently than relatively younger gymnasts very often due to psychological responses on puberty (increase of depressive symptoms and weight concerns, decrease of feelings of self-worth; Wattie et al., 2014); 3) RAE was noted in a group of the under-15 years old female Canadian gymnasts (those born earlier in the year appeared more frequently in the dataset) while in a group of over-15 years old gymnasts more of those born later in the year was recorded (Hancock, Starke, & Ste-Marie, 2015).

This unusual trend was explained by the time of the peak of female gymnasts performance (prior to adulthood) and with the possibility that before puberty, relatively older athletes are more cognitively prepared for the rigors of deliberate practice than their relatively younger counterparts. Only one study was found about RAE in male gymnastics: Baxter-Jones (1995) observed no RAE among British elite gymnasts and no significant RAE in males or females.

The aims of this study were: 1) to determine average age of all male finalists who participated at the OGs held from 1980 to 2016; 2) to determine differences in average age between different apparatus finalists, from the OG held from 1980 to 2016; 3) to determine differences between the proportions of gymnasts born in certain month and quarter of the year.

Methods

Subjects

The sample included all the elite male senior gymnasts who participated in All-Around Finals and Event Finals at all OG held from 1980 to 2016 (N=780). A number of participants in All-Around Finals differ due to the rules that were valid then: from 1980 to 2000 number of All-Around Finalists was 36; from OG 2000 number of All-Around Finalists was 24. The number of Event Finals was the same in the analyzed period (n=8). Names and birthdates of the sample were collected from open-access Internet websites; mostly from the official OG website: www.olympic.org/gymnastics-artistic.There were no ethical issues involved in the analysis and interpretation of the data used, as these data were obtained in secondary form and were not obtained by experimentation. The use of open access or Internet data in RAE studies has previously been described in other studies (Côté et al., 2006; Medic, Starkes, Weir, Young & Grove, 2009; Albuquerque et al., 2012; Albuquerque et al., 2015).

Variables

The variable sample is represented by a set of: 1) date of competition at the OG held from 1980 to 2016; 2) male gymnast's date of birth; 3) All-Around Finals Rank and Event Finals Rank obtained at all Olympic Games held from 1980 to 2016.The information's about competitions date and dates of gymnast's birth were collected on the Internet as well as values of the mentioned ranks (gymnasticsresults.com).Data about gymnasts' participation at the certain level of competition, as well rank at the certain OG have been retrieved from the specialized website for gymnastics results (gymnasticsresults.com)

Methods

Conversion of a date of birth into chronological age was done using MS Excel function *YEAR*. Parameters for this function were competitor's date of birth and the date of specific competition that was analyzed. Between subjects One-Way ANOVA was applied due to detection of the significance of differences in contestant's chronological age through OG years (1980–2016). Furthermore, 7-level between subjects ANOVA was applied due to detection of significance of differences in contestant's chronological age, according to their expertise at the certain level of OG competition, independently from the OG year (ALAR-age of All-Around finalists, FX-age of floor finalists, PH-age of pommel horse finalists, SR-age of still rings finalists, VT-age of vault finalists, PB-age of parallel

bars finalists, HB–age of high bar finalists). Bonferroni post hoc correction was applied for identification of particular differences between independent levels of the single factor. For applied ANOVA analyses, the effect size was estimated by using (partial) eta squared coefficient (η^2). A traditional investigation of RAE uses four quarters (Q1: January to March; Q2: April to June; Q3: July to September; and Q4: October to December) for data analysis (Côté et al., 2006; Delorme et al., 2010; Delorme et al, 2011; Albuquerque et al., 2012, 2013). Edgard and O´Donoghue (2005), have examined the RAE categorized in two semesters of 6 months (January to June as the first half of the year and July to December as the second half of the year). In this study data analysis included both of these methods; also a presentation and analysis of the number of competitors born in particular month. Chi-square (χ^2) test was applied for identification of differences between frequencies of affiliation of gymnast's birth date to a certain month and the quarter of the year. For all applied analyses type one error was set at α=5%. All data were calculated using data analysis software system Statistica 12 (StatSoft, Tulsa, Oklahoma, USA).

Results

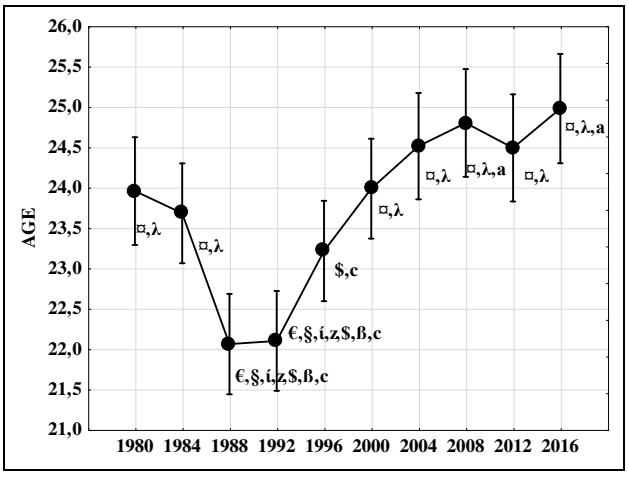


Figure 1 Average age of male gymnasts finalists from different OG held in period from 1980 to 2016

Legend: Data are presented as Mean±Standard Deviation, AGE-age of male gymnasts participants of different finals at the OG, 1980/1984/1988/1992/1996/2000/2004/2008/2012/2016-years of OG, €-significant difference from the scores determined at OG1980, §-significant difference from the scores determined at OG1984, ¤-significant difference from the scores determined at OG1988, λ-significant difference from the scores determined at OG1992, a-significant difference from the scores determined at OG1996, ί-significant difference from the scores determined at OG2000, z-significant difference from the scores determined at OG2004, $-significant difference from the scores determined at OG2008, ß-significant difference from the scores determined at OG2012, c-significant difference from the scores determined at OG2016.

Age of all male finalists at the OG held in the period from 1980 to 2016 is shown in Figure 1. Average age (AA) of all male finalists (All-Around and Event Finalist) from the OG held in the period from 1980 to 2016, generally ranged from 22.6 (OG1988) to 24.98 (OG2016), minimum age ranged from 16.83 (OG2004) to 19.52 (OG2016) while the maximum age ranged from 26.58 (OG1988) to 39.47 (OG2012).

Effect of factor *Year* was found to be significant ($F_{9,769}$=4.72; p<0.001; η^2=0.107). Bonferroni post hoc correction revealed significant differences between certain years; data are presented in Figure 1. AA of all male finalists, from different Apparatuses Finals, from the OG held in the period from 1980 to 2016, is shown in Figure 2.

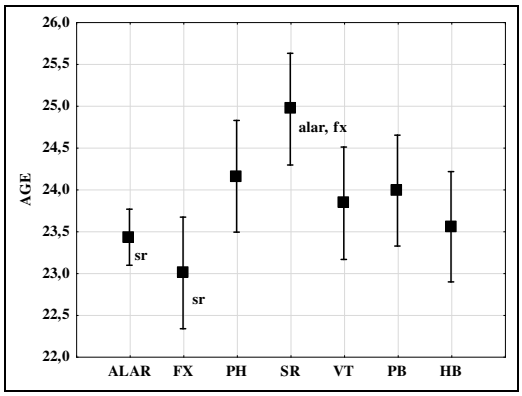
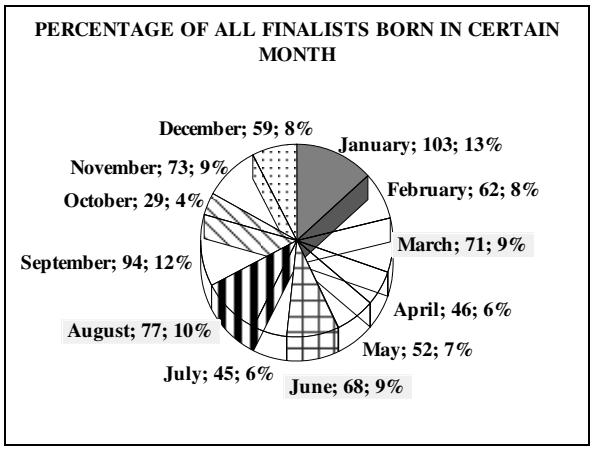
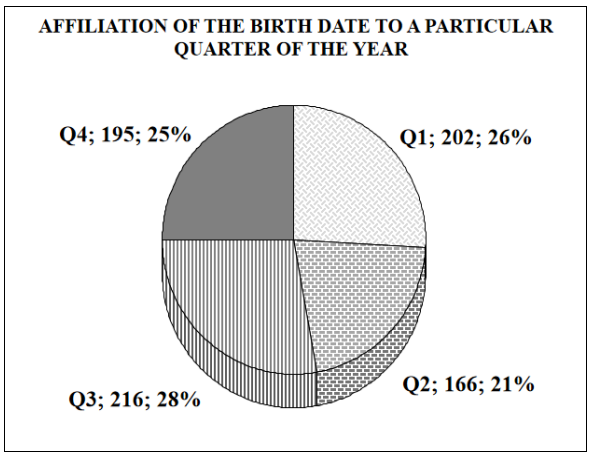


Figure 2 Average age of male gymnasts apparatus finalists from different OG held in period from 1980 to 2016

Legend: Data are presented as Mean±Standard Deviation, AGE-age of male gymnasts participants of different apparatus finals at the OG held from 1980 to 2016, ALAR-age of All-Around finalists, FX–age of participants of floor finals, PH–age of participants of pommel horse finals, SR–age of participants of still rings finals, VT–age of participants of vault finals, PB-age of participants of parallel bars finals, HB–age of participants of high bar finals, alar-significant difference from the age determined at All-Around finals, fx-significant difference from the age determined at floor finals, sr-significant difference from the age determined at still rings finals.

AA of All-Around and Event Finalists, of the OG held from 1980 to 2016, generally ranged from 22.99 (FX) to 24.95 (SR); the minimum age ranged from 16.82 (AA) to 18.76 (SR); the maximum age ranged from 31.02 (HB) to 39.47 (SR). Effect of factor *Expertise* was found to be significant ($F_{6,772}$=3.88; p<0.001; η^2=0.029). Bonferroni post hoc correction revealed significant differences between competitors at certain levels of OG competition; data are presented in Figure 2. Affiliation of the date of birth, of top male gymnasts, to a certain month, quarter and a half of the calendar year is shown in Figures 3, 4 and 5.The results presented in Figure 3 shows how the lowest percentage of OG finalists was born in October (4%) and the highest percentage was born in January (13%). Seen through quarters (Figure 4), the highest percentage of OG finalists was born in the third Quarter (Q3; n=216; 28%) and the lowest in the second Quarter (Q2; n=166; 21%).





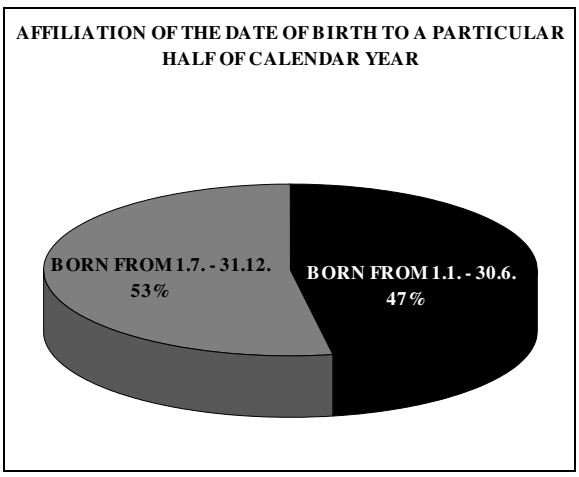


Figure 3, 4 and 5 Affiliation of the date of birth, of all elite male finalists in period from OG1980 to OG2016, to a particular month or part of the year, half quarter of the years and half of the year.

A significance of differences in affiliation to a certain month of the year (χ^2=74.08, p<0.001) have been determined while affiliation to certain quarters (χ^2=6.83, p=0.077) has not been determined.

By dividing the calendar year into two equal parts (Figure 5), it was found that a higher percentage of gymnasts was born in the second half of the year (born from 1.7. to 31.12.; 53%) and smaller percentage in the first half of the year (born from 1.1. to 30.6.; 47%).

Discussion

Although for the male gymnasts minimum allowable age for the participation at the OG (until 1997) was 16 years, from the obtained results it is evident that the average age of all finalists at the OG, held in the period from 1980 to 2016, was 23.78. The obtained results confirm how, although boys start young with gymnastics, to become a finalist at the OG they need time: 1) to develop muscle mass and strength of mostly upper body; 2) to adopt structurally complex skills from MAG. When it is known that development of strength is connected with the increased levels of Testosterone, that doesn't happen before 14 or 15 years (Malina, 2013), and that acquisition of most complex skills from MAG can start only when the gymnast possesses a certain level of strength, then it is logical that elite male gymnasts (OG finalists) are typically in their late teens to mid-20s. From the results of the range of minimum age of all finalists (Figure 1) can be concluded that in one of the apparatus finals (at the OG2004) existed competitor with a lowest permissible age (age 16.83). Original results review determined that it was a German gymnast Fabian Hambuchen, who at the OG2004 finished 23rd in the All-Around finals and seventh in the horizontal bar final.

His presence in the All-Around finals confirmed something that was apparent in the later years: he was an elite gymnast who did his superior performances even in the teenage, and continually perfected them until the age of 29 years (OG2016), when he won his first Olympic Gold. His OG2016 result confirms the hypothesis about lower pressure from the coaches in MAG and about far less rush (compared to WAG) to achieve a peak of the career, regardless of the initial quality of the gymnasts. The importance of the development of the power and the strength is determined in the analysis of differences in AA between different finalists (Figure 2). According to the obtained results, a significant difference was determined between the AA of All-Around (ALAR) and floor finalists (FX) in relation to the AA of the still rings (SR) finalists. Numerically seen, ALAR and FX had significantly lower AA than the SR finalists.

If this result is analysed through the exercising characteristics of those events (All-Around exercising requires "above average" development of strength of all parts of the body; floor exercising primarily requires "above average" muscle strength of the lower limbs; exercising on the still rings requires extreme upper-body strength) than it is logical to assume that development of required upper-body strength and accordingly of still rings elements (needed to become still rings finalists) takes more time that development of abilities and skills for other finals events. A significant difference has been determined in the analysis of the position of the date of birth in a certain month of the year.

The highest number of dates of births of male finalists was determined in the January and in September, although it didn't cause a significant difference between any quarters. The highest number of gymnasts born in January probably can be seen through the basic logic of the RAE: January 1st was probably used as the cut-off date. Accordingly, it is possible that, independently from the time needed to reach male gymnasts peaks, cognitive and physical development advantages of male gymnasts born in January (compared to gymnasts born in December of the same year) which they probably had in the beginning of their career were one of the stimulus in their path of reaching the elite male gymnastics levels later in career. If it is known that a male gymnasts are generally late maturers (Malina, 2014), and that a physical maturation is accompanied with performance factors influenced by muscle mass (sprinting, explosive power; Cobley, Baker, Wattie & McKenna, 2009), than the selection of the male gymnasts born in the beginning of the year (especially if it is a year which in the future will be the lowest one that allows a gymnasts participation at the OG) is more than logical result.

Obtained results confirm results of Barnsley, Thompson and Barnsley (1985) who, in elite sport, has determined the presence of an overrepresentation of athletes born in the first three months following the cut-off date than others born closer to the end of the age-band. Second highest number of male Olympians was determined in September (end of third quarter). Similar results have been found in a sample of gymnast members of the national team (most members of national teams were athletes born in the second and third quartiles; Baker et al., 2014). The assumption is those are male gymnasts who in the year of their first OG will be at least one chronological year older than from minimum prescribed age; their selection may be a part of coaches tactics. However, because physical maturity is correlated with performance in youth (Starkes, 2000) those gymnasts, in their early career can be found in the position not be selected as talents. Such mistake (selecting relatively older athletes for talents) has been confirmed in several studies (Starkes, 2000; Helsen, Hodges, van Winckel & Starkes, 2000; Schorer, Cobley, Büsch, Bräutigam & Baker, 2009; Sherar, Baxter-Jones, Faulkner & Russell, 2007). Not being recognized as talent, especially if it is only due to physical immaturity, is possibly one of the reasons of dropout in gymnastics. Despite significant differences between a number of male gymnasts born in the certain month of the year, when the dates of births were grouped in quarters and halves of the year, obtained results lead to an assumption that RAE doesn't exist in elite MAG. RAE also wasn't determined on a sample of elite national (English) gymnasts (Baker et al., 2014). The reason for such results probably arises from the indeterminate cut-off date for participation in the senior competitions in gymnastics, in relation to the existence of a certain cut-off date in other sports (usually 1.1. in the current calendar year). Gymnastic coaches are probably aware of the fact that in the selection of potential top gymnasts year of birth (if the practitioners are planning to participate in OG) is much more important than the date of birth.

Conclusion

Based on the analysis of the age of the finalists of the different competitions at all OG held in the period from 1980 to 2016, it can be concluded that the male finalists were generally in their twenties. This confirmed knowledge that the participation in the finals at the OG is linked to the long-term training process in which, probably primarily, dominate the development of the strength and learning processes of the structurally the most complex skills from the men's artistic gymnastics. The long-term training process is the most noticeable at the Ring finalists who were identified as the oldest apparatus finalists; significantly older than the All-Around and floor finalists. At the analyzed OG it was determined the existence of competitors with the lowest permissible age for the participation in these competitions. For the youngest finalist was found that his superior performance has been held during his 12-year Olympic career. Did other "young" finalists have a similar course of their gymnastic career, remains to establish in some further studies. The existence of RAE has not been confirmed in MAG despite some differences have been determined in the affiliation of the date of birth to a certain month of the year/quarter/half of the year. Summing the obtained results, and propositions of the FIG, regard the minimum age required for participation at the OG, could lead to the conclusion that the date of birth probably is not a criterion for the drop-out of gymnasts from the selection. In contrast, year of birth could be one of the criteria in the selection of potential top male gymnasts.

References

Albuquerque, M., Lage, G.M., Costa, V.T., Ferreira, R.M., Penna, E.M., Moraes, L.C.A., & Malloy-Diniz, L.F. (2012). Relative age effect in Olympic taekwondo athletes. *Perceptual & Motor Skill*, *114*(2), 1-8.

Albuquerque, M.R., Tavares, V., Lage, G.M., De Paula, J.J., Costa, I.T., & Malloy-Diniz, L.F. (2013). Relative age effect in Olympic judo athletes: a weight category analysis. *Science & Sports*, *28*(3), 59-61.

Albuquerque, M.R., Franchini, E., Lage, G.M., da Costa, V.T., Costa, I.T., & Malloy, L.F. (2015). The relative age effect in combat sports: an analysis of Olympic judo athletes, 1964-2012. *Perceptual & Motor Skill*, *121*(1), 1-9.

Arkaev, L., & Suchilin, N. G. (2004). *Gymnastics: how to create champions*. Oxford: Meyer & Meyer Verlag.

Baker, J., Janning, C., Wong, H., Cobley, S., & Schorer, J. (2014). Variations in relative age effects in individual sports: skiing, figure skating and gymnastics. *European J of Sport Science*, *14*(1), 183-190.

Barker-Ruchti, N. (2009). Ballerinas and pixies: A genealogy of the changing female gymnastics body. *The International Journal of the History of Sport, 26*(1), 45-62.

Barnsley, R.H., Thompson, A.H., & Barnsley, P.E. (1985). Hockey success and birthdate: the relative age effect. *Canadian Association for Health, Physical Education, Recreation and Dance Journal*, *51*, 23-28.

Baxter-Jones, D. (1995). Growth and development of young athletes. Should competition levels be age related? *Sports Medicine*, *20*, 59-64.

Brewer, J., Balsom, P., Davis, J., & Ekblom, B. (1992). The influence of birth date and physical development on the selection of a male junior international soccer squad. *Journal of Sports Sciences*, *10*, 561-562.

Caine, D., Lewis, R., O'Connor, P., Howe, W., & Bass, S. (2001). Does gymnastics training inhibit growth of females? *Clinical Journal of Sport Medicine, 11*(4), 260-270.

Cassas, K.J., & Cassettari-Wayhs, A. (2006). Childhood and adolescent sports-related overuse injuries. *American Family Physician, 73*(6), 1014-1022.

Claessens, A.L., Lefevre, J., Beunen, G.P., & Malina, R.M. (2006). Maturity-associated variation in the body size and proportions of elite female gymnasts 14-17 years of age. *European Journal of Pediatrics, 165*(3), 186-192.

Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual age-grouping and athlete development: a meta-analytical review of relative age effects in sport. *Sports Medicine*, *39*(3), 235-256.

Côté, J., Macdonald, D.J., Baker, J., & Albernethy, B. (2006). When ''where'' is more important than ''when'': birthplace and birthdate effects on the achievement of sporting expertise. *Journal of Sports Sciences*, *24*(10), 1065-1073.

Dallas, G., Zacharogiannis, E., & Paradisis, G. (2013). Physiological profile of elite Greek gymnasts. *Journal of Physical Education and Sport*, *13*(1), 27-32.

Daly, R.M., Bass, S.L., & Finch, C.F. (2001). Balancing the risk of injury to gymnasts: how effective are the counter measures? *British Journal of Sports Medicine, 35*(1), 8-19.

Delorme, N., Boiche, J., & Raspaud, M. (2010). Relative age effect in elite sports: methodological bias or real discrimination?*European Journal of Sport Science*, *10*(2), 91-96.

Delorme, N., Chalabaev, A., & Raspaud, M. (2011). Relative age is associated with sport dropout: evidence from youth categories of French basketball. *Scandinavian Journal of Medicine & Science in Sports*, *21*(1),120-128.

Dresler, C.M. (1997). Physical and emotional problems of elite female gymnasts. *New England Journal of Medicine, 336*(2), 140-140.

Edgar, S., & O'Donoghue, P. (2005). Season of birth distribution of elite tennis players. *Journal of Sports Sciences*, *23*(10), 1013-1020.

Grondin, S., Deschaies, P., & Nault, L.P. (1984). Trimester of birth and school output. *Apprentissage Social*, *16*, 169-174.

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., Hodges, N.J., van Winckel, J., & Starkes, J.L. (2000). The roles of talent, physical precocity and practice in the development of soccer expertise.*Journal of Sports Sciences,18*(9), 727-736.

Kerr, G., Berman, E., & De Souza, M.J. (2006). Disordered eating in women's gymnastics: Perspectives of athletes, coaches, parents, and judges. *Journal of Applied Sport Psychology, 18*(1), 28-43.

Kirkendall, D.T. (2014). The relative age effect has no influence on match outcome in youth soccer. *Journal of Sport and Health Science*, *3*(4), 273-278.

Lindholm, C., Hagenfeldt, K., & Hagman, U. (1995). A Nutrition Study in Juvenile Elite Gymnasts. *Acta Paediatrica, 84*(3), 273-277.

Malina, R.M. (1994). Physical growth and biological maturation of young athletes.*Exercise and Sport Sciences Reviews*, *22*, 389-433.

Malina, R.M. (2014). Top 10 Research Questions Related to Growth and Maturation of Relevance to Physical Activity, Performance, and Fitness. *Research Quarterly for Exercise and Sport, 85*(2), 157-173.

Malina, R.M., Baxter-Jones, A.D.G., Armstrong, N., Beunen, G.P., Caine, D., Daly, R. M., . . . Russell, K. (2013). Role of Intensive Training in the Growth and Maturation of Artistic Gymnasts. *Sports Medicine, 43*(9), 783-802.

Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, Maturation and Physical Activity*. United States: Human Kinetics, Champaign, IL.

Martindale, R.J.J., Collins, D., & Abraham, A. (2007). Effective Talent Development: The Elite Coach Perspective in UK Sport. *Journal of Applied Sport Psychology, 19*(2), 187-206.

Martinsen, M., Bratland-Sanda, S., Eriksson, A.K., & Sundgot-Borgen, J. (2010). Dieting to win or to be thin? A study of dieting and disordered eating among adolescent elite athletes and non-athlete controls. *British Journal of Sports Medicine, 44*(1), 70-76.

Medic, N., Starkes, J.L., Weir, P.L., Young, B.W., & Grove, J.R. (2009). Relative age effect in masters sports: replication and extension. *Research Quarterly for Exercise and Sport*, *80*(3), 669-675.
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, 147-167.
Ryan, J. (1995). Pretty girls in little boxes: The making and breaking of elite gymnasts and figure skaters. New York: Doubleday.
Schorer, J., Cobley, S., Büsch, D., Braütigam, H., & Baker, J. (2009). Influences of competition level, gender, player nationality, career stage and playing position on relative age effects.*Scandinavian Journal of Medicine & Science in Sports*, *19*(5), 720-730.
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*(8), 879-886.
Starkes, J.L. (2000). The road to expertise: Is practice the only determinant? *International Journal of Sport Psychology*, *31*(4), 431-451.
Tofler, R., Stryer, B.K., Micheli, L.J., & Herman, L.R. (1996). Physical and emotional problems of elite female gymnasts. *New England Journal of Medicine*, *335*(4), 281-283.
Wattie, N., Tietjens, M., Cobley, S., Schorer, J., Baker, J., & Kurz, D. (2014). Relative age-related participation and dropout trends in German youth sports clubs. *European Journal of Sport Science*, *14*(1), 213-220.
*** https://www.gymnasticsresults.com

UTJECAJ KRONOLOŠKE I RELATIVNE DOBI U MUŠKOJ SPORTSKOJ GIMNASTICI

Sažetak
Kronološka dob je tema o kojoj se godinama raspravlja u sportskoj gimnastici dok je relativna dob(RAE) pojam koji se veže uz varijacije u dobi između pojedinaca koji se natječu u istoj dobnoj skupini. Ako se sagledaju kroz kasno sazrijevanje gimnastičara te složenost i dugotrajnost procesa učenja u sportskoj gimnastici, ova dva čimbenika jako su kompleksna. Istraživanje je analiziralo utjecaj kronološke i relativne dobi kod gimnastičara koji su sudjelovali u višebojskim finalima i finalima po spravama na svim Olimpijskim igrama održanim od 1980-te do 2016. godine. Utvrđeno je kako su analizirani finalisti uglavnom bili u dvadesetim godinama; finalisti na karikama utvrđeni su kao najstariji finalisti (značajno stariji od finalista višeboja i finalista na parteru). Značajna razlika pronađena je u broju gimnastičara rođenih u određenom mjesecu godine (većina finalista rođena je u siječnju i rujnu). Značajne razlike nisu pronađene u postotku gimnastičara rođenih u određenom tromjesečju i/ili polovici godine. Zaključeno je: 1) da utjecaj RAE nije prisutan u vrhunskoj muškoj sportskoj gimnastici.; 2) da datum rođenja vjerojatno nije jedan od kriterija u izboru potencijalnih vrhunskih gimnastičara, dok bi godina rođenja potencijalnih vrhunskih gimnastičara to mogla biti.

Ključne riječi: *muška sportska gimnastika, kronološka dob, utjecaj relativne dobi, finalisti višebojskog natjecanja, sudionici finala po spravama*

Received: August 2, 2017
Accepted: August 16, 2017
Correspondence to:
Assoc. Prof. Sunčica Delaš Kalinski, PhD
University of Split
Faculty of Kinesiology
Teslina 6, 21000 Split, Croatia
Tel: +385(0)99 1502 9751
E-mail:suncica@kifst.hr