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Original Research

Relative Age Effect for Different Playing Positions in Adolescent Female Volleyball Players

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ABSTRACT

***International Journal of Exercise Science* 17(4): 1553-1567, 2024.** Understanding the Relative Age Effect (RAE) in female volleyball can provide a deeper insight into potential developmental advantages and selection biases between playing positions and volleyball-related performance characteristics. This study aimed to investigate the occurrence of the RAE in adolescent female volleyball players according to the playing position and the possible differences in anthropometric and performance characteristics between the relative age groups. The study involved 193 young female volleyball players from 12 different regions and 108 sports clubs from all over Greece, with an average age of 14.53 ± 0.31 years, height of 1.67 ± 0.07 m, weight of 57.20 ± 9.10 kg, and body mass index (BMI) of 20.34 ± 2.50. RAE was identified by the birth quarter of each player, categorizing thus the total sample into four sub-groups: Q1 (January–March), Q2 (April–June), Q3 (July–September), and Q4 (October–December). Anthropometrics, upper and lower limb power, agility, flexibility, and trunk strength were also assessed. The distribution of volleyball players differed significantly across birth quarters (34.19% of Q1, 25.9% of Q2, 22.79% of Q3, 17.09% of Q4; $\chi^2 = 11.788$, $p = 0.008$). Analysis revealed no significant association between birth quarter and playing position ($\chi^2 = 11.314$, $p = 0.730$). Present study's results indicated no RAE in young female volleyball players regarding their playing position. Also, performance tests did not differ significantly among the RAE groups. Moreover, despite athletes' early specialization based on assigned playing positions, no differences in athletes' position-related performance characteristics were observed. These findings suggest that interventions to mitigate RAE should be considered to ensure equitable development opportunities across all playing positions.

KEY WORDS: Birth date effect, month of birth bias, talent identification

INTRODUCTION

Relative age effect (RAE) refers to the possible impact that individuals' date of birth may have on their future cognitive, emotional, and sports achievements. In particular, the potential effect that children's birth-month can bear for their future pursuits and success in sports, especially when elite level is of quest. Athletes born in the last quarter of the year are less likely to be selected for high-performance sports activities. This happens not necessarily because they are less talented than their earlier-born peers but, instead, most likely because they are younger and less mature than them (14). Children born in the first month of a calendar or sports year are almost one year older than their peers, competing within the same age category, who are born in the last month of the same year. This phenomenon is particularly common at a junior level and tends to gradually diminish at adolescent and senior levels (38). To address this issue and limit selection imbalances education systems and sports development programs usually opt for narrow range age categories (e.g., annual or at most biannual groups). Such approach aims to offer each age group with appropriate sports-related knowledge, education on training loads, and competitive experiences that consider athletes' cognitive, physical and physiological adaptations based on their developmental phase (4).

Talent identification sport systems select athletes with physical developmental advantages and superior performance based on sport-specific battery tests (43). This selection bias process can be explained by the advanced maturation status of talented athletes, which is related to the physical differences that are often observed within a year, especially during the pubertal spurt period (23). This phenomenon may lead to increased support and attention from their parents, coaches and educational environment, significantly impacting their performance outcomes (20, 21). However, this overrepresentation of young athletes with advanced physical traits and physiological abilities may not automatically imply future elite performance in team sports with high technical and tactical demands (49).

To investigate the extent of RAE in youth sports, considerable research has reported its contribution to successful performance by comparing peers of the same chronological age, of different gender, levels, and specializations (13). Several studies have been conducted on both male and female athletes of various sports such as ice hockey (45, 47), football (17, 47, 50), figure skating (3), gymnastics (46), water polo (6), volleyball (15, 16, 28, 32), with equivocal results, may due to the nature of the sport, with strength-related sports being more susceptible to RAE (2). However, a relatively small percentage of the many RAE studies focus on female athletes (1). There may be many reasons why women's sports have less profound RAE than men's. A meta-review found that the RAE is less frequent in female athletes and that many connected constraints may affect its variability (48). A higher over-presentation of female athletes born in the first and second quarters of the selection year was explained by the age range of the participants (14), the advanced maturational stages (13), the unique sport-specific demands (strength, speed, technical skills) (9), and the social gender roles of the female participants (44).

Monitoring longitudinal team sports has shown that early-born participants within the same competitive category acquire not only excess linear anthropometric traits and physical performance advantages but also specific technical and tactical skills for successive performance in the relative competitive positions. For example, one study on Swedish women's ice hockey found significant relative age effects (RAEs) across all age groups and playing positions, except for goalies, indicating that older players are more likely to be selected and perform better (41). Another study on Canadian women's ice hockey also reported RAEs, with a higher proportion of players born in the first half of the year, suggesting that early-born players have more opportunities for participation and advancement (47). Conversely, a study on male football players in the UEFA Youth League found significant RAEs. However, playing position has no influence on the size of RAEs, and significant differences in RAEs between countries, highlighting variability in how RAEs manifest across contexts (42). The scarcity of research on female sports, particularly compared to male sports, could be attributed to the less pronounced effect of relative age on female athletes (48), less frequent participation of females in strength-demanded sports (7), and different interests and willingness to participate in exercise and sport science research (29). This observation warrants the need for further investigation to understand fully these dynamics.

Research on RAE in female volleyball has yielded mixed results. Okazaki, Keller, Fontana and Gallagher (30) reported that 74% of the international female players, aged 14, were born in the first half of the year. At the same time, Reed, Parry and Sandercock (33) found a strong RAE in female volleyball participants in inter-school competitions. In contrast to these findings, Papadopoulou et al. (32) did not observe any RAE in anthropometric and physiological characteristics in young female volleyball players selected for the national team and club players of similar age. Centers, opposites, hitters, setters, and liberos are the most common player classifications in volleyball (24). The demands of each specific playing position require players to have certain body dimensions and physiological abilities (40), since the requirements for appropriate technical and tactical action vary across different playing positions (11).

Concerning playing positions, Garcia de Alcaraz et al. (19) explored the RAE in beach volleyball players across various age categories, finding a RAE only regarding male blockers. To our knowledge, there has yet to be a study to investigate the presence of RAE in different playing positions among adolescent female volleyball players. Thus, this study aimed to investigate the presence of RAE between different volleyball playing positions in a representative group of 14-year-old female volleyball players. Growth and maturation not only impact anthropometric and physiological variables but also affect sport-specific technical performance and competitive characteristics (e.g., blocks and spikes). These factors may be associated with RAE (25, 31). Considering that different playing positions are age-dependent and impose distinct demands on players from an early age (27), it is plausible to hypothesize that RAE might also be present in these various playing positions.

METHODS

Participants

A representative group of 193 female volleyball players (age: 14.53 ± 0.31 years, height: 1.69 ± 0.06 m, weight: 8.23 ± 8.73 kg, BMI: 20.30 ± 2.41 kg/m^2) from the same age group of the preselection of the national under-15 teams, from 12 different regions and 108 sports clubs all over Greece, volunteered to participate in the present study. They had at least one year of experience in national volleyball championships. The inclusion criteria required athletes not to have injuries during the last six months and to undergo systematic training for at least five years. A prior power analysis was not conducted as the entire available population was included, precluding the need for sample size estimation based on statistical power considerations.

Players were classified into six groups according to their playing positions (setters: *n* = 39, liberos: *n* = 13, middle blockers: *n* = 40, outside-hitters *n* = 70, opposites: *n* = 22 and 7 without playing position/specialization). The players' positions were determined based on their trainers' reports. Their weekly training consisted of basic technical and tactical volleyball drills, plyometrics, and coordination exercises, 90 min each time, three times a week. To define the distribution in the birth quarter, volleyball players were separated into four groups according to the date of birth; Q1 (January–March), Q2 (April–June), Q3 (July–September), and Q4 (October–December). Participants were informed about the study's purpose and risks. Moreover, their parents or legal guardians signed informed consent after taking detailed written information. All protocol procedures were conducted in accordance with Helsinki Declaration as revised in 2012 and approved by the Ethical Review Board of the School of Sport Science and Physical Education, National and Kapodistrian University of Athens (number of approval 1292/03-07-2021). This research was carried out fully in accordance to the ethical standards of the *International Journal of Exercise Science* (26).

Protocol

The first day of a regional training camp organized by the Hellenic Volleyball Federation for talent detection, physical and physiological measurements performed by trained volleyball coaches. Participants were divided into groups, and after their anthropometric measures were taken, they started under the supervision of the volleyball coaches a typical 10-minute warm-up, consisting of 5 minutes of jogging and 5 min of dynamic stretching, followed by their participation in the assigned tests in random order. All athletes were familiarized with the measurements and the testing procedures, since they had undergone similar tests throughout the competition period.

After completing the informed consent, the participants were measured for their height (HT), extended arm height (ARMHT), arm span (AS) and body mass (BM). HT and ARMHT were measured to the nearest 0.1 cm with a stadiometer (Seca 220, Hamburg, Germany). Body mass (BM) was measured to the nearest 0.1 kg with an electronic scale (Seca Alpha 770, Hamburg, Germany). Participants were asked to stand barefoot in both measurements. Body Mass Index (BMI) was calculated from BM and HT (kg/m^2).

The explosive power of the upper body was evaluated through a 1-kg overhead medicine ball throw (MBT) from a seated position. Volleyball players were required to forcefully throw the medicine ball with both hands to reach the maximum possible distance. The distance was recorded to the nearest 0.1 m from the seated position to the landing point. Two repetitions were performed and the best one was analyzed.

Different jump tests, such as the standing long jump (LJ), countermovement jump (CMJ), and spike jump (SJ), were used to evaluate leg power. To conduct the standing LJ, players had to swing both arms and bend their knees to jump as far as possible. The distance from the starting point to the landing point at heel contact was used for statistical analysis. All trials were measured to the nearest 0.01 m using a floor tape. CMJ involves a vertical jump from a standing position with a self-depth preliminary countermovement and the free arms. Spike jump consisted of a three-step approach that precedes a vertical jump performed in competitive conditions. CMJ performance and spiking height were evaluated using a Vertec device by subtracting the height of the extended arm in the standing position from the jumping height. Three trials were performed for each test and the best trial was kept for statistical analysis. Between trials, 30 seconds of rest was allowed, and 5 minutes of rest between tests.

Flexibility was assessed by the sit-and-reach test. Players reached forward slowly, with palms facing down one on the top of the other, maintaining their legs stretched against the YMCA sit-and-reach box (foot-line at 22 cm), for at least two seconds. Two repetitions were performed, and the best one was analyzed.

The T-Test was used to assess multi-direction movement ability. Players had to complete a T-shaped course sprinting forward along with the 10-yard distance (9.14 m), shuffle sideways (a total distance of 10 yards), and then run backward (10 yards) to the starting position covering, a distance of 40 yards. Players, while shuffling, were not allowed to cross over their feet. Participants' time was kept with a manual stopwatch. Two repetitions were performed and the best one was analyzed.

To evaluate the endurance of the abdominal and hip-flexor muscles, participants had to perform as many sit-ups as they could in 30 seconds from a lying position with the knees bent and the hands clasped behind the neck throughout the test. A teammate knelt in front of the participant to assist them in stabilizing their feet against the ground. The 30-second sit-up test was performed once, taking into consideration the intensity of the test.

Statistical Analysis

Data presented as means ± standard deviations. For the statistical analysis, the SPSS v.23 (IBM, NY) was used. Kolmogorov-Smirnov test was used to assess data normality, indicating that normality was violated. A chi-square test (χ^2) examined whether the observed distribution per quarter significantly differed from the expected theoretical distribution for the date of birth. Cramer's V effect size was calculated for χ^2. A multivariate Kruskal-Wallis was conducted with all dependent performance variables to investigate differences among the independent variables of playing position and RAE groups. Spearman's correlation coefficient was calculated to assess the relationship between variables. The interclass correlation coefficient (ICC) calculation with a 2-way mixed model was used for test-retest reliability for all the dependent variables. For each analysis, the level of significance was set at $p \leq 0.05$.

RESULTS

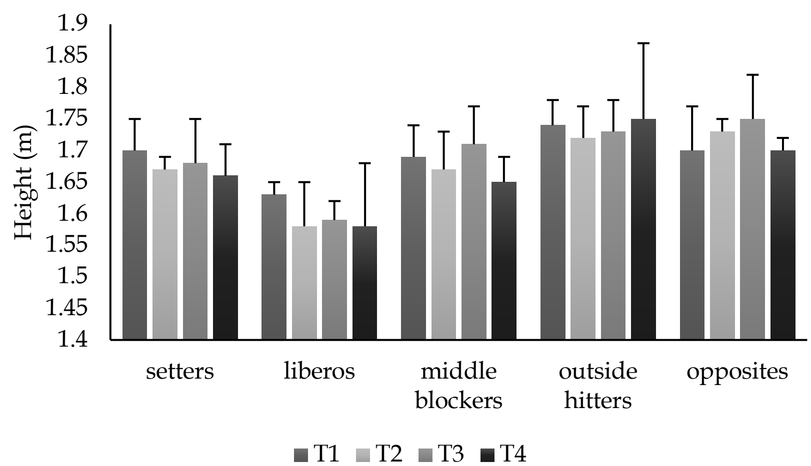
The mean values and the relative standard deviations for all parameters (anthropometric and physiological) by birth quarter are presented in Table 1. The numbers of the volleyball players for each birth quarter were: Q1 = 66 (34.19%), Q2 = 50 (25.9%), Q3 = 44 (22.79%), and Q4 = 33 (17.09%) (χ^2 = 11.788, Cramer's V = 0.14, p = 0.008). The ICC for the medicine-ball throw was 0.91, for the standing long jump test was 0.94, for the countermovement jump was 0.92, for the spike jump was 0.93, for the flexibility was 0.91, and for the T-test was 0.94 ($p < 0.001$ for all variables).

Table 1. Mean values and standard deviation of the selected parameters by birth quarter.

	Q1 (*n* = 66)	Q2 (*n* = 50)	Q3 (*n* = 44)	Q4 (*n* = 33)	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	*p*
Age, years	14.78 ± 0.08	14.48 ± 0.17	14.24 ± 0.12	13.99 ± 0.07	0.001
HT, m	1.69 ± 0.06	1.68 ± 0.06	1.70 ± 0.07	1.66 ± 0.07	0.081
BM, kg	58.57 ± 7.62	58.35 ± 8.39	58.69 ± 10.30	56.74 ± 9.58	0.674
BMI, kg/m^2	20.30 ± 2.13	20.44 ± 2.42	20.09 ± 2.54	20.37 ± 2.81	0.873
ARMHT, m	2.17 ± 0.07	2.16 ± 0.07	2.19 ± 0.10	2.15 ± 0.10	0.558
AS, m	1.71 ± 0.06	1.69 ± 0.24	1.71 ± 0.08	1.67 ± 0.09	0.530
SPIKE, m	0.42 ± 0.08	0.43 ± 0.07	0.41 ± 0.09	0.40 ± 0.09	0.235
CMJ, m	0.38 ± 0.09	0.40 ± 0.09	0.37 ± 0.08	0.36 ± 0.10	0.081
LJ, m	1.77 ± 0.21	1.69 ± 0.24	1.69 ± 0.23	1.69 ± 0.26	0.099
SR, cm	11.51 ± 9.54	15.16 ± 10.23	16.84 ± 13.66	17.94 ± 16.66	0.064
ABD, reps	34.65 ± 10.05	36.18 ± 10.11	34.15 ± 8.7	36.30 ± 9.77	0.693
MBT, m	4.17 ± 1.17	3.91 ± 1.34	4.05 ± 1.03	3.94 ± 1.26	0.456
T-TEST, s	11.91 ± 0.88	12.01 ± 1.09	12.03 ± 0.95	12.56 ± 1.29	0.104

SD = standard deviation; HT = height; BM = body mass; BMI = body mass index; ARMHT = standing reach; AS = arm span; SPIKE = spike jump; CMJ = countermovement jump; LJ = long jump; SR = sit-and-reach; ABD = sit-ups; MBT = medicine ball throw; T-TEST = Agility T-test

No association was observed between birth quarter and playing position ($\chi^2 = 11.314$, $p = 0.730$) (Figures 1 and 2).



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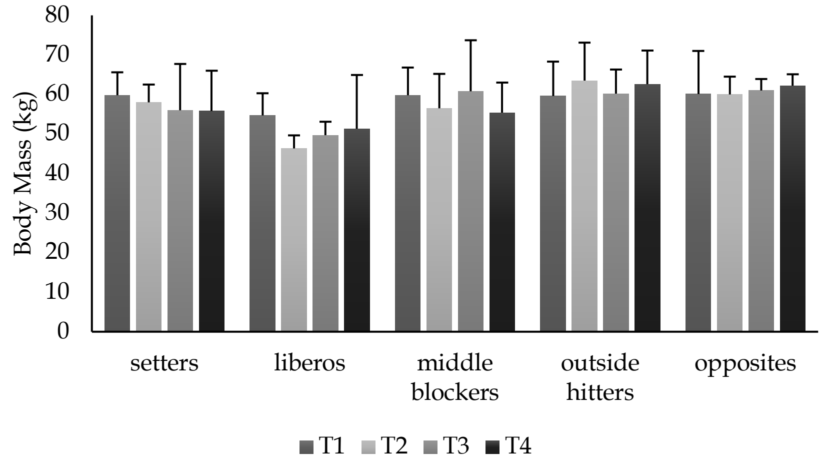

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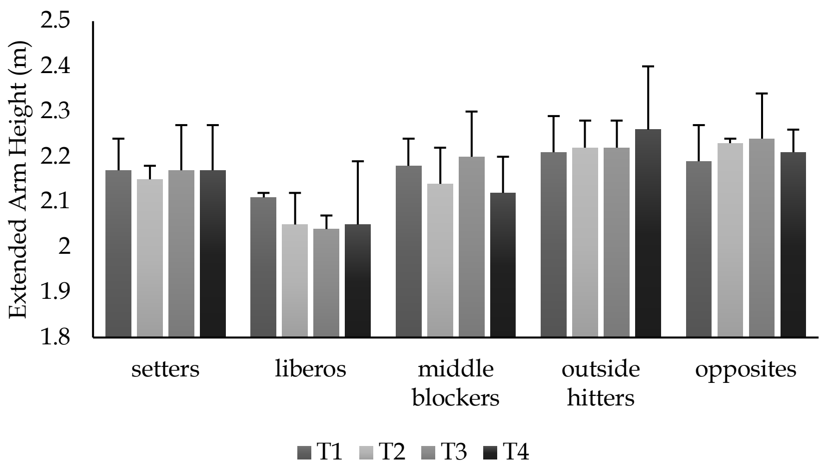

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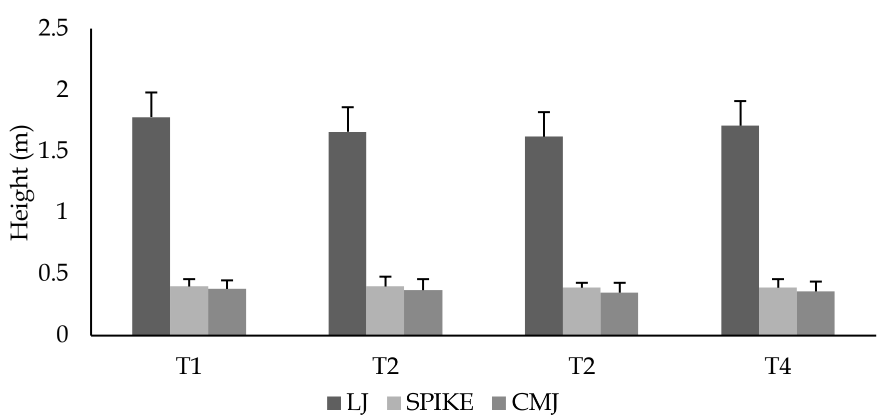
Figure 1. Distribution of birth characteristics (Q1–Q4) for a) height, b) body mass, and c) extended arm height between playing positions.



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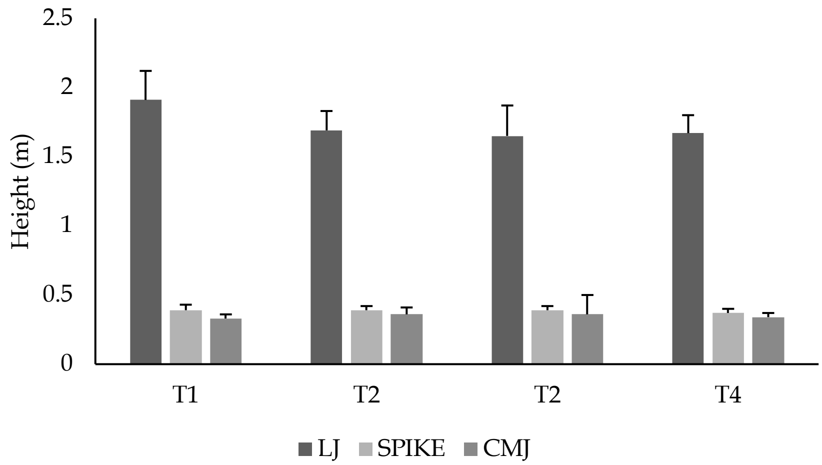
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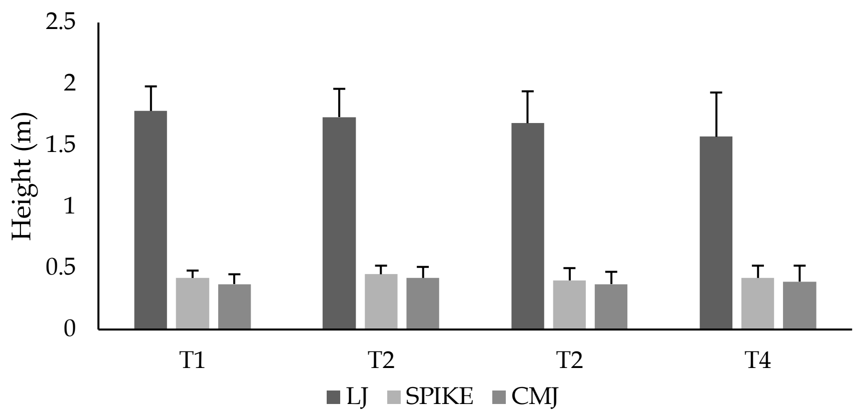
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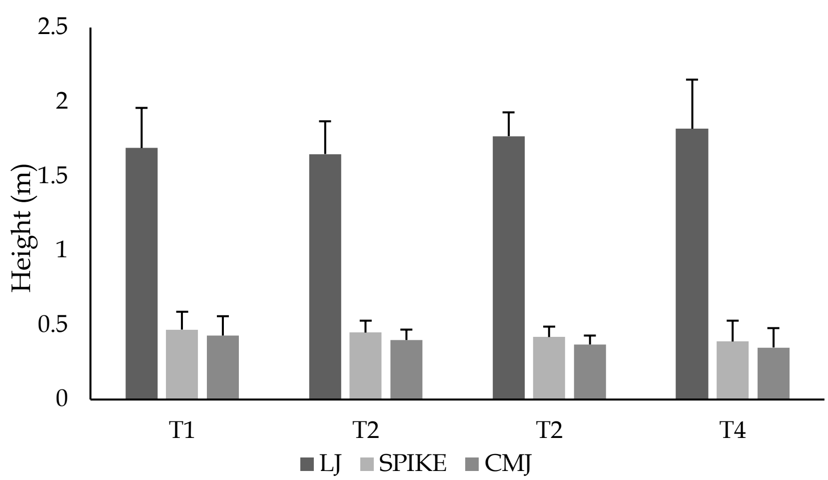
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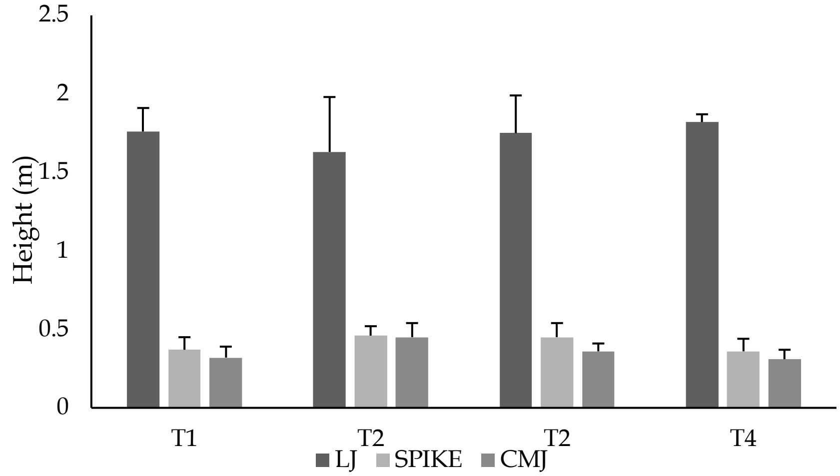
d)



e)

Figure 2. Distribution of birth characteristics (Q1–Q4) for long jump (LJ), spike jump (spike) and countermovement jump (CMJ) in a) setters, b) liberos, c) opposites, d) outside-hitters, and e) middle blockers.

Statistically significant correlations were observed between age and spike jump (ρ = 0.227, $p < 0.001$), CMJ (ρ = 0.240, $p < 0.001$), abdominals strength (ρ = −0.246, $p < 0.001$), MBT (ρ = 0.135, $p = 0.008$), and agility T-test (ρ = −0.231, $p < 0.001$). From multivariate Kruskal-Wallis analysis, no statistically significant difference among the RAE or playing position groups was identified for any performance test.

DISCUSSION

The aim of this study was to determine the presence of RAE between groups of different volleyball playing positions in female club volleyball players 14 years old. To our knowledge, this is the first study that examined the prevalence of RAE in adolescent female volleyball playing positions.

Although a RAE was present in our sample, no RAE was observed across different playing positions. The findings of our study indicate comparable linear dimensions, body composition, and physiological abilities irrespective of birth quarter. This suggests that in the context of adolescent female volleyball players, factors other than the month of birth may play a more significant role in determining playing position and performance. It could imply that the selection and development of players in these age groups are more influenced by individual skills, training experiences, and perhaps even coaching strategies rather than the age-related advantages typically associated with RAE (2, 8, 37). Additionally, it highlights the importance of focusing on a broad range of developmental aspects, including technical skills and physical conditioning, rather than relying on the physical maturity advantages that might come from being born earlier in the year.

Contrary to our results, no RAE was found in elite female Brazilian volleyball players (15), revealing a balanced birthday distribution among this population. A possible explanation could be the earlier maturational process experienced by young female athletes (22), thereby increasing the likelihood that coaches consider factors beyond physical attributes, such as technical and tactical performance, when determining the inclusion and continuity of female athletes in youth sports (15). The identification of RAE in young volleyball players participating in the first level of a national talent selection aligns with other findings. More specifically, Rubajczyk and Rokita (35) identified an overrepresentation of female players born in the first quarter who took part in a talent identification camp for the national team. Jumping ability and body height were decisive factors in the selection process. Similar results were observed by Okazaki et al. (30), who found that 74% of the female team members, 14 years old, who participated in an international volleyball cup, were born in the first half of the year. RAE was also investigated in a representative group of female volleyball players from four continents who participated in the last seven (2007–2017) Word Championships, reporting that the greater percentage of females were born in the first months of the year compared to other months of the competitive biennium. The magnitude of the RAE expression was more evident in the medalist teams, whose members appear to also have linear anthropometric advantages compared to other teams (10).

In our study, we conducted a multivariate Kruskal-Wallis analysis for independent samples to explore the potential influence of the RAE and playing positions on performance tests. Our findings indicated no statistically significant differences among the RAE or playing position groups across any performance test. These results suggest that neither the birth month nor the specific playing position significantly affects the performance outcomes in our sample. A previous study found that performance tests, such as anthropometrics, jumping ability, and agility, can discriminate those who participate in a National Volleyball Development Program with high accuracy (35). Our findings contrast with Rubajczyk and Rokita (35), who observed significant differences in birth quarter distributions among Polish youth volleyball players regarding jumping ability (spike reach and block jump) and agility. Additionally, a large observational study conducted on professional handball players found that the RAE significantly impacted the selection and performance of male and female athletes in international competitions. In that study, older athletes played more minutes and achieved better performance scores in sport-specific parameters, such as blocked shots and steals (36). However, our findings agree with Papadopoulou et al. (32), who found no significant association between RAE and the anthropometric and physiological characteristics of selected and non-selected Greek youth female volleyball players, suggesting that RAE might not influence performance in this demographic.

In team sports, athletes participate earlier in national age group championships, than the long training development programs' scientific guidelines. Consequently, athletes tend to join more hours of practice focused on a specific approach to their assigned position rather than establishing necessary basic volleyball skills and physiological abilities. This is particularly evident for athletes demonstrating higher RAE (13, 18). Thus, tactical schemes and the specific characteristics for each playing position are included earlier in the training routines of young athletes (5). For example, in soccer, RAE prevalence is more intense in midfielders, defenders, and goalkeepers in young male athletes born in the first months of the competitive year (34).

In young female volleyball players, playing position-related differences in anthropometric and physiological characteristics continue to be under research. Recently, Cherouveim et al. (12) found different anthropometric but similar physiological characteristics between the playing positions in the same cohort of female volleyball players, revealing that middle blockers were the tallest players, whereas liberos and setters were with the shortest stature height. Our current study analysis indicated that these differences could not be attributed to the RAE in this sample. However, the anthropometric differences among playing positions remain significant. This finding suggests that future research should investigate other factors that may determine playing positions in female volleyball athletes.

The study's main strength was that it captured all the preselected youth volleyball players of the Greek national under-15 teams, representing 101 local clubs from all over the country. On the other hand, a limitation was that the testing procedures for the investigation of RAE in different playing positions did not include specific technical drills that are important for elite volleyball performance (18). Overall, future studies are needed to investigate further and understand if RAE plays a crucial role in the later selection of young athletes. For a more detailed investigation of RAE, physiological abilities' demands for each playing position should be considered in the selection of methodological procedures. Specialists and organizations should reorganize age-related stages of identification and selection, using holistic procedures, including later and gradually anthropometrical, physiological, technical, and cognitive abilities in the talent developmental programs.

This is the first study investigating the RAE prevalence among playing positions for anthropometrical and physiological measures in adolescent female volleyball players. The findings of this study have several practical implications for coaches, practitioners, stakeholders, and federations involved in the selection and development of young female volleyball players. Coaches should focus on various developmental aspects, including technical skills, physical conditioning, and psychological factors, rather than relying on physical maturity advantages associated with RAE. This approach can ensure that all athletes, regardless of their birth month, have equal opportunities to develop their potential. Selection processes should consider individual skills, training experiences, and potential rather than just physical attributes, which can help identify and nurture talent that may be overlooked due to late physical development.

Training programs should be designed to support the individual needs of athletes, emphasizing skill development, overall conditioning, and tactical knowledge (39). For example, a recent study indicates that musculoskeletal fitness, functional sport-specific ability, and declarative tactical knowledge account for 31%, 45%, and 53% of the performance variance, respectively, in 14-year-old female volleyball players (39). Early specialization based on physical maturity should be avoided to prevent the exclusion of late-developing athletes. Continuous monitoring and evaluation of athletes' progress, including their maturation and sport-specific demands, can help them make informed decisions about their development and playing positions. This can aid in mitigating the long-term effects of RAE. Federations and organizations should develop policies and strategies to address RAE in talent identification and development programs. This can include adjusting age group classifications, implementing measures to ensure equitable opportunities, and promoting awareness among coaches and stakeholders about the implications of RAE.

The absence of RAE across different playing positions in young female volleyball players suggests that early exposure to advanced training programs does not yet clearly establish the characteristic demands of the playing positions. Practically, the complexity of the RAE phenomenon is of great interest in designing and enhancing the effectiveness of training and conditioning programs to support the gradual development of young, high-level volleyball players. By adopting these practices, the premature exclusion of potentially talented young athletes can be minimized, and a more inclusive and effective development pathway can be established for young female volleyball players.

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None of the authors declare that they have any conflict of interest.

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