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Relative age effect in volleyball: Does early birth influence elite success?

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Abstract

Background: The Relative Age Effect (RAE) refers to the unequal representation of athletes according to their birth timing within a selection year. This phenomenon may influence talent identification, athlete development, and access to competitive opportunities. However, limited evidence is available regarding the relationship between RAE, playing-position distribution, and tactical-technical performance among competitive university volleyball players in India.

Aims: This study examined the presence of RAE and its association with playing positions and tactical-technical performance among male volleyball players competing at the national inter-university level in Tamil Nadu, India.

Methods: A cross-sectional observational design involved 160 male players from universities in Tamil Nadu who participated in national inter-university tournaments during the 2024–2025 season. Participants were classified into four birth quartiles: Q1 (January–March), Q2 (April–June), Q3 (July–September), and Q4 (October–December). Playing positions and performance indicators, including attack efficiency, block success, serve pressure, reception efficiency, and overall performance index, were analyzed using chi-square goodness-of-fit tests and the Kruskal–Wallis test.

Results: A significant unequal distribution of players was observed across the birth quartiles (χ^2 = 10.40, p = 0.015, Cohen's w = 0.25). Players born in Q1 represented 32.5% of the sample, whereas those born in Q4 accounted for 17.5%, with Q1 players being approximately 1.86 times more likely to be represented than Q4 players. Significant position-specific differences were identified among opposite hitters (χ^2 = 8.11, p = 0.04) and middle blockers (χ^2 = 9.02, p = 0.02). However, no significant differences were found across birth quartiles in attack efficiency, block success, serve pressure, reception efficiency, or overall performance index (p > 0.05; η^2 = 0.008–0.014).

Conclusion: RAE remained evident in player representation and positional distribution but was not associated with tactical-technical performance. These findings suggest that birth timing may influence selection opportunities more than actual competitive ability. Talent identification should therefore use multidimensional criteria and prioritize athletes' long-term developmental potential rather than age-related physical advantages.

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INTRODUCTION

Relative age effect (RAE) refers to the tendency to have an overrepresentation of individuals born earlier in the given selection year, and the phenomenon has been well documented in many competitive sports (Dudink, 1994; Toselli et al., 2022; Leyhr et al., 2024). The bias is mainly caused

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by the use of chronological age classification groups favoring relatively older athletes, who generally demonstrate more developed physical, cognitive, and psychological abilities compared with their younger peers in the same group (Cobley et al., 2009; Wattie et al., 2015; Becerra-Patiño et al., 2024). Thus, such a favorable start might create more opportunities for selection, training, and competition, leading to increased engagement in sport (Andronikos et al., 2016). The phenomenon is a major issue in sports science because it can impact talent identification, athlete development, and the allocation of equitable opportunities in competitive sport. Practically, it may result in the exclusion of talented young athletes from development programs on the grounds of being born earlier or later (Kelly et al., 2022; Bhengu et al., 2026).

The presence of relative age effects (RAE) among youth and adolescents in sport settings has been well-established in previous research, with special attention paid to talent identification and development programs (Sweeney et al., 2023; Fitzgerald et al., 2024). Evidence of high RAE prevalence has been shown for football, basketball, handball, and volleyball, implying that birth date distribution may play a significant role in athlete selection processes and future opportunities for participation in sports (Delorme et al., 2010; Rubajczyk & Rokita, 2020; Schorer et al., 2025; Grigoletto et al., 2023). However, the size and persistence of RAE vary across sports, competitive level, gender, and playing position. Although a considerable number of research works are available related to RAE in youth sports, for the longest time, research has been dominated by elite or professional athletes and focused more on the distribution of birth dates while ignoring birth timing relative to performance outcomes in sport (Ávila-Martínez et al., 2024; Ntozis et al., 2024). Data regarding the prevalence and implications for performance of RAE among college athletes, especially in volleyball, is scarce (Yang et al., 2026; Rebelo et al., 2024; Wang & Tian, 2024). The relationship between RAE, playing position, and multidimensional performance indicators needs further exploration (Sliwa et al., 2024; Garcia-de-Alcaraz et al., 2022).

There is evidence that the effect of RAE may decrease in elite athletes, since the success of such participants depends mainly on the development of techniques and tactical awareness and not on maturational differences (de la Rubia et al., 2020; Aku & Yang, 2024). Still, recent findings show that RAE persists in the professional league despite the elimination of maturational factors as a source of advantage. Thus, RAE can be maintained due to selection practices that develop during the athlete's early career (Rey et al., 2023; Işık et al., 2025).

The combination of anthropometric features and technique makes RAE analysis relevant in volleyball. Indeed, playing positions such as middle blocker and opposite require good height and power, while setter and libero demand better decision-making and technical abilities (Drikos et al., 2025; Ntozis et al., 2024; Palani et al., 2024). Previous studies investigating RAE in volleyball have mostly attempted to describe the prevalence of RAE in various competitive environments. While Campos et al. (2020) investigated the birth date distribution of participants of the Girls' U18 Volleyball World Championship, Albaladejo-Saura et al. (2022) analyzed RAE during youth volleyball talent identification. The work of Oliveira Castro et al. (2024) has shed light on the relationship between RAE, gender, position, and competitive level among elite Brazilian volleyball players, and Ntozis et al. (2024) studied RAE in relation to the position of adolescent female volleyball players. Finally, Redman et al. (2025) have recently provided further evidence of RAE in competitive volleyball populations. Despite these advancements in RAE research in volleyball, most studies have concentrated on youth and elite samples, specific positions, and birth date distribution, neglecting multidimensional performance indicators within the same analysis framework (Keoliya et al., 2024). Moreover, there has been almost no evidence on collegiate volleyball in Asian countries. So far, no study has comprehensively investigated the interrelationship between birth quartiles, playing positions, team competitive level, and performance measures in male volleyball players in India. Such a study is not only theoretically relevant but also practically important as collegiate sport becomes an important phase of transition from youth sport to the elite level where talent identification and athlete development decisions are made.

The innovation of this study is that it investigates relative age distribution along with playing position, competitive level, and performance measures in the case of volleyball players. The study is different from the previous literature that mainly focused on the description of how common RAE is by providing a multidimensional view on the issue of whether there exists a link between relative age and competitive performance to make a valuable contribution to the literature of talent

identification and athlete development. At the same time, this study will bring a unique Asian perspective to RAE issues in collegiate volleyball in India, where research on RAE in volleyball is scarce despite increased competitiveness in university sport. Therefore, the goal of this study was to examine the prevalence of RAE among male volleyball players and its correlation with playing position and multidimensional performance variables. The results of the study are expected to contribute to the literature on RAE in volleyball and provide evidence supporting fair talent identification and athlete development practices in university sports.

METHOD

Research Design

The present study used a non-experimental research design with observational procedures and a cross-sectional approach, focusing on natural data analysis related to volleyball players. The research design is compatible with the principles of selective methodology, and its main goal is to identify relationships between various variables, including birth quartiles, playing positions, and performance parameters (Ato et al., 2013; Anguera et al., 2011; Castro et al., 2024). The study uses a group-based (nomothetic) and analytical research approach, where numerous variables are analyzed in one go to discover their connections. Information was gathered at one point in time during the 2024–2025 competition season, providing a snapshot of how RAE affects volleyball players at the present moment. The cross-sectional approach provides evidence of ecological validity and allows for interpreting results in a competitive environment. The present study was carried out to explore the extent of the Relative Age Effect (RAE) and its relationship with playing position and performance markers among competitive male university volleyball players in the 2024-2025 competition year. While a cross-sectional observational study allows for associations to be identified within competitive reality, no causal connections or changes can be observed using this method. Moreover, the results are only relevant for the sample of male university volleyball players from Tamil Nadu, India, who compete nationally between universities.

Participants

The sample population consisted of 160 male volleyball players 18-25 years (chronological age) representing various universities in Tamil Nadu, India, and who participated in national inter-university volleyball tournaments conducted during the 2024–2025 academic year. Instead of labeling all participants as 'elite' athletes, in this study, the participants will be referred to as competitive university volleyball athletes playing at the national inter-university level. These individuals managed to pass through university, district, and state level selection processes and participated in national inter-university tournaments implying highly competitive level. Inclusion criteria for participants involved being officially enrolled in the university team, participation in national level inter-university volleyball tournaments during the 2024–2025 academic year, and having complete records related to demographics and competition results. Athletes who were unable to provide full competition record and missing their birth date information were excluded from further analysis. Permission to access competition records was provided by sports authorities of respective universities. As the study involves use of official competition records and anonymized performance data, confidentiality and anonymity of the participants were ensured during the whole research process. All personal identifiers were deleted before analysis and all data were safely stored and used only for research purposes.

Procedures

The data used in the current study were collected systematically from competition records and institutional sources associated with the 2024-2025 national-level volleyball season in Tamil Nadu. Athletes who did not have any verifiable records were removed from the study. Generally, the academic year in India starts from June-July, and school admission is based on age cut-off dates set up by educational authorities. Considering that, in sports research, the relative age effect is usually evaluated according to calendar year, athletes were categorized based on their birth month and assigned to one of the four birth quartiles: Q1 (January-March), Q2 (April-June), Q3 (July-September), and Q4 (October-December). Regarding this classification system, athletes born in Q1 are relatively older within the annual group and have some developmental advantages. In comparison, athletes

born in Q4 are relatively younger and have relative disadvantages during the talent selection processes. Several performance-related variables were analyzed. Athletes were categorized according to playing position as setter, outside hitter, opposite hitter, middle blocker, or libero. Teams were classified based on their standing at the end of the tournament. Teams in ranks 1-10 were considered high-level teams, ranks 11-20 mid-level teams, and ranks 21-30 low-level teams. This classification was used to determine if there is any effect of Relative Age Effect across different levels of teams' competitiveness. The performance indicators used in this study were based on official statistics of matches played in the tournament setting. The attack efficiency indicator is the percentage of attacks made successfully that lead to scoring points. The block efficiency indicator is the percentage of successful blocks that result in points. The serve pressure index, which took into consideration the service aces and the serves that produced errors during the receiving phase for the opponents, was used to measure the serve pressure. A higher value on the index meant a more effective serve pressure.

Statistical Analysis

The frequency distribution of the relative age quartile groups was analyzed through chi-square goodness-of-fit tests, with effect size presented as Cohen's w. Additionally, odds ratios (ORs) with 95% confidence intervals were used to estimate representation in quartiles. To test for statistically significant differences among quartiles in terms of their performance levels, which were not normally distributed, a Kruskal-Wallis test was used, while its effect size is presented as η^2. The significance threshold was set at $p < 0.05$, and all calculations were performed using SPSS software.

RESULTS AND DISCUSSION

Results

To determine whether the Relative Age Effect was present in the study sample, the distribution of the 160 players across the four birth quartiles was first examined. The observed frequencies were compared with an expected equal distribution using a chi-square goodness-of-fit test. In contrast, Cohen's *w* and the Q1-to-Q4 odds ratio were used to estimate the magnitude of the effect and the likelihood of player representation. The results of this initial analysis are presented in Table 1.

Table 1. Relative Age Quartile Distribution of Volleyball Players

Relative Age Quartile	Observed (n)	%	χ^2	p-value	w	OR (Q1:Q4)
Q1	52	32.5	10.40	0.015	0.25	1.86
Q2	44	27.5				
Q3	36	22.5				
Q4	28	17.5				

From Table 1, it is seen that there is an unequal distribution of players in each birth quartile, with the earlier-born players being present more often than the later ones. The maximum number of participants belongs to Q1, while Q4 includes the minimum number of players. Thus, there is definitely an effect of relative age in the studied sample. The chi-square goodness-of-fit test demonstrated a significant deviation from the expected equal distribution across quartiles ($\chi^2 = 10.40$, $p = 0.015$, $w = 0.25$). Furthermore, the odds ratio (OR = 1.86) indicated that players born in Q1 were nearly twice as likely to be represented as players born in Q4.

Table 2. Relative Age Quartile Distribution by Playing Position

Position	Q1	Q2	Q3	Q4	χ^2	p-value	w
Setter	10	9	8	7	0.52	0.91	0.08
Outside Hitter	16	14	12	8	3.24	0.35	0.16
Opposite	12	10	6	4	8.11	0.04	0.28
Middle Blocker	10	9	5	3	9.02	0.02	0.31
Libero	4	2	5	6	2.14	0.54	0.13

As is evident from Table 2, the strength of the effect of relative age varies from one playing position to another. In particular, the biggest effect of RAE could be found in opposites and middle blockers. However, in setters, outside hitters, and liberos, there is an equal number of players regardless of their birth quartile, and the differences between the quartiles are statistically insignificant. Therefore, the impact of RAE could depend on the physical and positional features of volleyball. Significant differences were found for the Opposite position ($\chi^2 = 8.11$, $p = 0.04$, $w = 0.28$) and Middle Blocker position ($\chi^2 = 9.02$, $p = 0.02$, $w = 0.31$).

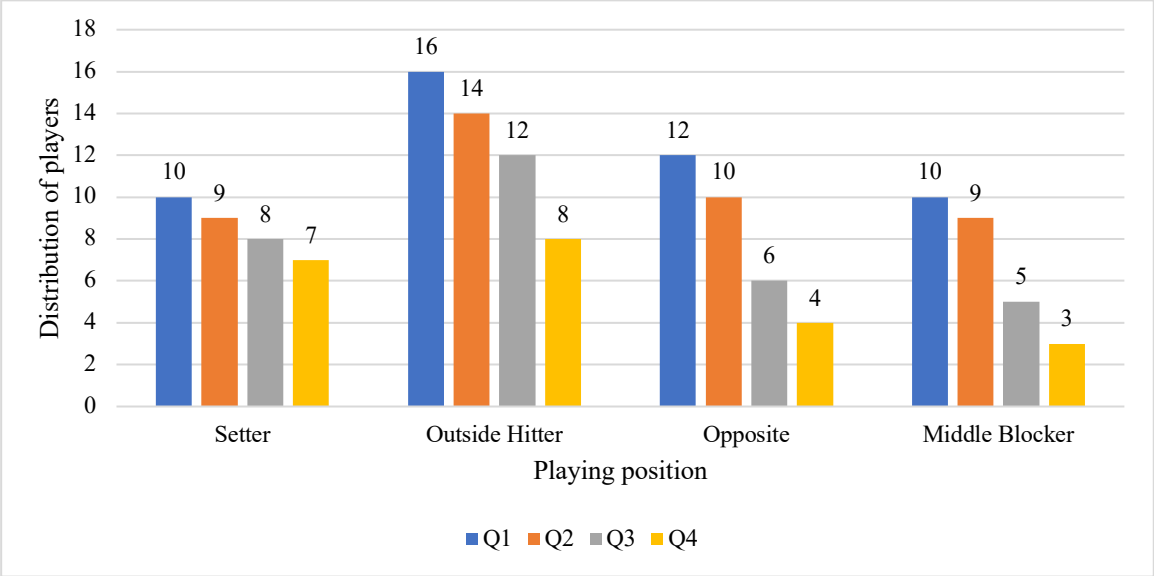

Figure 1. The Distribution of Relative Age Quartiles across Selected Playing Positions

Figure 1 visually illustrates the distribution of players across the relative age quartiles according to their playing positions. Across the positions presented, players born in Q1 and Q2 generally showed higher representation than those born in Q3 and Q4. The difference was particularly evident among opposite hitters and middle blockers, where the number of players progressively decreased from Q1 to Q4. In contrast, the distribution among setters was relatively balanced. This pattern supports the statistical findings presented in Table 2, indicating that the Relative Age Effect was more pronounced in positions associated with greater physical demands.

Table 3. Tactical-Technical Performance by Relative Age Quartile

Variable	Q1	Q2	Q3	Q4	H	p-value	η^2
Attack Efficiency	48.2 ± 6.1	47.5 ± 5.9	47.0 ± 6.3	46.8 ± 6.5	2.84	0.41	0.012
Block Success	2.9 ± 0.8	2.8 ± 0.7	2.7 ± 0.9	2.6 ± 0.8	3.12	0.37	0.014
Serve Pressure	1.8 ± 0.6	1.7 ± 0.5	1.7 ± 0.6	1.6 ± 0.5	1.95	0.58	0.009
Reception Efficiency	62.4 ± 7.2	61.8 ± 7.5	61.1 ± 7.8	60.9 ± 8.0	2.21	0.52	0.010
Performance Index	15.6 ± 3.2	15.2 ± 3.1	15.0 ± 3.3	14.8 ± 3.4	1.67	0.64	0.008

Table 3 demonstrates the similarities in the performance of players in different birth quartiles. Although players from Q1 tend to have higher mean values for some performance measures, such differences are insignificant. Hence, relative age was shown to have an impact only on the number of players in the sample and not on their performance. The results of the Kruskal-Wallis test show that there is no statistically significant difference between birth quartiles concerning attack efficiency, block efficiency, serve pressure, reception efficiency, and overall performance ($p > 0.05$, $\eta^2 < 0.02$).

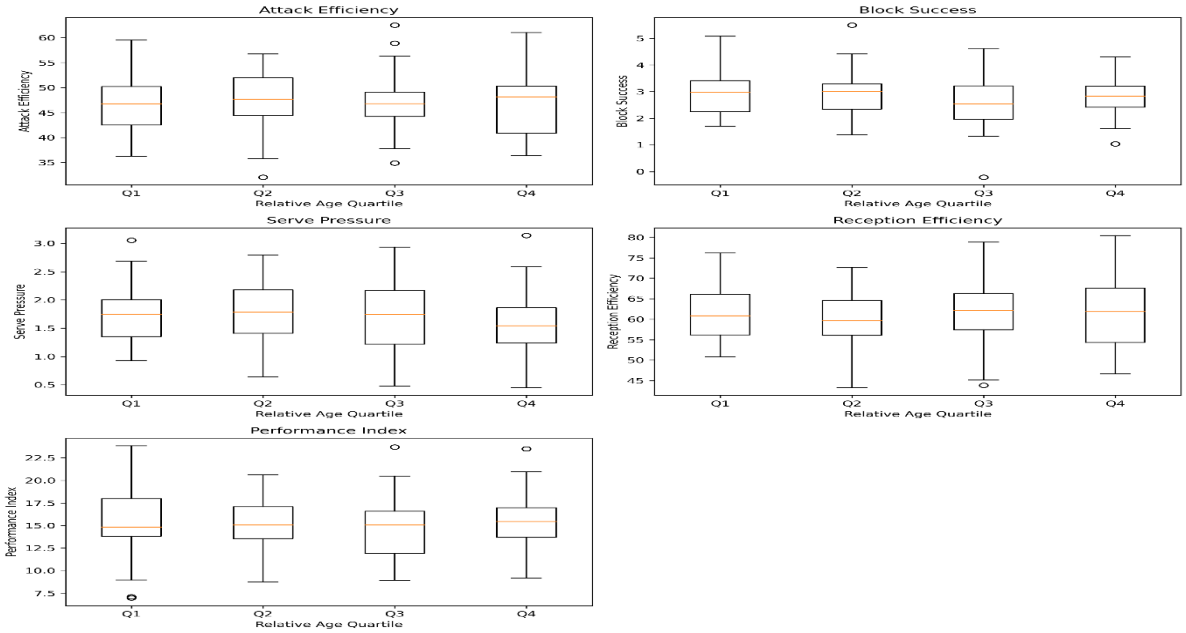

Figure 2. Distribution of tactical-technical performance variables across relative age quartiles.

Figure 2 provides a visual comparison of the distributions of tactical-technical performance variables across the four relative age quartiles. The boxplots show substantial overlap in the median values and interquartile ranges for attack efficiency, block success, serve pressure, reception efficiency, and the overall performance index. Although minor variations and several individual outliers are visible, no consistent pattern of superiority is observed for any birth quartile. These visual patterns support the results presented in Table 3, confirming that relative age was not significantly associated with tactical-technical performance among the players.

Discussion

The goal of this study was to analyze the presence of the Relative Age Effect (RAE) and its relationship with playing positions and performance variables among male volleyball players. The findings indicate that RAE remains evident in the representation of athletes in collegiate volleyball. The significant inequality in birth-quartile distribution (χ^2 = 10.40, p = 0.015, Cohen's w = 0.25) showed that players born in Q1 represented 32.5% of the sample, whereas those born in Q4 accounted for only 17.5%. Furthermore, Q1 players were approximately 1.86 times more likely to be represented than Q4 players. These findings suggest that the selection advantages experienced by relatively older athletes during earlier developmental stages may persist into collegiate competition. This pattern can be explained using the Developmental Systems Model of RAE proposed by Wattie et al. (2015), according to which relative age outcomes result from interactions among individual, environmental, and task-related factors rather than chronological age alone. Earlier selection may provide relatively older athletes with greater access to high-quality coaching, structured training, and competitive opportunities, thereby increasing their chances of continued development. The greater representation of athletes born earlier in the selection year is consistent with previous studies showing that relatively older athletes are more likely to receive opportunities for participation and development (Brustio et al., 2024; Joyner et al., 2017; Brustio et al., 2022). Nevertheless, because the present study used a cross-sectional observational design, these results should be interpreted as an association between birth timing and athlete representation rather than evidence that relative age directly causes selection success.

About playing positions, the greater frequency of RAE among opposite hitters and middle blockers is consistent with previous findings in volleyball (Ntozis et al., 2024), suggesting that positional demands may influence athlete selection. Significant birth-quartile differences were identified among opposite hitters (χ^2 = 8.11, p = 0.04, w = 0.28) and middle blockers (χ^2 = 9.02, p = 0.02, w = 0.31), whereas setters, outside hitters, and liberos did not show significant differences. Opposite hitters and middle blockers generally require greater height, reach, blocking ability, and

explosive power, characteristics that may be more apparent among relatively older athletes during earlier stages of development. Consequently, coaches may be more likely to select relatively older athletes for positions in which physical attributes are perceived as particularly important. Similar position-specific patterns of RAE have also been reported in other competitive volleyball populations (Oliveira Castro et al., 2022; Ntozis et al., 2024). However, this interpretation should be treated cautiously because anthropometric characteristics, biological maturity, training experience, and previous positional selection were not assessed in the present study. Therefore, RAE cannot be regarded as the only factor influencing playing-position distribution, and the current findings do not establish that physical maturity directly determined positional selection.

Although inequalities in birth-quartile distribution were evident, no significant differences were found in tactical-technical performance (McCarthy et al., 2022). Attack efficiency, block success, serve pressure, reception efficiency, and the overall performance index did not differ significantly across the four birth quartiles, with all p-values exceeding 0.05 and effect sizes remaining very small (η^2 = 0.008–0.014). Although Q1 players recorded slightly higher mean values for several indicators, the substantial overlap in the performance distributions suggests that these numerical differences had limited statistical and practical relevance. The findings therefore indicate that RAE may influence the likelihood of gaining access to selection and competitive participation but may not determine long-term playing ability. Although relatively older athletes may initially benefit from earlier physical maturation, these advantages may gradually diminish as athletes accumulate training experience and develop technical skills, tactical understanding, and adaptation to competitive demands. This interpretation is consistent with previous studies indicating that, at higher competitive levels, performance depends more strongly on sport-specific skills, tactical ability, and experience than on relative age (Campos et al., 2020; de la Rubia et al., 2020; Shen et al., 2026).

Taken together, the findings reveal an important distinction between athlete representation and actual competitive performance. The unequal birth-quartile distribution and the position-specific patterns among opposite hitters and middle blockers indicate that relative age may influence which athletes reach competitive university volleyball and the playing roles in which they are developed. However, the absence of meaningful differences in tactical-technical performance demonstrates that the greater representation of relatively older players should not be interpreted as evidence of superior playing ability. In this context, RAE appears to be more strongly associated with selection and developmental pathways than with performance superiority at the collegiate level.

One possible explanation is that relatively older athletes may receive greater visibility, encouragement, and selection opportunities during earlier developmental stages, particularly when maturational differences are more apparent. These advantages may accumulate through increased coaching exposure, training volume, competitive experience, and continued inclusion in athlete development systems. By the time players reach national inter-university competition, however, technical proficiency, tactical knowledge, psychological adaptation, and accumulated experience may reduce the importance of the initial advantages associated with birth timing. This interpretation remains provisional because the study did not directly measure biological maturity, anthropometric characteristics, training age, coaching exposure, or previous selection experiences. Longitudinal evidence would therefore be required to determine how these developmental factors interact with relative age throughout an athlete's pathway.

The present findings expand existing knowledge of RAE by demonstrating that inequalities in birth-quartile representation do not necessarily correspond to differences in match-related performance among university volleyball players. Birth quartile may therefore function as an indicator of unequal access to developmental opportunities, but it appears to have limited value as an indicator of long-term competitive capability. This distinction is particularly important because talent identification systems may favour athletes who demonstrate earlier physical development while overlooking relatively younger players whose long-term performance potential may be comparable. Accordingly, the persistence of RAE should be understood primarily as a potential structural bias within athlete selection and development pathways rather than as a direct marker of superior sporting potential.

Implications

These findings have practical implications for talent identification and athlete development in collegiate volleyball. The greater representation of relatively older athletes, despite the absence of

significant differences in tactical-technical performance, suggests that birth timing may influence selection opportunities more strongly than actual playing ability. Therefore, coaches and talent selectors should employ multidimensional and evidence-based assessment procedures that consider technical competence, tactical understanding, physical characteristics, developmental potential, and competitive performance rather than relying predominantly on age-related physical advantages. Regular reassessment should also be conducted to provide relatively younger athletes with sufficient time and opportunity to demonstrate their long-term potential. Such practices may help reduce selection bias associated with the Relative Age Effect and promote more equitable athlete development pathways.

Research Contribution

This study contributes to the existing literature on the Relative Age Effect by simultaneously examining birth-quartile distribution, playing-position patterns, and multidimensional tactical-technical performance among male collegiate volleyball players in India. Unlike many previous studies that have focused primarily on birth-date distribution or youth and professional athletes, the present study provides empirical evidence from the collegiate sport environment, which represents an important transitional stage between developmental and higher-level competition. The findings further contribute by demonstrating that the overrepresentation of relatively older athletes does not necessarily correspond to superior match-related performance. This distinction provides a more comprehensive understanding of RAE as a potential selection and developmental bias rather than a direct indicator of competitive ability.

Limitations

Several limitations should be considered when interpreting the findings. First, the cross-sectional observational design does not allow causal conclusions or an examination of how RAE changes throughout athletes' developmental pathways. Second, the sample was restricted to male collegiate volleyball players from Tamil Nadu, India, which limits the generalizability of the findings to female athletes, other regions, competitive levels, and volleyball systems. Third, the study did not assess anthropometric characteristics, biological maturity, training age, coaching exposure, previous selection experiences, or psychological factors, all of which may influence athlete representation, positional assignment, and performance. In addition, the use of official competition records may not fully capture contextual factors such as playing time, quality of opposition, team tactics, and the specific opportunities received by each player. Therefore, the findings should be interpreted as associations within the investigated sample rather than as evidence of direct developmental effects.

Suggestions

Future studies should employ longitudinal designs to examine how birth-quartile differences develop, persist, or diminish across different stages of the athlete development pathway. Larger and more diverse samples involving athletes from multiple regions, competitive levels, and both sexes are also needed to improve the generalizability of the findings. Researchers should incorporate anthropometric, physiological, maturational, psychological, and training-related variables to clarify the mechanisms underlying RAE and its relationship with playing-position selection and competitive performance. In addition, future studies should examine coaching decisions, playing time, selection history, and developmental opportunities to determine whether the overrepresentation of relatively older athletes results from physical advantages, accumulated training opportunities, or institutional selection practices. These approaches may support the development of fairer and more evidence-based talent identification systems in volleyball.

CONCLUSION

This study examined the Relative Age Effect (RAE) and its relationship with playing-position distribution and multidimensional tactical-technical performance among male collegiate volleyball players. The findings revealed an unequal birth-quartile distribution, indicating that relatively older players were more strongly represented in national inter-university volleyball competition. Position-specific patterns were also observed, particularly among opposite hitters and middle blockers. However, no significant differences were found across birth quartiles in attack efficiency, block

success, serve pressure, reception efficiency, or overall performance. These findings suggest that relative age may be more strongly associated with athlete selection and positional distribution than with actual competitive performance. Therefore, talent identification and athlete development systems should evaluate players using multidimensional criteria, including technical ability, tactical understanding, physical characteristics, competitive performance, and long-term developmental potential, rather than relying primarily on age-related physical advantages.

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AUTHOR CONTRIBUTION STATEMENT

KAD, GR, SS, SVP, GI, YK, and PR contributed to the conception and design of the study. KAD, GR, and SS were responsible for data collection and organization. SVP, GI, and YK conducted the statistical analysis and interpreted the findings. KAD and SS drafted the manuscript, while PR contributed to the critical review and refinement of the manuscript. All authors critically reviewed, revised, and approved the final version of the manuscript for publication.

AI DISCLOSURE STATEMENT

The authors declare that this research was prepared, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

CONFLICTS OF INTERES

There is no conflict of interest in this article.

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