KINESIOLOGY & COACHING

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Analysis of the Relative Age Effect in Elite Wrestlers

Key word: relative age effect, success, wrestling

Abstract

Background. The relative age effect has been used to refer to the age differences between individuals who have been grouped together in a sports competition. In this sense, the relative age effect is considered a determining factor of sporting success.

Problem and Aim. Determine the influence of relative age on the achievement of success by athletes in top-level competitions in modern wrestling.

Methods and materials. In the research paper, the data of the athletes (n = 682) who took from 1 to 8 places at the 2017, 2018 and 2019 World Championships and the 2016 Olympic Games in Greco-Roman and freestyle wrestling are considered. The athletes were sub-categorized by the athletes' dates of birth; medalists; participation and achieved success in the cadets and juniors competitions.

Results. There are more athletes who were born in the first half of the year than in the second: 54.7% versus 45.3%, respectively. The distribution of medal winners by date of birth is as follows: it turned out that 53.3% of medalists were born in the first half of the year while 46.7% – in the second half of the year (p>0.05).

Conclusion. The data obtained show that the relative age effect does not affect the achievement of success in wrestling and is leveled at the adult stage. However, the analysis has shown that the greatest influence of the relative age effect on athletes was revealed at the cadet level.

Introduction

Talent identification may be influenced by many factors [Vaeyens *et al.* 2008]. Birth timing is one of the factors that play an important role in selection. In most sports, international federations use a system for competitors with January 1 as the cut-off date to establish the age groups. The relative age effect has been used to refer to the age differences between individuals who have been grouped in a sports competition. In this connection, the relative age effect is considered a determining factor of sporting success [Abbott *et al.* 2005; Wattie, Schorer, Baker 2015]. Relatively older children have advantages in growth, biological maturity, and cognitive development [Cumming *et al.* 2017]. The relative age effect has been confirmed in many types of sports, including athletics, swimming [Medic *et al.* 2009; Cobley *et al.* 2019], sports games [Salinero *et al.* 2013; McCunn *et al.* 2017; Arrieta *et al.* 2016] and others [Muller *et al.* 2016].

The influence of the relative age effect on most types of combat sports should be considered separately from other sports since athletes are divided into weight groups and the advantage of height and weight development is leveled. However, the impact of other components of relative maturity is observed [Franchini, Gutierrez-Garcia, Izquierdo 2018]. The influence of the relative age effect

in combat sports is investigated in the following research works: judo [Fukuda 2015; Albuquerque *et al.* 2015], taekwondo [Albuquerque *et al.* 2012], boxing [Edginton, Gibson, Connelly 2014; Delorme 2014]. Some studies the influence of RAE in combat sports separately, taking into consideration the weight category of the athlete; or whether the athlete is a medalist [Delorme 2014; Albuquerque *et al.* 2015].

In most of the articles, various periods in terms of duration and chosen time (not only the modern period) are examined, which may lead to controversial conclusions. Besides, it is worth noting that quite a few articles are devoted to wrestling as an Olympic sport (often wrestling is considered with other sports). An important factor in the selection and talent identification is the extent to which relative age effect influences on the achieved success (medalist) of world elite athletes. Also an important issue is whether the RAE mattered to the world-class athletes at the cadet/junior stages (retrospective analysis). We have not found such studies at the moment. Therefore, the aim of the given paper is to determine the influence of the relative age effect on the modern achievement of success in the competitions of the top level in modern wrestling; and also to analyze this effect among the performances of athletes at the cadets/juniors' stages.

Materials and methods

Data collection (participants)
In the research paper, the data of athletes (n = 682) who took from 1 to 8 places at the 2017, 2018 and 2019 World Championships and the 2016 Olympic Games in Greco-Roman and freestyle wrestling are considered. To determine the influence of the relative age effect on the achievements of athletes, all athletes were divided according to certain parameters [Pereira Martins *et al.* 2019]. Among the total number of athletes there are 272 medalists (1st to 3rd place) and 410 non-medalists (5th to 8th place). Additionally, the achievements of these athletes in cadet and junior age were considered (retrospective analysis): participation in competitions and winning the medal in competitions among cadets/juniors (Continental Championship, World Championship). Data on performances and dates of birth of athletes are taken from open sources, the official website in particular (https://unitedworldwrestling.org/database).

Procedure
All the athletes were divided into groups depending on their date of birth. A traditional approach to investigate the relative age effect is to use four quarters (Q1 – January to March; Q2 – April to June; Q3 – July to September and Q4 – October to December) for data analysis. However, there are also more and less detailed

divisions, for example: by month [Wingfield 2017] and half of the year [Albuquerque *et al.* 2015] In this research paper, we use half-year divisions in order to identify the presence / absence of this effect among elite wrestlers.

Data analysis
In the article, the standard methods for statistical data analysis have been applied. To identify statistically significant deviations, the chi-square statistic was used [Delorme, Champely 2015]. To calculate a statistically significant difference for all the athletes, it was assumed that 50% of athletes were born in the first half of the year and 50% were born in the second half of the year. In order to obtain a statistical significance for other indicators, the actual distribution of the analyzed athletes born in the first and second half of the year was considered. Statistical significance is taken at the level of $p < 0.05$. The data analysis was carried out using the Python 3.8. (Pandas, NumPy).

Results

Table 1 shows the number of athletes born in the first and second half of the year (semester), as well as the distribution of the number of wrestlers, depending on their performance in the competition and the weight category.

Table 1. The number and the percentage of athletes by relative age (the first and the second semester).

Athletes	1 semester	2 semester	Chi^2	p
All (total) *	373 (54.7 %)	309 (45.3 %)	2.8	0.09
Medalists	145 (21.3 %)	127 (18.6 %)	0.26	0.61
Non-Medalists	228 (33.4 %)	182 (26.7 %)		
Light Weight	79 (11.6 %)	73 (10.7 %)		
Middle Weight	141 (20.7 %)	113 (16.6 %)	0.58	0.75
Heavy Weight	153 (22.4 %)	123 (18.0 %)		

Note: * the calculation was made for the estimated amount (50% to 50%).

As seen in Table 1, in general, there are more athletes who were born in the first semester than in the second: 54.7% versus 45.3%, respectively.

For predicting the performance of athletes, the information on the distribution of medalists / non-medalists is the most important. Considering only medalists, it turns out that 53.3% of them were born in the first semester and 46.7% in the second semester. For non-medalists, this distribution is as follows: 55.6% of athletes were born in the first semester and 44.4% in the second. Analyzing the distribution of medalists / non-medalists and the distribution of athletes by weight categories (light, middle and heavy), no statistically significant differences have been found between the groups with different RAE.

Table 2 provides information on the number of athletes at the junior and cadet levels earlier, depending on their date of birth.

Table 2. The number and the percentage of athletes at junior and cadet levels by relative age (the first and the second semester).

	1 semester	2 semester	Chi²	p
Junior Success	194 (28.5 %)	159 (23.3 %)	0.01	0.95
No Junior Success	179 (26.2 %)	150 (22.0 %)		
Junior Participation	246 (36.1 %)	211 (30.9 %)	0.32	0.57
No Junior Participation	127 (18.6 %)	98 (14.4 %)		
Cadets Success	129 (18.9 %)	91 (13.3 %)	1.8	0.18
No Cadets Success	244 (35.8 %)	218 (32.0 %)		
Cadets Participation	177 (26.0 %)	129 (18.9 %)	2.0	0.16
No Cadets Participation	196 (28.7 %)	180 (26.4 %)		

There have been no statistically significant differences found between the athletes born in the first and in the second semesters for all the considered indicators. The most important indicators for identifying talent are successes in junior and cadet age. Among 353 athletes who achieved success in the junior age, 54.9% were born in the first semester and 45.1% in the second. Among those who achieved success at the cadet level there are 58.6% of athletes born in the first semester and 41.4% in the second. The smallest p-value has been found when calculating the differences between the athletes born in the first and second semesters with successes in the cadets' age: 0.18 and 0.16, respectively, for success and participation at the cadet level. But still, there are no statistically significant differences (statistical significance at the level of $p < 0.05$).

Discussion

There is no doubt that investigations on the relative age effect are still relevant, and modern research works deepen and update the knowledge in this field. In the given paper it is shown that at the present stage of competitive activity in wrestling (2016-2019), the number of participants in the competition born in the first half of the year is greater (almost 55%) than in the second half of the year. These data are statistically insignificant (p = 0.09), but the p-value is small. These data have been confirmed by other studies that were conducted for the Olympic Games participants: Wingfield [2017] showed a statistically significant relationship between the date of birth (for each month separately) and the number of participants in the 2012 and 2016 Olympic Games. There were more athletes born in the first months of the year compared to other months (the number of athletes decreases almost linearly at the end of the year). All sports were under analysis in this work, including combat sports: wrestling, judo, taekwondo and fencing. The confirmation of the received data is also shown in the scientific papers related to the analysis of birth data

of Olympic Games participants in freestyle and Greco-Roman wrestling [Albuquerque et al. 2014]. There have been found statistically significant differences for wrestlers of both styles. However, there are works in which this tendency has not been confirmed [Albuquerque et al. 2015]: among all the Olympic Games participants in judo from 1964 to 2012, there was almost an equal number of athletes born in the first semester (50.68% and 51.43%) and in the second (49.68% and 48.57%), for men and women, respectively. A rather long period of analysis, which may not reflect current trends, should be noted as well.

Summing up these results, it can be stated that participation in competitions of the highest level is a success for most athletes since they passed the national selection and are the best representatives of the country. The research analysis has shown different tendencies depending on sports and periods of analysis [Wingfield 2017; Medeiros et al. 2017], however, it should be pointed out that there is a certain relationship between the date of birth and the success in the world-class competitions. The reasons that led to this phenomenon require additional research – what level these athletes were selected and continued to perform at: is it the influence of the selection at the early levels (before the cadet and junior) or is it a certain tendency for the adult sports. Perhaps some of the talented and promising athletes in the early levels stopped their performances due to the high competition with relatively older athletes [Hancock, Adler, Cote 2013]. These athletes might have had a chance to achieve success in adult sports, when the differences in relative age would have leveled out.

The data on the influence of the relative date of birth on the achievement of success (winning a medal) can be used in planning and predicting the results of performances. Our research has shown that among the medalists, 53.3% of athletes were born in the first semester, and 46.7% in the second semester. However, in the percentage of the total number of athletes born in the first and second semesters, no tendency has been revealed (it has been confirmed by the statistical calculations). The absence of the relationship between the date of birth of an athlete and their success in competitions (winning a medal) was confirmed in a number of studies on the combat athletes. Likewise, there was no evidence of the RAE when considering the best results at the Olympic Games and making comparisons between the medalists, finalists and non-finalists [O'Neill et al. 2016]. There was no dependence on the relative age revealed in the analysis of the dates of birth of the Olympic Games medalist-wrestlers [Albuquerque et al. 2014]. The data obtained show that the relative age effect does not affect the achievement of success in wrestling and is leveled at this stage. Therefore, this indicator (relative age) is not key for the elite athletes and cannot be qualitatively used to predict the performance results (it should be clarified that we

considered only the elite athletes and perhaps this criterion has affected the performance results athletes who hold below the eighth place).

The last part of the research dealt with the success of athletes at the earlier levels: cadets and juniors. The study did not reveal statistically significant differences between athletes born in the first and second semesters of the cadet and junior age. However, for the athletes of cadet age, the p-value is the lowest among all the values and is the closest to significant.

In confirmation of the data obtained, the study [Lorenzo-Couso, Quel 2016] did not reveal the influence of RAE on athletes aged 16-17 years (cadet age) and 18-20 years (junior age) practicing karate. But it demonstrated statistically significant differences depending on the date of birth for athletes under the age of 16.

When analyzing the athletes involved in sports related to weight categories (judo, karate, wrestling, boxing) between the ages of 7 and 20, the data obtained showed the dependence on RAE as well as its absence for various ages and levels of athletes [Romann *et al.* 2018].

Still, the opposite data were also obtained. There was shown a statistically significant relationship between the date of birth of junior athletes in the first quarter and the date of birth in the third and fourth quarters [Fukuda *et al.* 2017]. The data for all weight categories of freestyle and Greco-Roman wrestlers and for medalists were considered separately. The research was conducted for athletes who took part in the 2006-2014 World Junior Championships. Also, similar studies [Fukuda 2015]. were carried for athletes of cadet and junior age, practicing judo (top 7 athletes were selected at the World Championships for each age group). They showed statistically significant dependences of the relative age effect between the groups of athletes. The study period for cadets was from 2009 to 2013, and for the juniors from 1990 to 2013.

These data indicate the inconsistency of the influence of the relative age effect in the stages of athletes training up to the adult level. From the point of view of selection and identification of talent, it is important what achievements elite athletes had in the early stages (and whether RAE influenced these achievements). It should be stated that Rae is important for the success of the cadet / junior performance (although in our study these data are not statistically significant but the above studies are presented in which the significance is shown). More biologically mature athletes have advantages in this age group and are selected for competitions more often. However, the data show that the percentages of athletes who took part/achieved success at the cadet/junior level are almost the same for different relative ages group. Therefore, RAE did not have an impact on further careers and the indicator should not be considered a significant indicator for the selection of perspective wrestlers for an adult career. Further research is needed to study prospective analysis (to consider the existing

career of successful athletes at the cadet/ junior stages and the influence of RAE on their careers).

Conclusions

In current work, the data of 682 athletes who took from 1 to 8 places at the 2017, 2018 and 2019 World Championships and the 2016 Olympic Games in Greco-Roman and freestyle wrestling have been analyzed. There were more athletes born in the first semester than in the second: 54.7% versus 45.3%, respectively. The distribution of medalists by date of birth is as follows: it has turned out that 53.3% of them were born in the first semester and 46.7% in the second semester (p> 0.05). At the same time, the distribution of non-medalists is presented as follows: 55.6% of athletes were born in the first semester and 44.4% in the second (p> 0.05). Among 353 athletes who achieved success in the junior age, 54.9% were born in the first semester and 45.1% in the second (p> 0.05). As for the athletes who achieved success at the cadet level, there were 58.6% of athletes born in the first half of the year and 41.4% in the second (p> 0.05). The analysis has shown that the greatest influence of the relative age effect on athletes was revealed at the cadet level. However, for all the considered indicators, there were no statistically significant differences revealed between the athletes born in the first and second semesters.

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Analiza efektu względnego wieku wśród elitarnych zapaśników

Tło. Względny efekt wieku jest stosowany w odniesieniu do różnic wiekowych między osobami, które zostały zgrupowane podczas zawodów sportowych. W związku z tym efekt wieku względnego uważa się za czynnik decydujący o sukcesie sportowym.

Problem i cel. Określenie wpływu wieku względnego na osiąganie sukcesów przez sportowców w zawodach najwyższej rangi w zapasach.

Metody i materiały. W pracy badawczej uwzględniono dane sportowców (n = 682), którzy zajęli od 1 do 8 miejsca na Mistrzostwach Świata w 2017, 2018 i 2019 roku oraz Igrzyskach Olimpijskich w 2016 roku w zapasach w stylu grecko-rzymskim i wolnym. Zawodnicy zostali podzieleni na kategorie według daty urodzenia, zdobytych medali, udziału i osiągniętych sukcesów w zawodach kadetów i juniorów.

Wyniki. Więcej sportowców urodziło się w pierwszej połowie roku niż w drugiej: odpowiednio 54,7% i 45,3%. Rozkład medalistów ze względu na datę urodzenia jest następujący: okazało się, że 53,3% medalistów urodziło się w pierwszej połowie roku, a 46,7% - w drugiej połowie roku (p>0,05).

Wnioski. Z uzyskanych danych wynika, że efekt wieku względnego nie ma wpływu na osiąganie sukcesów w zapasach i wyrównuje się w wieku dojrzałym. Analiza wykazała jednak, że największy wpływ efektu względnego wieku na sportowców ujawnił się na poziomie kadetów.