Original article

The Relative Age Effects on Senior Weightlifting Athletes in Turkey

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Summary. Relative age effect has been used to refer to the age differences between individuals who have been grouped together in a sports competition. The aim of this study is to analyze the birth date distribution of the senior athletes in Olympic style weightlifting, who participated in Turkish Weightlifting Championships between the years 2018 and 2020. This study also aims to find out the quarter of the year in which elite athletes with ranking in the first three in weightlifting championships were born. The data collection was obtained from the website of the Turkish Weightlifting Federation with a sample made of 478 senior athletes in the last five Turkish Weightlifting Championships (2018, 2019 and 2020). The players' birthdates were classified into four seasons of 3 months starting from January to March inclusive (Q1) and ending with October to December inclusive (Q4). The weightlifters were divided into subset weight categories; lightweight, middleweight, heavyweight. The quarter of the year in which elite senior athletes ranking in the first three in championships were born was also obtained. The data was analyzed using SPSS version 25 series of Chi-Square tests. Statistical significance level was set at p< 0,05. In male group of the study, the relative age effects were determined in lightweight ($\chi^2(3)= 28.08, p <.001$) and middleweight category ($\chi^2(3)= 23.60, p <.001$). Significant relative age effects for female athletes were observed in middleweight category ($\chi^2(3)= 13,15, p <.01$). Both for male and female groups, the athletes ranking in the first three in the competitions were observed to be born in the Q1 of the year ($\chi^2(3)= 10.57, p <.01$); ($\chi^2(3)= 11.68, p <.01$) respectively). In male and female senior groups, significant relative age effects are present on athletes in Olympic style weightlifting regardless of their body weight category.

Key words: Relative age effect**,** Birth date, Age-categories, Olympic style weightlifting

Introduction

To avoid effects coming out of different age, children are grouped into annual age groups both in school and sport. For that, a given birthdate is used as a cut-off date, which is 1st January in most countries. However, in contrast to what is intended, a good number of children born in the first months after this cut-off date has been observed to have less success in sports, which seems to be resulting from the Relative Age Effects (RAEs). The number of these relatively younger athletes is a matter of concern because athletes born in the last months of the year are not given equal opportunities (1). The RAEs in sports was firstly documented by Barnsley, Thompson, and Barnsley (2) on a study analyzing the birth dates of professional ice hockey players from Canada. A number of different studies (e.g., Boucher & Mutimer (3) found that in general, a significantly higher number of world-class athletes are born in the first quarter of the selection year than in the last quarter of the selection year. In a recent extensive review of the literature on the RAEs

in sports, Musch and Grondin (4) concluded that the RAEs exists in many sports including baseball, cricket, ice hockey, soccer, swimming, tennis and at various levels of competition (varying from professional young adult athletes to top-level adolescents). However, they also showed that the RAEs does not exist in sports such as American football (5), basketball (5,6), golf (6), male gymnastics (7), and dancers (8). The greater success of chronologically older players is based on the fact that individuals born for instance in January may have a nearly 12-month developmental lead (in terms of physiological, morphological and psychological assumptions), compared to the individuals born in December of the same year (9,4). Athletes born earlier have notably higher levels of strength, endurance, and speed, which enables them to achieve better performance, especially in sports with high demands on their fitness levels (9). Other studies on different sports found that athletes born early in the selection year are more likely to be selected for elite teams and talent development programs than those born later in the same year (10-13). This overrepresentation of relatively older athletes in youth sport is labelled as the RAEs (2). The RAEs is a problem that applies to sports selections at various levels and to various categories, both children's and junior as well as senior categories. In a number of sports, an important factor influencing sports performance is the body height and weight, which is connected with a higher level of physical condition (14). Several factors such as genetics, training, diet, family history and sociocultural differences contribute to become an elite athlete. Over the years, the RAEs has been accepted as a factor in successful sporting events. That is, elder athletes in a certain age group are more likely to be more successful than younger ones in the same group (15). Specifically in sports where strength, speed, and endurance are key factors, the RAEs has often been linked to anthropometric and physical-performance advantages (4,16,17). It was reported that the "early-born" members of junior soccer clubs are more likely to be successful in their adult professional careers (18). Barnsley et al (19) analyzed the RAEs on the football players of the 1990 World Cup and reported that there was a strong correlation between age and success the same effect was also confirmed by Vaeyens et al. (20), Cobley et al. (21), Thompson et al. (22) with baseball players and by Barnsley and Thompson (23) with senior hockey athletes. The RAEs seems to be more effective in physically demanding sports (24), male athletes are more susceptible to the RAEs than women (25) and the RAEs diminishes as athletes mature (26).

In Olympic style weightlifting for which the championships are held for snatch and clean-and-jerk techniques, senior male and female athletes participate in different body weight categories (27). In sports such as weightlifting, the RAEs seems to base on age and body weight categories, however, few studies are present, and they were carried out senior weightlifting athletes.

The aim of this study is firstly to define to what extent the RAEs is present in male-female senior athletes in Olympic style weightlifting depending on body weight category and secondly to investigate if the RAEs has real effects on weightlifting performance of both genders.

Methods

Participants and Data collection

The data for a total of 478 athletes in Olympic style weightlifting, who competed in Turkish Weightlifting Championships held in 2018, 2019 and 2020, were evaluated for senior athletes (male (n= 325; age:21.69±0.7, average 20-22.50 years); female (n= 153; age:21.15±0.4, average 20-22 years). The data of this study was collected from five different championships which were scheduled in Turkish Weightlifting Federation agenda and held in different cities in Turkey; Senior Individual Turkey Weightlifting Championships (Niğde/06-09, September, 2018), Naim Süleymanoğlu Senior Clubs Turkey Weightlifting Championships (Gaziantep/01-04, March, 2018), Senior Individual Turkey Weightlifting Championships (Sivas/10-14, September, 2019), Naim Süleymanoğlu Senior Clubs Turkey Weightlifting Championships (Denizli/24-27, January, 2019), Naim Süleymanoğlu Senior Individual Turkey Weightlifting Championships (Antalya/23-26, January, 2020).

The birth dates and medal ranking in the championships of the athletes in Olympic style weightlifting

were collected from an online source of Turkish Weightlifting Federation (https://halter.gov.tr) and technical weightlifting referee organization. The athletes who participated in Turkey Weightlifting Championships more than once were counted once in the study and duplicates were removed from the study. Furthermore, the athletes that had invalid lifts were also excluded. The study complies with the Declaration of Helsinki and the ethical approval of the study was obtained from the University of Necmettin Erbakan, Social and Humanities Scientific Research Ethics Committee (dated 2021 and numbered 500).

Procedure

To determine the existence of the RAEs, the month of birth of each athlete was classified into quarters (Q). The calendar year from January 1 to December 31 was used; Q1 represents the birthdate in January, February, and March; Q2 represents April, May, and June; Q3 represents July, August, and September; and Q4 represents October, November, and December (28-31).

Olympic style weightlifting events are held for male and female athletes in different age and in 10 different body weight categories (apart from Olympic Games). All senior male and female weightlifting athletes in our study were divided into different subset weight classes; male lightweight (LW) (55 kg, 61 kg and 67 kg), male middleweight (MW) (73 kg, 81 kg, 89 kg and 96 kg), male heavyweight (HW) (102 kg, 109 kg and +109kg), female lightweight (LW) (45 kg, 49 kg, and 55 kg), female middleweight (MW) (59 kg, 64 kg, 71 kg and 76kg) and female heavyweight (HW) (81 kg, 87 kg and +87 kg) (32). As International Weightlifting Federation decided to change body weight categories in 2018, all athletes in both male and female groups were classified in accordance with subset body weight categories mentioned above. The medal ranking of the athletes in Turkey Weightlifting Championships is calculated depending on the total maximal weight lifted in snatch and clean-and-jerk techniques by the athletes. In addition, as the athletes ranking in the first three are more likely to be selected in Turkish National Weightlifting Team, the athletes in senior male and female groups, who ranked in the first three, along with their birthdate quarter were determined.

Statistical analyses

Statistical analyses Chi-square tests were conducted on the birthdates of each athlete within the four quarters to assess the significance of deviation from the expected number of births in each quarter. Chi-square analyses were conducted for each body weight category and overall. Additionally, the differences in each subgroup were reported. To find out whether a significant difference existed in the rate of the ranking in the first three in championships and the rate of birthdate quarter, Chi-Square analyses were realized. Also, the differences in overall subgroups were reported. The significance level of the analyses was set $p<.05$. All data regarding this study was analyzed using SPSS computer software for Windows (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp).

Results

Table 1 shows the rate of birthdate quarter of senior male and female athletes in Turkey Weightlifting Championships from 2018 to 2020. The distribution of the birthdate quarters of the athletes was statistically different in male senior athletes in overall ($\chi^2(3)= 50.00$, $p <.001$), LW ($\chi^2(3)= 28.08$, $p <.001$) and MW ($\chi^2(3)= 23.60$, $p <.001$). According to the further analyses to figure out from which group the difference arises, the rate of Q1 in overall was significantly higher than the rates of Q2, Q3 and Q4 ($\chi^2(1)= 19.17$, $p <.001$; $\chi^2(1)= 23.69$, $p <.001$; $\chi^2(1)= 35.77$, $p <.001$; respectively). The rate of Q1 in LW was observed to be higher than Q2, Q3 and Q4 ($\chi^2(1)= 11.20$, $p <.001$; $\chi^2(1)= 15.52$, $p <.001$; $\chi^2(1)= 19.44$, $p <.001$; respectively). Similarly, the rate of Q1 in MW was also significantly higher than Q2, Q3 and Q4 ($\chi^2(1)= 14.09$, $p <.001$; $\chi^2(1)= 10.67$, $p <.001$; $\chi^2(1)= 16.04$, $p <.001$; respectively). Nevertheless, in HW category no statistically significant difference was present in all groups ($p >.05$) (Table 1).

The Chi-square tests showed that the distribution of birthdates was statistically different in female senior athletes in overall ($\chi^2(3)= 37.77$, $p <.001$) and MW ($\chi^2(3)= 13{,}15$, $p <.01$). To evaluate the reason for the difference, we carried out extra analyses and we noticed that the rate of Q1 in overall was higher than the rates of Q2, Q3 and Q4 ($\chi^2(1)= 13.83$, $p <.001$; $\chi^2(1)= 26.18$, $p <.001$; $\chi^2(1)= 11.33$, $p <.001$; respectively). The rate of Q1 in MW was found to be significantly higher than Q3 and Q4 ($\chi^2(1)= 11.11$, $p <.001$; $\chi^2(1)= 5.49$, $p <.05$; respectively). In HW category, the number of the athletes was lower than five individuals, so only the rates of Q1 and Q4 were compared. Depending on the results of the extra analyses for HW category, no significant difference was found in the rates of Q1 and Q4 ($p >.05$). In LW category, no significant difference was present in all groups ($p >.05$) (Table 1).

The distribution of the birthdate quarters of the male and female weightlifting athletes participated in championships in Turkey (2018 to 2020) is shown in Table 2. The rates of the athletes born in Q1 in LW and MW categories of male groups and only in MW category of female groups were found to be significantly higher than the rate of Q4. Although the rate of Q1 in HW category of male athletes and in both LW and HW categories of female athletes was numerally higher than the rate Q4, it was not statistically significant (Table 2).

The Chi-square tests regarding the rate of medal rankings, as there should be at least five individuals in each counted cell, were only carried out for overall comparison. When the rate of medal rankings of male athletes in overall was compared, the difference among the groups was significant ($\chi^2(3)= 10.57$, $p <.01$). In further analyses to find out the reason for

Table 1. The quarterly birthdate rate distribution of the senior athletes participated in Turkey Weightlifting Championships held in 2018, 2019 and 2020.

Gender	Weight Category	n	Q1	Q2	Q3	Q4	Total	χ^2	*p*	Pairwise Comparisons
Male	LW	n	49	22	18	15	104	28.08***	**.001**	Q1> Q2, Q3, Q4
	MW	n	64	29	33	27	153	23.60***	**.001**	Q1> Q2, Q3, Q4
	HW	n	22	21	15	10	68	5.53	.137	-
	Overall	n	135	72	66	52	325	50.00***	**.001**	Q1> Q2, Q3, Q4
Female	LW	n	21	11	11	11	54	7.19	.066	-
	MW	n	28	17	8	13	66	13.15**	**.004**	Q1> Q3, Q4
	HW	n	19	3	1	10	33	2,79	.095	-
	Overall	n	68	31	20	34	153	37.77***	**.001**	Q1> Q2, Q3, Q4

LW: Lightweight, **MW:** Middleweight, **HW:** Heavyweight, **Q:** Quarter, *p <.05, **p <.01, ***p <.001

Table 2. The quarterly birthdate rate distribution of male and female weightlifting athletes (%)

Q	Male				Female			
	LW	**MW**	**HW**	**Overall**	**LW**	**MW**	**HW**	**Overall**
Q1	47.1	41.8	32.4	41.5	40.7	42.4	57.6	45.8
Q2	21.2	19.0	30.9	22.2	18.5	25.8	9.1	19.0
Q3	17.3	21.6	22.1	20.3	20.4	12.1	3.0	13.1
Q4	14.4	17.6	14.7	16.0	20.4	19.7	30.3	22.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

LW: Lightweight, **MW:** Middleweight, **HW:** Heavyweight, **Q:** Quarter

Table 3. The quarterly birthdate rate distribution of male and female athletes ranking in the first three in the weightlifting championships held in 2018, 2019 and 2020.

Gender	Weight Category	n	Q1	Q2	Q3	Q4	Total	χ^2	p	Pairwise Comparisons
Male	LW	n	7	9	8	3	27	10.57^{**}	**.01**	Q1>Q4; Q2> Q4
		%	25.9	33.3	29.6	11.1	100.0			
	MW	n	12	10	5	3	30			
		%	40.0	33.3	16.7	10.0	100.0			
	HW	n	6	11	6	4	27			
		%	22.2	40.7	22.2	14.8	100.0			
	Overall	n	25	30	19	10	84			
		%	29.8	35.7	22.6	11.9	100.0			
Female	LW	n	8	4	5	8	25	11.68^{**}	**.01**	Q1>Q3; Q4> Q3
		%	32.0	16.0	20.0	32.0	100.0			
	MW	n	13	9	2	7	31			
		%	41.9	29.0	6.5	22.6	100.0			
	HW	n	8	3	2	8	21			
		%	38.1	14.3	9.5	38.1	100.0			
	Overall	n	29	16	9	23	77			
		%	37.7	20.8	11.7	29.9	100.0			

LW: Lightweight, **MW:** Middleweight, **HW:** Heavyweight, **Q:** Quarter, $^{*}p$ <.05, $^{**}p$ <.01, $^{***}p$ <.001

the difference, it was found that the rates of Q1 and Q2 were significantly higher than the rate of Q4 ($\chi^2(1)= 10.00$, p <.01; $\chi^2(1)= 6.43$, p <.05; respectively). When we studied the rate of medal rankings of female groups in overall, the difference was significant among the groups (χ^2 (3)= 11.68, p <.01) and it was also found that the reason for the difference was the rates of Q1 and Q4 were significantly higher than the rate of Q3 (χ^2 (1)= 10.53, p <.01; χ^2 (1)= 6.13, p <.05; respectively) (Table 3).

Discussion

In the present study, we aimed to ascertain if the RAEs is present on weightlifters and if the RAEs is related to weightlifting performance. Several studies on the RAEs have been conducted in other sports such as tennis players (33), swimming, track and field (34), water polo (31), judo (29), boxers (28) and taekwondo (35). However, there exist few studies on weightlifting, thus, we aimed to enhance our knowledge in this sport in order to contribute to improving the performance of both male and female athletes in Olympic style weightlifting. The reason for the RAEs seems to be that relatively older children and adolescents are taller and heavier, and they display better performance; hence, they have more opportunities to be selected for better teams. The presence of the RAEs has been accepted especially in the most popular sports (4), such as football, basketball, rugby, hockey, tennis, track and field, taekwondo and others. However, similar RAEs studies in male-female are scarce; in the case of weightlifting athletes, to the best of our knowledge, they are non-existent.

In a study on the RAEs including world-class master swimmers and track and field athletes from different athletes and master weightlifting and rowing athletes, on whom no former studies was present, the researchers reported that the RAEs exists on masters swimming and track and field athletes, but not in masters weightlifting and rowing athletes (36). Furthermore, the authors stated that their study particularly showed the likelihood of participating in the world-level masters swimming competition is higher for individuals in the first year of an age category, besides,

the likelihood of track and field athletes participating in the world-level event is higher for individuals in the first or second year and lower in the fourth or fifth year of an age category. On the other hand, the weightlifting and rowing data showed that the probability of participating in the world level competition was equally distributed among individuals across all 5 years of an age category (36). In a study on the RAEs on male and female wrestlers, it was reported that no RAEs is present in female athletes, however, the RAEs was present on male athletes of Greco-Roman and freestyle wrestling. Moreover, the authors of the study also declared that the rate of Q1 of freestyle and Greco-Roman wrestlers was higher than the rate of Q4 (37). Several different studies on soccer players also reported that significantly more players were born in Q1 (18, 30). Another study into the season of birth of elite junior and elite senior tennis players pointed out that for both genders, the rate of Q1 was higher than the rate of Q4 (33).

In our study into the RAEs on weightlifting athletes, the rates of male athletes born in the first quarter in LW (47.1%), MW (41.8%) and overall (41.5%) categories were significantly higher than the rates of male athletes born in the fourth quarter of the year (14.4%, 17.6%, 16.0%, respectively). In female groups, the rates of female athletes born in the first quarter in overall (%45.8) and MW (%42.4) categories were significantly higher than the rates of female athletes born in the fourth quarter of the year (22.2%, 19.7%, respectively).

In a study to determine whether body weight categories reduce the RAEs of young boxing athletes, Delorme (28) reported that weight categories eliminate the RAEs of male and female boxers. Fukuda (29) examined judo athletes and stated that lower RAEs is evident in elite youth judo athletes, most notably in cadets, males, and the light/middleweight categories. It was reported that the RAEs did not exist in most of the male and female taekwondo athletes participated in Olympic Games (35). Moreover, the authors explained that the absence of the RAEs in combat sports was the relationship between appropriate criteria (age, level or belt and weight) for grouping youth participants into competitive categories. Some authors Musch and Grondin (4); Cobley et al. (1); Albuquerque et al. (35); Delorme, (28) suggested some new alternatives to eliminate the RAEs, especially in sporting events requiring body weight categories. The elimination of the RAEs is based on a competitive class based on weight categories, thus, for these researchers, combat sports are an interesting model to figure out the mechanisms that might explain the RAEs. For body weight categories, there exists many studies, for instance, Albuquerque et al. (35); examined taekwondo athletes; Delorme, (28) studied amateur and professionals boxers; and Albuquerque et al. (38) analyzed judo athletes. Albuquerque et al. (35) and Delorme, (28) did not find any effects of relative age in Olympic taekwondo athletes and amateur and professionals boxers, (respectively), including in analyses that were separately conducted for male and female athletes.

Musch and Grondin (4) and Delorme, (28) argued that in competitive sports based on weight categories the RAEs should be prevented. Nevertheless, Albuquerque et al. (38) found relative age effects in Olympic judo athletes, but only in heavier athletes. In this case, the hypothesis proposed by Musch and Grondin (4), Albuquerque et al. (35) and Delorme, (28) regarding competitive sports based on weight categories seems to be not applicable to the judo athletes in the heavyweight category. In the study on the evaluation of the RAEs in male and female weightlifting athletes, Kollars et al. (32) reported the RAEs exists on three different weight categories of male athletes (LW, MW, HW), whereas it's existent only in lightweight category of females and the researchers also stated that the RAEs is not present on middle and heavy weight categories of female athletes.

In our study including senior male and female weightlifting athletes, we found that the RAEs exists on LW and MW categories of males and only in MW category of female athletes. Therefore, as it is stated in the studies of Albuquerque et al. (35), Musch and Grondin (4) and Delorme, (28), it might be mentioned that the hypothesis of prevention of the RAEs in weight categories also seems unapplicable in senior LW and MW of males and MW of female athletes.

Barrenetxea-Garcia et al. (31) studied the RAEs on water polo players and observed that the RAEs exists on male players, whereas it's not existing in

females. The RAEs was present only on a small and nonsignificant athlete groups of U.S. female Olympic regional and national prospects and no effect was found for female players at the state team level, whereas the RAEs was strong for males at all of these levels (25). In our study, the RAEs was found to be present on two weight categories of male athletes and only in one weight category of female athletes.

Biological age helps to determine physiological performance in order to experience high performance. Unfortunately, for many sports, trainers rely on chronological age as the key criterion of athlete classification. Many studies have shown that athletes born in December have a lower chance of success than those born in January in the same year (39). Helsen et al. (14) tried to find out the correlation between the RAEs and the rate of selection of male and female players in different leagues of European countries. They declared that in the groups of national players in U15, U16, U17 and U18 age, the athletes born in the first quarter of the year are mostly selected by elite national teams. Romaneiro et. al. (40) observed the correlation between the RAEs and success in females (athletics, badminton, basketball, modern pentathlon, rowing, and swimming) and in males (athletics, basketball, canoeing, road cycling, football, handball, rowing, swimming, and volleyball) and they stated that in all cases, the distribution showed a higher participation of athletes born in the beginning of the year. Furthermore, the researchers also cited that their study findings clearly showed the birthdate has an obvious effect on high level performance and success of athletes. In their study on the presence of the RAEs on elite male and female water polo players, Barrenetxea-Garcia et al. (31) observed that in the medal group (only men), an overrepresentation of players born in the first quarter is evident: 43.6% of the players were born in Q1, with only 15.4% in Q4 and they stated that this distribution was significantly different from that of the general population. The study of Ulbricht et al. (30) showed that the RAEs exists in the selection of youth tennis players in Germany, with a greater percentage of players analyzed born in the first quarter compared to all licensed tennis players in the country, and more pronounced with an increased competition level in youth players. The study results of Medic et al. (34) indicated that master athletes of swimming and track and field who are in the early years of any 5-year age category were more likely to achieve higher performance by breaking National/World records and were also more likely to participate in championship competition. In comparison, master athletes who were in the later years of a 5-year age category were less likely to set a record and were less likely to participate in National competition.

In the male medal group of our study, we observed an overrepresentation of athletes born in the Q1and Q2 was evident: 29.8% of the athletes were born in Q1, 35.7% of the athletes were born in Q2 with only 11.9% in Q4, whereas in the female medal group of our study an overrepresentation of athletes born in the Q1and Q4 was evident: 37.7% of the athletes were born in Q1, 29.9% of the athletes were born in Q4 with only 11.7% in Q3. Several factors contribute to the success of weightlifting athletes: training level, physical capacity, health, genetic, motivation and personal behaviors (physical activity level and eating habits). Besides these, the findings of our study revealed the RAEs is an important factor to be considered in weightlifting performance in senior weightlifting athletes.

In conclusion, our study clearly shows that the RAEs is present on male and female senior athletes in Olympic style weightlifting. Therefore, the fact that senior male and female weightlifters born in the first quarter and their peers born in the last quarter of the same year have performance differences should be taken into consideration by trainers and sports experts in weightlifting events and training. Further studies are needed on the RAEs in Olympic style weightlifting using samples of male and female teams of World Weightlifting Championships, European Weightlifting Championships and Continental Weightlifting Competitions.

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