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# THE RELATIVE AGE EFFECT IN THE VOLLEYBALL OLYMPIC GAMES

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**Abstract:**
**Introduction:** The objective of the present study was to analyze the Relative Age Effect (RAE) in volleyball athletes in the four editions of the Summer Olympic Games (2008, 2012, 2016 and 2020), as well as its magnitudes referenced to the period of the athlete's career, the final ranking, and the continent. **Material and Methods:** A total of 1,152 birth dates were subjected to analysis according to four quartiles, and the resulting data were compared to different phases of the athletes' sporting careers, the teams' final rankings, and the continent of origin. A chi-square goodness-of-fit test ($p < 0.05$) was performed. **Results:** The results showed that there was partially the presence and magnitude of the RAE in men's volleyball and during the athletes' consolidation period, but this effect was not observed when analyzing the final classification of the teams and the continents, excepting on the European male teams. RAE was not observed in the female context, in any of the comparisons. **Conclusions:** This finding may evoke a reflection on the different sports developmental processes in different countries and categories worldwide.

**Keywords:** RAE; talent; age; net sports; Olympics

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## 1. Introduction

The first studies about Relative Age Effects (RAE) were carried out in the field of education. The findings indicated that older children at the outset of the academic year exhibited superior academic performance [1] and even in the financial sector [2]. The literature also presents several studies analyzing the RAE in different sports, both in individual and team sports. Individual sports include tennis [3], badminton [4], track and field [5, 6], and in team sports include soccer [7, 8], hockey [9], basketball [10], and volleyball [11, 12, 13, 14]. These studies relate to how this grouping in the youth categories can influence these adult sports.

In the context of competitive sports, the implementation of age-based adjustments to the participation of young athletes in youth competitions is regarded as a crucial measure to ensure equitable conditions for all competitors. The strategy of indicating specific chronological age groups for this purpose is a common practice in the sports field. However, it may result from disparities among participants, thereby undermining the principle of equal opportunity for all. RAE encompass both immediate participation in youth-level competitions and long-term engagement in sports activities until adulthood. This biased distribution is due to the age categories determined by different sports organizations. This biannual age grouping is a common organizational strategy in volleyball. Evidence indicates that notable discrepancies exist between young individuals in youth categories. To illustrate, two athletes competing in the same category may have a difference of 23 months in age, whereas those born in the same year may have a difference of 11 months [15]. The literature offers some explanations for this fact. In the initial phase of athlete development, physical, physiological, psychological and motor characteristics are identified as determining factors in the selection and retention of young talents. It is well documented that there are differences in maturation between individuals born in the same year, with those born in the first months of the year tending to maturation more rapidly than those born in the latter months [16].

Thus, greater chronological age in young athletes may confer certain advantages with regard to growth, including anthropometric characteristics (e.g., height, muscle mass) and conditional skills (fundamental and sports), as well as cognitive knowledge and psychological capacity [16]. For example, a considerable number of volleyball players tend to be in advanced stages of maturation during talent selection processes [17]. Consequently, athletes who are born in the second half of the year and/or present late maturation are often inappropriately used or even completely excluded from the process, which prevents them from participating under equal conditions in sporting events, even within the same competitive category [18]. As a consequence of the RAE there is an overrepresentation of athletes who are chronologically older than their counterparts within the same age cohort is observed.

In volleyball, a notable discrepancy was observed in the distribution of birth dates, which served to underscore the existence of the RAE [4]. The variable was also analyzed in men's volleyball competitions, including the U19, U21, and U23 World

Championships, as well as the World Cup. It was observed that there was a prevalence of athletes born at the beginning of the competitive year, particularly in younger competitions [12]. Moreover, as athletes progress in their career, the RAE appears to shift. This is evidenced by the absence of a relation between athletes` dates of birth and their performance outcomes [19, 20]. Additionally, studies have documented the emergence of a significant proportion of athletes born in the final months of the selection year [21].

It is important to note that no longitudinal studies have been conducted on the RAE in Olympic volleyball. This suggests a need for analysis of the prevalence of RAE in this type of competition. This information would be of practical interest to volleyball athletes, as well as other human resources involved in the development of the sport, since an observation of a disproportionately high number of volleyball players born throughout the year would indicate a potential bias related to the RAE. Such a bias could increase the risk of dropout among volleyball players, especially in younger athletes [13]. Furthermore, despite the increase in the number of publications about RAE in volleyball [13, 14, 22], no study has yet examined the relationship between the RAE and a team's final ranking, as well as the continent origin and gender.

The present study was designed to examine four objectives: (a) the prevalence of RAE in male and female volleyball players across the four editions of the Olympic Games (from 2008 to 2020), (b) the evolution of RAE relationships according to the athlete's career period, (c) the relationship between RAE and final Olympic Games rankings, and (d) the comparative analysis of RAE across different continents. Two specific hypotheses were formulated: I. The current structure of volleyball development, with procedures for early talent identification, may contribute to the observed prevalence of RAE in adult athletes and in top-level competitions like the Olympic Games, both in male and female athletes. II. The RAE may vary according to different athletes' career periods, rankings, continents, and genders.

## 2. Material and Methods

The study involved a group of volleyball players (male n = 576, age: 28.3 ± 4.4 years, and female n = 576, age: 26.9 ± 4.4 years) who participated in the 2008, 2012, 2016 and 2020 Summer Olympic Games.

The data was transcribed directly from the official website of the International Volleyball Federation, available at https://www.fivb.com/en/volleyball/competitions. The competition website provides information regarding the players, including each athlete's full name and date of birth. The athletes were categorized into four relative age quarters (Q) according to their birth month independently of the birth year (i.e., Q1: January to March; Q2: April to June; Q3: July to September; and Q4: October to December).

In accordance with the ethical standards governing research, the present study did not require informed consent or approval from an ethics committee, as the data were publicly accessible and free of charge. The International Federation website does not

explicitly or implicitly prohibit the use of these data for scientific research purposes. This methodology for analyzing data extracted from websites is a common practice in the field of sports [23, 24].

The study employed basic descriptive statistics, including mean, standard deviation, and percentage. A non-parametric chi-square goodness-of-fit test ($\chi^2$) was conducted to ascertain whether the observed distribution per quarter exhibited a significant discrepancy from the expected theoretical distribution ($p < .05$). The RAE was identified when a discrepancy was observed between the theoretically expected number of athletes born per month or quarter and the observed number of players. Furthermore, a one-way analysis of variance was performed to compare among ranking teams (medalists: 1st to 3rd place, intermediaries: 4th to 8th place and lowest ranking: 9th to 12th place). Additionally, the sports career periods were classified into three categories: the development period (up to 24.9 years), the consolidation period (from 25.0 to 34.9 years), and the final period (above 35 years). Additionally, the analysis considered the impact of continental geographical location on players, categorizing them as representing either Africa, America, Asia, Europe, or Oceania. All calculations were conducted using IBM SPSS Statistics 25.0 and Microsoft Office Excel software.

## 3. Results

Table 1 presents the distribution of birth dates (quartiles) of all athletes, classified according to the Olympic Games and gender. A statistically significant greater frequency of athletes born in the first quartile and a low frequency of athletes born in the fourth quartile were observed at the Beijing Olympics ($\chi^2$=7.833; $p < .05$). In contrast, no differences were observed among all quartiles at the Olympic Games in London, Rio de Janeiro, and Tokyo ($p > .05$), indicating a similarity in the distribution of athletes' birth quartiles.

**Table 1:** Distribution of players according to birth quartile, gender and Olympic Game (n and %)

| | Gender | Q1 | Q2 | Q3 | Q4 | $\chi^2$ |
|---|---|---|---|---|---|---|
| Beijing 2008 | M | 47 (32.6)* | 30 (20.8) | 41 (28.5) | 26 (18.1)* | 7.833 |
| | F | 46 (31.9) | 31 (21.5) | 35 (24.3) | 32 (22.2) | 3.944 |
| London 2012 | M | 41 (28.5) | 36 (25.0) | 37 (25.7) | 30 (20.8) | 1.722 |
| | F | 41 (28.5) | 25 (17.4) | 36 (25.0) | 42 (29.2) | 5.056 |
| Rio de Janeiro 2016 | M | 40 (27.8) | 34 (23.6) | 42 (29.2) | 28 (19.4) | 3.333 |
| | F | 36 (25.0) | 31 (21.5) | 40 (27.8) | 37 (25.7) | 1.167 |
| Tokyo 2020 | M | 36 (25.0) | 38 (26.4) | 34 (23.6) | 36 (25.0) | 0.222 |
| | F | 42 (29.2) | 35 (24.3) | 29 (20.1) | 38 (26.4) | 2.500 |
| **Total** | **M** | **164 (28.5)** | **138 (24.0)** | **154 (26.7)** | **120 (20.8)** | **7.722** |
| | **F** | **165 (28.6)** | **122 (21.2)** | **140 (24.3)** | **149 (25.9)** | **6.708** |

*p < .05

Table 2 shows the results of the quartiles according to the final position of the teams. These data did not find any RAE when the final classification at the Olympic Games was analyzed ($p > .05$).

**Table 2:** Distribution of players by team ranking, gender and birth quartile (n and %)

| | Gender | Q1 | Q2 | Q3 | Q4 | $\chi^2$ |
|---|---|---|---|---|---|---|
| Medalists (1st-3rd position) | M | 45 (31.3%) | 34 (23.6%) | 36 (25.0%) | 29 (20.1%) | 3.722 |
| | F | 34 (23.6%) | 33 (22.9%) | 34 (23.6%) | 43 (29.9%) | 1.833 |
| Intermediaries (4th to 8th position) | M | 73 (29.0%) | 58 (23.0%) | 67 (26.6%) | 54 (21.4%) | 3.524 |
| | F | 71 (29.6%) | 47 (19.6%) | 62 (25.8%) | 60 (25.0%) | 4.900 |
| Lowest ranking (9th to 12th position) | M | 46 (25.6%) | 46 (25.6%) | 51 (28.3%) | 37 (20.6%) | 2.267 |
| | F | 60 (31.3%) | 42 (21.9%) | 44 (22.9%) | 46 (24.0%) | 4.167 |

As evidenced in Table 3, an examination of the data revealed a symmetrical profile in relation to the quartiles of birth across the span of their careers. However, during the consolidation period, the RAE was confirmed with the prevalence of athletes born asymmetrically throughout the year ($\chi^2 = 8.182$; $p < .05$).

**Table 3:** Distribution of players by career period, gender and birth quartile (n and %)

| | Gender | Q1 | Q2 | Q3 | Q4 | $\chi^2$ |
|---|---|---|---|---|---|---|
| Development period | M | 39 (28.5%) | 29 (21.2%) | 35 (25.5%) | 34 (24.8%) | 1.482 |
| | F | 65 (31.7%) | 40 (19.5%) | 46 (22.4%) | 54 (26.3%) | 6.844 |
| Consolidation period | M | 116* (29.3%) | 95 (24.0%) | 107 (27.0%) | 78* (19.7%) | 8.182 |
| | F | 97 (27.6%) | 79 (22.4%) | 87 (24.7%) | 89 (25.3%) | 1.864 |
| Final period | M | 9 (20.9%) | 14 (32.6%) | 12 (27.9%) | 8 (18.6%) | 2.116 |
| | F | 3 (15.8%) | 3 (15.8%) | 7 (36.8%) | 6 (31.6%) | 2.684 |

*$p < .05$

Figure 1 illustrates the comparative analysis of male quartiles across diverse continental regions. The results demonstrated asymmetries in birth dates exclusively on the European continent ($\chi^2 = 9.937$; $p < .05$), whereas symmetrical differences were observed on the other continents. The results for the African continent ($\chi^2 = 7.000$; $p = .07$), American continent ($\chi^2 = 1.098$; $p = .78$), Asian continent ($\chi^2 = 3.600$; $p = .31$), and Oceania continent ($\chi^2 = 2.000$; $p = .57$) were not statistically significant.

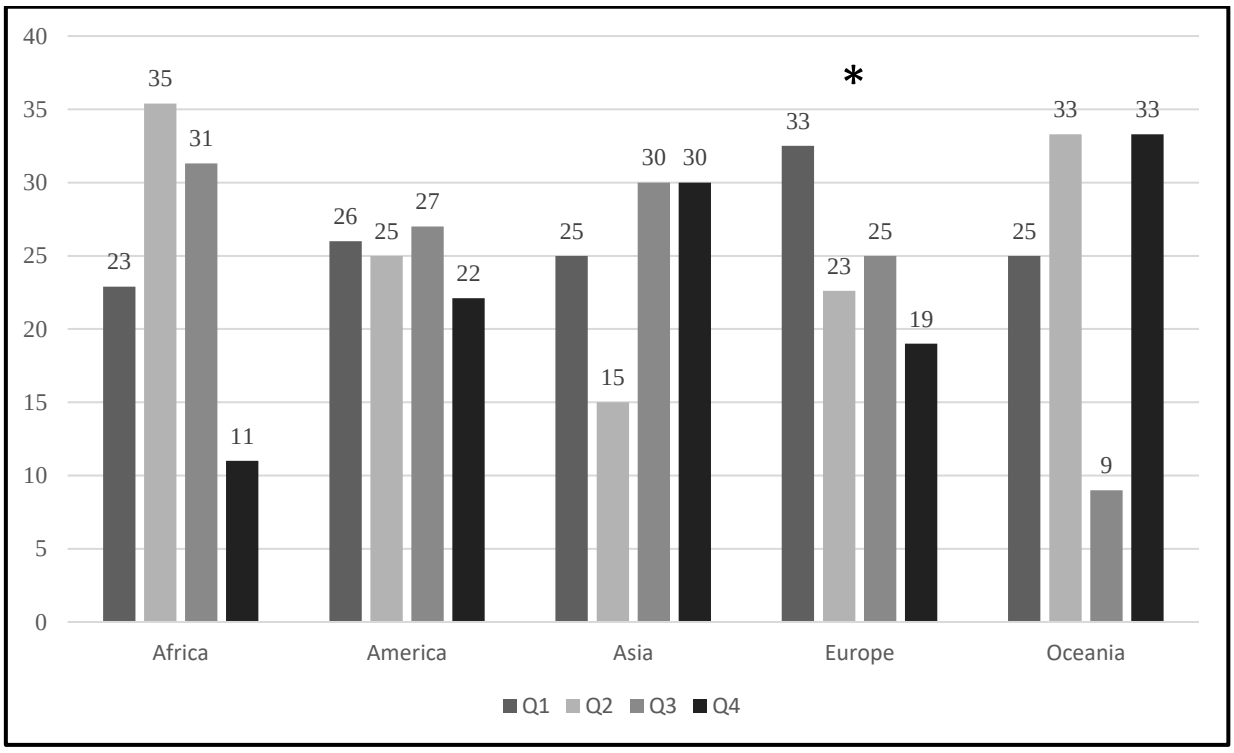


**Figure 1:** Distribution of players by continent according to birth quartile (male). * $p < .05$

Figure 2 shows the comparison between the different continents in relation to female quartiles. The results demonstrated a symmetrical distribution across the African ($\chi^2$=4.500; p=.21), American ($\chi^2$ = 3.022; p = .39), Asian ($\chi^2$ = 4.833; p = .18), and European ($\chi^2$ = 4.157; p = .25) continents.

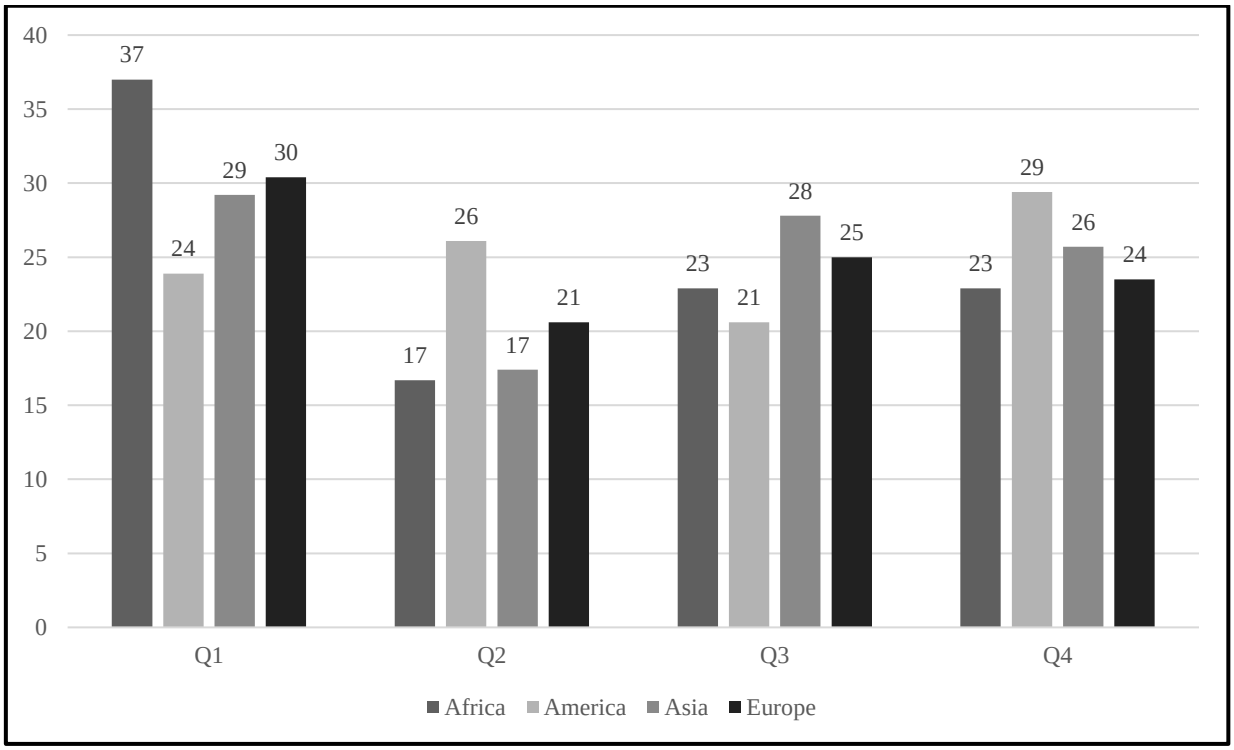


**Figure 2**: Distribution of players by continent according to birth quartile (female)

## 4. Discussion

The objective of the present study was to analyze the prevalence and magnitude, longitudinally, of RAE in volleyball athletes participating in the Olympic Games (2008, 2012, 2016 and 2020). The RAE was broken down according to the team's final classification, the players' career period and the teams' continent. The present study focused on the specific question of whether age affects the availability of opportunities in the sporting careers of male and female athletes in senior categories, particularly those played at the Olympic Games.

The results of the study indicated that the initial hypothesis was partially rejected, and no significant differences were identified with regard to competitive level and gender. With regard to the second hypothesis, specific differences were observed with respect to the athletes' career period and different continents (e.g., the men's group). To the best of our knowledge, this was the first study to examine these variables in volleyball in representative and important competitions for the sport, such as the Olympic Games. The primary findings indicated an asymmetry when analyzing the Olympic Games (London), and this same effect was not observed in other editions. It is also noteworthy that, when considering the total number of athletes across the four editions, no evidence was found to suggest that the RAE had any significant impact.

The phenomenon of RAE may be attributed to individual structural constraints, such as height or physical development, or to perceptions of "talent," which can be considered an environmental constraint. This manifests in the manipulation of play systems or tactics for short-term advantage, such as winning a game, without consideration for long-term development [25].

Despite identifying the magnitude of the RAE in young volleyball athletes who participated in the world championships in youth categories, it was not possible to verify the same when analyzing the RAE in the adult category. The results observed in this category were less consistent than those seen in the aforementioned categories [12]. Accordingly, the reduction in RAE in the adult category may prove challenging to elucidate, as there may be a number of potential explanatory factors. A factor that has been previously identified in research is the participation of young athletes in adult national teams, which has the potential to influence the results to some extent [26]. However, in the present study, only 14 athletes (representing 3.24% of the total sample) were of sufficient age to participate in volleyball competitions in lower categories, such as youth, where the age limit is 21 years.

In the context of volleyball, the extent to which the RAE manifests itself in Olympic athletes has been studied in detail, with a particular focus on the possible correlation between this phenomenon and anthropometric variables and technical elements [27]. The RAE was not observed in Olympic volleyball athletes, and no relationship was found between this phenomenon and anthropometric or performance variables. This suggests that other variables may be more closely associated with volleyball training and therefore the RAE may not be a significant factor in this context.

Given that the athletes have already reached biological maturation, it seems reasonable to conclude that the RAE does not represent a physical advantage. Rather, it is a consequence of the selection and promotion of talents in the youth categories in the countries under investigation [12, 28]. The current findings revealed a comparable trend in athletes participating in the Olympic Games when compared to other sports, including basketball [29], swimming [30], and volleyball beach [31]. In light of these findings, it can be posited that the resilience demonstrated by athletes who have been subjected to an early selection process, despite the inherent age inequalities present in the lower categories, may ultimately lead to the emergence of more talented individuals who reach their peak performance in the adult category, irrespective of their date of birth [32].

Upon analysis of the final classification of the teams, no asymmetries were observed with regard to athletes in the adult category. In light of the high level of performance exhibited by the athletes in this, the largest international volleyball competition between countries, it became evident that the RAE was not a significant predictor of differences in the final classification in volleyball during the Olympic Games. In contrast to the situation observed in volleyball, an inverse phenomenon was observed in handball. Specifically, there was an excessive representation of relatively older players in the teams that reached the top positions in the World Handball Championships [28].
With regard to the careers of athletes, previous studies have indicated that there are differences in the RAE throughout the period [19, 26]. Indeed, there is a possibility that the early adult years may be influenced by the RAE. However, this phenomenon was not observed in the present study, as this magnitude was only observed during the career consolidation period.

Moreover, it can be postulated that the RAE may vary according to different continents, thereby underscoring aspects pertaining to varying degrees of participation by the population in specific sports and the existence of heightened competition for team positions. The present study demonstrated that the RAE was present only in teams from the European continent, in comparison to others. This finding may be attributed to the popularity of this sport in Europe, suggesting that the physical demands of athletes during training (base categories) may be a contributing factor to the observed magnitude in the adult category [4].

As previously stated, the results may be perceived as controversial in relation to different countries due to the influence of various contextual factors. These include the social context, level of competitiveness, popularity, and the number of active participants, which can collectively impact the magnitude of the RAE. To the best of our knowledge, there is no definitive strategy to address the adverse effects of RAE in volleyball at the youth level. Among the alternative proposals to minimize this magnitude are the use of smaller cohort data and strategies in grassroots championships held in groups according to physical characteristics. Nevertheless, it is important to note that this effect has not yet been conclusively identified, necessitating further investigation to elucidate this phenomenon in volleyball.

## 5. Conclusion

The findings of the present study offer partial confirmation of the effects and magnitudes of the RAE, as observed in the male volleyball athletes who participated in the four editions of the Olympic Games under analysis. In the context of the women's category, no RAE was observed. No differentiation was observed in the representation of athletes born in the four distinct quartiles of the year. The RAE was observed exclusively during the athletes' careers, particularly during the consolidation period (between 25.0 and 34.9 years of age). It is noteworthy, however, that this magnitude was not evident in the final classification of the teams, nor in the analysis of the different continents, except when analyzing the European continent. It is therefore important to consider the necessity for further studies investigating aspects related to anthropometric characteristics, motor performance, and research evaluating technical and tactical elements. Such studies should not be limited to the adult category but should also encompass the entire athlete training period in volleyball.

**Authors' Contribution**
FADC and LCBC designed the study. FADC and LCBC conducted searches and extracted the data. FADC, EMM, and AMJ wrote the original manuscript. FADC, LCBC, EMM, AMJ and AGA revised and edited the manuscript. All the authors have read and approved the final version of the manuscript.

**Availability of Data and Materials**
All data will be made available on request.

**Ethics Approval Statement**
Ethical approval was not required for this study, as it involves the analysis of publicly available data from a website.

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**Conflict of Interest Statement**
The authors declare no conflicts of interest.

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