Artículo original / Original Article

Relative Age Effect in Male Basketball Athletes: Association with Individual and Collective Performance

Efecto de la Edad Relativa en Atletas de Baloncesto Masculinos: Asociación con el Rendimiento Individual y Colectivo

Alexandra Folle [1], Mônica Cristina Flach [1], Leonardo Egerland Souto [1], Mariana Klauck Beirith [1]
[1]Universidade do Estado de Santa Catarina

***Correspondence:** alexandra.folle@udesc.br

DOI: 10.17398/1885-7019.22.55

Recibido: 18/06/2025; Aceptado: 05/02/2026; Publicado: 23/04/2026

OPEN ACCESS

Sección / Section:
Performance Analysis in Sport

Editor de Sección / Edited by:
Sergio J. Ibáñez
Universidad de Extremadura, España

Citación / Citation:
Folle, A., Flach, M. C., Souto. L.E. y Beirith, M. K. (2026). Relative Age Effect in Male Basketball Athletes: Association with Individual and Collective Performance. *E-balonmano Com, 22*(1), 55-66

Fuentes de Financiación / Funding:
Santa Catarina State Research Foundation (FAPESC)

Agradecimientos/ Acknowledgments:
Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES), Brazilian National Council for Scientific and Technological Development (CNPq) and the Santa Catarina State University (UDESC).

Conflicto de intereses / Conflicts of Interest:
All authors declare no conflict of interest

Abstract

This study aimed to assess the relative age effect (RAE) in male basketball athletes in the U17 and U19 categories, focusing on individual and collective performance during the 2021 season of the Santa Catarina State Basketball Championship (Brazil). A total of 248 athletes participated in the study, of which 177 played in U17 teams and 71 in U19 teams. Data were obtained from the official website of the Santa Catarina Basketball Federation. Chi-square test, Fisher's exact test, one-way analysis of variance, and Kruskal-Wallis test were used for inferential analysis. The results showed that, in the U17 category, despite the higher proportion of athletes born in the first quartile of the year, there was a significant difference only in the performance indicator "state call-ups"; that is, a greater number of athletes born in the first quartile were selected for state teams. In the U19 category, there was a homogeneous distribution in birth quartiles, with no significant differences in performance indicators between birth periods. Concluded that, in the 2021 season, there was no RAE in individual (number of games played, points scored, average points per game, and number of competitions played in the year) or collective (final team ranking) performance indicators among male basketball athletes.

Keywords: Athletes; Basketball; Maturation; Knowledge.

Resumen

Este estudio tuvo como objetivo evaluar el efecto relativo de la edad (RAE) en atletas masculinos de baloncesto de las categorías sub-17 y sub-19, centrándose en el rendimiento individual y colectivo durante la temporada 2021 del Campeonato Estatal de Baloncesto de Santa Catarina (Brasil). Participaron 248 atletas, de los cuales 177 jugaron en equipos sub-17 y 71 en equipos sub-19. Los datos se obtuvieron del sitio web oficial de la Federación Catarinense de Baloncesto. Para el análisis inferencial se utilizaron las pruebas de chi-cuadrado, exacta de Fisher, análisis de varianza unidireccional y Kruskal-Wallis. Los resultados mostraron que, en la categoría sub-17, a pesar de la mayor proporción de atletas nacidos en el primer cuartil del año, solo se observó una diferencia significativa en el indicador de rendimiento "convocatorias estatales"; es decir, un mayor número de atletas nacidos en el primer cuartil fueron seleccionados para las selecciones estatales. En la categoría sub-19, se observó una distribución homogénea en los cuartiles de nacimiento, sin diferencias significativas en los indicadores de rendimiento entre los períodos de nacimiento. Se concluyó que, en la temporada 2021, no hubo RAE en los indicadores de rendimiento individuales (número de partidos jugados, puntos anotados, promedio de puntos por partido y número de competiciones disputadas en el año) ni colectivos (clasificación final del equipo) entre los atletas masculinos de baloncesto.

Palabras clave: Deportistas; Baloncesto, Maduración, Conocimiento.

Introduction

Athletes, considered sporting talents, frequently demonstrate during training and competitions, high potential to achieve the desired level sporting excellence. In this case, young sporting talents are considered to be those who show high performance in the present and potential to become even better in the future, that is, to have high-level performance and athletic success (John & Thiel, 2022; Oliveira et al., 2025). However, it is necessary to take into account that this potential needs to be evaluated in terms of the performance differences presented by the athlete in relation to their direct opponents, given that the potential being analyzed often depends on the competitive level and context (national or international) in which they participate (John & Thiel, 2022).

Therefore, the identification, selection, and development of talent represent important steps in the context of sports development and competition (John & Thiel, 2022), arising from a combination of intrinsic (physical, technical, psychological) and extrinsic (training, parents) factors and the mastery of diverse sport-specific skills, such as collective tactics (Cotta-Ortega et al., 2025) or physical performance improvement (Antoranz et al., 2025) highlighting the inherently multidimensional nature of this process. (Buekers et al., 2014). In this multidimensional process, athletic profile and the Relative Age Effect (RAE) play crucial roles in the development of sports talent (Irid et al., 2025).

Thus, sporting success depends on several factors, one of which is the potential psychological and physical advantage that more mature athletes have over their peers and younger competitors (Babić et al., 2022). Given this, four indicators have garnered growing attention in the field of sports over the last decades: RAE; early specialization; training volume; and sports diversification (Ortega et al., 2021).

RAE is understood as a phenomenon that can create (dis)advantages for athletes in sports competitions, leading to a biased distribution of individuals within a sports context. Individuals born in the later months of the year face greater challenges and unfair competition (Bilgiç & Işın, 2023; Babić et al., 2022; Brustio et al., 2022). Early-born individuals have advantages in terms of physical growth, cognitive development, and biological, psychological, and emotional maturity, consequently having higher chances of participating in competitions and better performance in matches (Joyner et al., 2017). Thus, the RAE results in an overrepresentation of chronologically older athletes within their respective age group categories (Bonal et al., 2024; Bilgiç & Işın, 2023; Brustio et al., 2022).

Sports organizations commonly group children and adolescents by chronological age, typically using homogeneous cut-off points with intervals of one or two years (Brustio et al., 2022; Gil et al., 2021). This grouping strategy aims to ensure fair learning opportunities and competitive experiences for young athletes by minimizing intragroup differences in physical and cognitive abilities, particularly in invasion team sports (Brustio et al., 2022). However, athletes born in January and those born in December are often placed in the same team, resulting in age differences of 12 months within the same age category (Gil et al., 2021; Delorme et al., 2010; Ribeiro et al., 2023). In discussing this topic, Babić et al. (2022) argued that relatively younger athletes will only have high chances of selection if they mature early.

In the international sports sector, as well as in national and regional competitions, athletes are often grouped into broader age ranges with two-year intervals, which increases the age difference to up to 24 months. For example, the International Basketball Federation (FIBA) promotes the Under-19 (U19) and U17 Basketball World Cups and the U15 Skills Challenges. The Brazilian Basketball Confederation (CBB) holds the U19, U17, and U15 Brazilian Interclub Championships. The Santa Catarina State Basketball Federation (FCB, Federação Catarinense De Basketball), the sports organization that will be the focus of this study, also categorizes youth competitions into age groups at two-year intervals (U19, U17, U15, and U13).

Although the RAE is frequently overlooked by sports coaches in performance analysis, it has attracted increasing attention from sports researchers (Babić et al., 2022). Studies on RAEs in sports began in the 1980s, initially focusing on athletes in collective disciplines, such as hockey and volleyball. Over the years, research extended to other disciplines and

adopted a more comprehensive approach, investigating factors such as participation trends, dropout rates, injuries, and performance indicators (Bilgiç & Işın, 2023; Joyner et al., 2017).

In the context of basketball research, several investigations on RAEs in international competitions have been performed, with both young and adult athletes (Almeida et al., 2024; Tascioglu et al., 2023; Kalén et al., 2021). Studies were conducted in Asian countries, such as Malaysia (Hassan et al., 2025), China (Bonal et al., 2023) and Israel (Gottlieb et al., 2023); European countries, such as Frace (Irid et al., 2025), Spain (Díaz-Aroca & Arias-Estero, 2022; González et al., 2021), England (Kelly et al., 2021), and Poland (Rubajczyk et al., 2017); and in American countries, such as Brazil (Pereira et al., 2026; Castro et al., 2024; Gonçalves & Carvalho, 2021; Ribeiro Junior et al., 2023; 2021; 2020; Maciel et al., 2022; 2021; Oliveira et al., 2017a,b). In examining the theme, Tascioglu et al. (2023), Maciel et al. (2022), and Kelly et al. (2021) found that a higher number of athletes were born in the first quartiles of the year. These authors, however, did not observe significant differences in individual performance between birth quartiles.

Nevertheless, Maciel et al. (2021) and Kelly et al. (2021) reported that early-born athletes had higher chances of being selected for state and national teams, respectively. By contrast, Kalén et al. (2021) identified that players born in the fourth quartile were more likely to be re-selected by the age of 20 years than players born in the first quartile (inverse effect). In turn, Ribeiro Júnior et al. (2021) revealed that RAE is present in formative training categories but does not influence a players' career progression in the main competition for the male adult category in Brazil. Pereira et al. (2026) corroborate these findings, revealing that RAE is also present in Brazilian youth basketball teams, while Almeida et al. (2024), analyzing elite world competitions, found prominent discrepancies in male youth teams in the adult category, although RAE was present, it showed a tendency to reverse.

In a study assessing the relationship between the RAE and physiological variables, Gottlieb et al. (2023) observed significant differences for young male athletes but not for young female athletes. Interestingly, González et al. (2021) found no significant association between the RAE and inhibitory control of motor responses. Ribeiro Junior et al. (2023), in analyzing the relationship between the RAE and physical characteristics (height), found a greater proportion of U15 athletes born in the first half of the year and adult athletes born in the second half (inverted RAE), as well as Ribeiro Júnior et al. (2020), also found that RAE applies to tall athletes in the U12 to U16 age groups, but concluded that tall athletes tend to be selected at younger ages due to RAE, whereas with increasing age this selection tends no longer to favor the tallest athletes. Furthermore, Irid et al. (2025) observed that athletes born in the first half of the year showed superior physical performance in speed, agility, jump height, and aerobic capacity than those born in the second half, although physical attributes did not reliably predict success in adulthood.

As for playing positions, Bonal et al. (2023) observed greater significant differences for point guards and shooting guards, whereas Ribeiro Junior et al. (2023) identified a weak RAE in point guards and a stronger RAE among centers in younger categories. Some studies examined the RAE on collective performance. Tascioglu et al. (2023) and Díaz-Aroca & Arias-Estero (2022) found significant differences in team rankings in competitions, with a predominance of early-born athletes at top positions. In the Brazilian context, while Oliveira et al. (2017a,b) identified an association between RAE and the final ranking of male and female teams participating in the Brazilian Youth Championship, Pereira et al. (2026), Castro et al. (2024), Ribeiro Junior et al. (2023) and Oliveira et al. (2019) found no significant association between these variables in youth competitions.

It can be seen that the RAE may be associated with several indicators that can be measured and warrant investigation. A greater understanding of how this phenomenon persists in sports may contribute to minimizing biases in training and career development (Silva et al., 2022). In the context of basketball, it is possible to analyze sporting success from different perspectives, one of which is individual performance based on metrics such as number of games played, points scored, average performance indices, and personal achievements (e.g., salary and awards). Another perspective focuses on collective performance, as represented by team rankings in competitions (Riaza et al., 2020).

Thus, it is emphasized that, especially in Brazilian basketball, despite the advancement of research on RAE (Pereira et al., 2026; Castro et al., 2024; Ribeiro Junior et al., 2023; 2021; 2020; Maciel et al., 2022; 2021; Oliveira et al., 2017a,b), there are still few investigations that analyze this phenomenon in a contextualized way at the state level, considering different youth categories and indicators of participation, individual and collective performance, such as scoring metrics, volume of competitions played, call-ups to state teams, and final team ranking. Therefore, a knowledge gap is identified regarding the manifestation of RAE in state youth competitions in the country, justifying the present study. In view of the relevance of the theme and the need for further research on the RAE in Brazilian basketball, this study aimed to analyze the RAE in male basketball athletes in the U17 and U19 categories by assessing their individual and collective performance in the 2021 season of the Santa Catarina State Basketball Championship (Campeonato Catarinense De Basquetebol) in Brazil.

Methodology

This is a descriptive study with an associative approach (Ato, López, Benavente, 2013).

Participants and Sources of Information

The sample comprised 248 Brazilian male athletes aged between 16 and 19 years (general 17,04 ± 1; U17 - 16,5 ± 0,5; U19 - 18,4 ± 0,5) who participated in state championships organized by the FCB in the U17 (n = 177) and U19 (n = 71) categories in the 2021 season. Some athletes of the U17 category also participated in the U19 category, but they were analyzed only in their category of origin (relative to their chronological age). Likewise, U15 athletes were not included in the analysis of the U17 category.

In the U17 male basketball championship, 16 teams competed in the qualifying rounds, which were organized into five brackets. In the semifinals, eight teams played in two brackets of four teams each. The best two teams from each semifinal bracket advanced to the finals, held in an elimination format. The qualifying rounds of the U19 male basketball championship were organized into three brackets, each containing three teams. The top two teams from each bracket advanced to the semifinals, which were organized into two brackets of three teams each. The Final Four comprised the top two teams from each semifinal bracket.

Data collection procedures

Data on age category, date of birth, number of games played, total points scored, mean number of points scored per game, call-ups, number of championships played in the year, and final team rankings were obtained from the official website of FCB (https://sistema.basket-fcb.com.br/). Tabulation was carried out in July 2024. The collected information is publicly available via the internet (Maciel et al., 2021; 2022). All data were aggregated and analyzed together, without reference to individual team or player names.

Data analysis

To analyze the data, the variables ‘games played’, ‘points scored’, and ‘average points’ were presented using mean and standard deviation, while the variable ‘call-ups’ for state teams was categorized as ‘no’ and ‘yes’, and the variable ‘number of competitions played in the year’ was categorized as 1 competition or 2 or more. The athletes' ‘month of birth’ was categorized into quartiles: Quartile 1 (Q1) - athletes born between January 1st and March 31st; Quartile 2 (Q2) - athletes born between April 1st and June 30th; Quartile 3 (Q3) - athletes born between July 1st and September 30th; Quartile 4 (Q4) - athletes born between October 1st and December 31st, while the ‘final ranking’ was categorized as: Finals - athletes who competed for teams that qualified for the final four; Semifinals - athletes who competed for teams that

qualified for the semifinal stage but did not qualify for the final stage; Qualifying - athletes who competed for teams that did not qualify for the semifinal stage of the State Championship.

Descriptive analysis was carried out by determining the mean and standard deviation of symmetric continuous variables and the median and interquartile range (p25–p75) of asymmetric variables. Categorical variables were presented as percentages (%). In the inferential analysis of the data, differences between performance indicators were investigated using chi-square and Fisher's exact tests for categorical variables and one-way ANOVA and Kruskal–Wallis test for variables with normal and non-normal distribution, respectively. The statistical significance was set at 5%. Data analysis was conducted using Stata software version 16.0 (StataCorp LP, College Station, Texas, USA).

Results

In the U17 category, there was a greater number of athletes born in the first (n = 52) and second (n = 52) quartiles than in the third (n = 42) and fourth (n = 31) quartiles. However, significant differences between birth quartiles were only observed for the variable state team call-ups ($p < 0.05$). Athletes born in the first quartile were more frequently called-up for state teams than those born in the second and third quartiles (Table 1).

Table 1. Performance indicators of U17 male basketball athletes according to birth quartile.

Variable	**Q1** **mean ± SD**	**Q2** **mean ± SD**	**Q3** **mean ± SD**	**Q4** **mean ± SD**	***p*-value**
Games played	7.27 ± 2.92	7.21 ± 3.19	7.50 ± 3.27	7.68 ± 3.51	0.91*
Points scored[a]	32.0 (10.5, 55.0)	28.0 (6.0, 55.5)	29.5 (6.0, 64.0)	22.0 (10.0, 71.0)	0.96†
Points scored per game[a]	4.7 (2.0, 7.5)	4.2 (1.0, 7.0)	3.5 (1.2, 8.2)	3.5 (1.4, 10.1)	0.97†
Variable	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	***p*-value**
State call-ups					
No	41 (78.9)	50 (96.1)	39 (92.9)	27 (87.1)	0.03§
Yes	11 (21.1)	2 (3.9)	3 (7.1)	4 (12.9)	
Championships played in a year					
1	34 (65.4)	33 (63.5)	28 (66.7)	22 (71.0)	0.92‡
2 or more	18 (34.6)	19 (36.5)	14 (33.3)	9 (29.0)	
Ranking					
Finals	14 (26.9)	19 (36.5)	15 (35.7)	12 (38.7)	
Semifinals	9 (17.3)	7 (13.5)	7 (16.7)	11 (35.5)	0.11§
Qualifying rounds	29 (55.8)	26 (50.0)	20 (47.6)	3 (25.8)	

Note: SD, standard deviation; Q1, January to March; Q2, April to June; Q3, July to September; Q4, October to December. aMedian and interquartile range. *Analysis of variance. †Kruskal–Wallis test. ‡Chi-square test. §Fischer's exact test.

In the U19 category (Table 2), there was a homogeneous distribution of athletes born in the first two quartiles (first quartile, n = 18; second quartile, n = 19). The number of athletes born in the third and fourth quartiles was slightly higher (n = 22) and lower (n = 12), respectively. There were no significant differences ($p < 0.05$) in performance indicators between birth quartiles.

Table 2. Performance indicators of U19 male basketball athletes according to birth quartile.

Variable	Q1 mean ± SD	Q2 mean ± SD	Q3 mean ± SD	Q4 mean ± SD	*p*-value
Games played	5.72 ± 2.37	5.42 ± 2.32	5.50 ± 2.11	4.92 ± 2.61	0.83*
Points scored[a]	23.0 (4.0, 61.0)	20.0 (11.0, 50.0)	23.5 (12.0, 89.0)	11.5 (5.0, 53.0)	0.56†
Points scored per game[a]	3.84 (2.1, 8.4)	5.0 (0.5, 8.1)	5.8 (2.0, 12.3)	2.3 (1.8, 8.6)	0.59†
Variable	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	***p*-value**
State call-ups					
No	11 (61.1)	15 (79.0)	18 (81.8)	11 (91.7)	0.25§
Yes	7 (38.9)	4 (21.0)	4 (18.2)	1 (8.3)	
Championships played in a year					
1	10 (55.6)	13 (68.4)	6 (27.3)	7 (58.3)	0.05‡
2 or more	8 (44.4)	6 (31.6)	16 (72.7)	5 (41.7)	
Ranking					
Finals	10 (55.6)	8 (42.1)	10 (45.5)	5 (41.7)	
Semifinals	5 (27.8)	8 (42.1)	5 (22.7)	3 (25.0)	0.73§
Qualifying rounds	3 (16.6)	3 (15.8)	7 (31.8)	4 (33.3)	

Note: SD, standard deviation; Q1, January to March; Q2, April to June; Q3, July to September; Q4, October to December. aMedian and interquartile range. *Analysis of variance. †Kruskal–Wallis test. ‡Chi-square test. §Fischer's exact test.

Discussion

This study aimed to analyze the RAEs in male basketball athletes of the U17 and U19 categories. For this, we evaluated athletes' individual and collective performance in the 2021 season of the Santa Catarina State Basketball Championship, Brazil. In the U17 category, there was a greater number of athletes born in the first two quartiles of the year. Significant differences between quartiles were only observed for state team call-ups. By contrast, in the U19 category, there was a homogeneous distribution of athletes across birth quartiles, resulting in no significant differences in performance variables. Such evidence reinforces the notion that the RAE is not always an adequate predictor of long-term athletic performance (Castro et al., 2024).

Studies from other countries have reported a greater number of male basketball athletes born in the first quartiles in youth categories; furthermore, no correlations have been identified between individual performance and RAE, whether in international competitions (Tascioglu et al., 2023; Ibáñez et al., 2018), in athletes from English national teams (Kelly et al., 2021), or in national competitions in Spain (Díaz-Arouca & Arias-Estero, 2022; González et al., 2021). By contrast, Rubajczyk et al. (2017) observed better game statistics in a group of Polish players born in the first semester. Arrieta et al. (2016), in investigating athletes participating in European competitions, found that older players spent more minutes on the court and, consequently, obtained better absolute values in most performance parameters.

In Brazil, Maciel et al. (2022) observed a greater number of basketball athletes born in the first quartiles. The authors found that male athletes of the U13 category born in the first months of the year participated in a greater number of games and had a higher average number of points accumulated in the competition, while Ribeiro Junior et al. (2021) identified that, in the initial categories, athletes born in the first quartiles were more frequently called up to state teams than athletes born in the last quartile of the year. Furthermore, Pereira et al. (2026) corroborate that the RAE is also present in Brazilian basketball teams over decades. However, Gonçalves and Carvalho (2021) studied athletes of the U11 to U17 categories and found that being born in the first quartile of the year did not provide advantages in biological maturation, functional capacities, or psychological factors.

In the current study, the only indicator associated with birth quartile was state team call-ups. U17 athletes born in the first quartile were more frequently called to represent Santa Catarina State in Brazilian national championships. Similarly, Ribeiro Junior et al. (2023; 2021), in investigating national basketball competitions of youth categories in Brazil, found that athletes born in the first semester of the year had greater representation among state teams. In England, Kelly et al. (2021)

found significant differences in the distribution of youth athletes from national teams among birth quartiles, with a greater frequency of early-born individuals.

In this scenario, it can be inferred, from the reflections of Pereira et al. (2026), that the selection process for representation in competitions, which mainly depends on classification in previous tournaments, may imply the call-up of older athletes because they demonstrate temporary advantages (chronological, maturational, and biological), but which will not necessarily be decisive for better performances. Furthermore, by being selected more frequently, athletes born in the first trimesters end up accumulating greater experience in terms of both level and quality of training and competition, which can provide performance improvements for them and, consequently, exclusion or reduction of chances for other players. Hassem et al. (2025) corroborate that it is due to the disparity in maturation months between those born in the first and last months of the year that there is a greater probability of advantages and selections over time, given that the former are frequently directed to highly qualified technical commissions, obtaining greater prospects for engagement in training and competitions and, consequently, higher levels of competitive engagement.

Collective performance has been shown to be associated with RAEs in basketball. Athletes born in the first quartiles generally play in the highest-ranked teams, a result not seen in the current study or in research with athletes participating in Brazilian championships (Ribeiro Junior et al., 2023) or the 2012 Olympics (Werneck et al., 2016). Tascioglu et al. (2023) found that, among U16 basketball athletes participating in international tournaments, teams with the highest number of athletes born in the first months of the year obtained better rankings. Riaza et al. (2022), in a systematic literature review, observed the impact of the RAE on the final classification of men's basketball teams; however, such an effect was not observed on the performance of women's teams. Furthermore, Oliveira et al. (20217a), when investigating young Brazilian athletes, found that RAE may be the cause of a better ranking of the state teams participating in the Brazilian Youth Championships.

Díaz-Arouca & Arias-Estero (2022) found that the three best teams in the Spanish mini-basketball championship (U12) had a greater number of players born in the first semester. Arrieta et al. (2016) observed significant correlations between the classification of national teams in the European U20 Championships and the relative age of athletes: the highest-ranked teams were mainly composed of early-born athletes. Rubajczyk et al. (2017) found that teams composed of players born in the first half of the calendar year exhibited better match outcomes. With this finding, the authors demonstrated the impact of the RAE on the success of youth basketball teams in Poland.

In view of the above, it can be said that athletes at a more advanced stage of maturity have more opportunities to participate in higher-tier competitions, as was observed here among athletes of the U17 category. Interestingly, this relationship was not observed in U19 athletes. Silva et al. (2022) argued that RAEs are visible in popular and competitive sports; their greater prevalence in puberty is due to the physical changes occurring in athletes during this phase. Nevertheless, RAEs tend to decrease with increasing age, as maturational and physical differences between athletes become less pronounced. Thus, Irid et al. (2025) infer that, as in several cases, athletes who show inferior performance in certain tests, especially physical ones, due to their later birth date, are, conversely, those who showed a greater probability of reaching the elite level in basketball. Such evidence highlights the importance of considering individual performance trajectories and relative age in the identification and selection of sporting talent, which suggests the adoption of long-term player evaluation approaches, thus questioning selection based on early physical superiority.

Ribeiro Junior et al. (2023) stated that youth athletes who are older within their age group are biologically more mature than younger athletes, possibly explaining their greater representation in sports competitions. Furthermore, Díaz-Arouca & Arias-Estero (2022) argued that young athletes are being evaluated and selected on the basis of their biological maturity. However, as athletes age and compete in higher categories, such differences gradually decrease, owing to biological maturation, as stated by Ribeiro Junior et al. (2023). Therefore, it is important to consider biological maturity when assessing youth athletes to prevent the potential loss of talented young individuals during the early stages of training and competition. In agreement with Kelly et al. (2021), the results of this and previous studies showed that the

overrepresentation of early-born athletes in youth categories does not translate into better individual performance in competitions. Thus, the initial physical advantage/disadvantage that may motivate the decision to select/exclude athletes depending on their birth quartile disappears as athletes advance through age categories and are immersed in training and competition processes (Gonçalves & Carvalho, 2021).

Finally, this is complemented by findings from this and other studies in the Brazilian context, as well as inferences from Pereira et al. (2026) and Castro et al. (2024), which indicate that in the Brazilian national context, there is strong cultural pressure for immediate individual and, especially, collective results. This pressure can contribute to the selection of athletes born in the first quarters of the year, who appear more developed chronological, maturational, and biologically (perceived as more talented), but who are initially only older than their peers. However, the authors reflect that, even with the imminent pressure for immediate results, it is of paramount importance to identify, select, and provide similar opportunities not only to those young people who demonstrate good current performance, but also to those with good future sporting projections. As a suggestion, Oliveira et al. (2017b) indicate that the way the Brazilian Youth Basketball Championships are organized and, consequently, the State Championships analysed in this study that follow the same structure, needs adjustments to reduce the effect of relative age in the talent selection process for basketball in the country.

Irid et al. (2025) add that it is necessary to improve training and competition structures in youth basketball, with programs that aim to balance current performance assessments with those of future success prospects, recognizing that some athletes with late maturation end up being neglected by conventional selection models, but that they may possess potential, resilience, and non-physical attributes to become high-level references, since initial maturation advantages do not reliably predict success in adulthood. Such approaches that integrate distinct training trajectories can foster a more equitable and effective development of sporting talents. Thus, Buekers et al. (2014) corroborate that the best talent detection programs will be useless unless a solid program to develop skills and high-quality training follow-up, provided by well-designed training programs and the interaction and cooperation between trainers and scientists, are guaranteed.

Furthermore, it is added that, to mitigate RAE, changes should be implemented in age categories and new competition formats should be proposed. To this end, it is necessary to sensitize coaches to the need to provide real and equal opportunities, regardless of the birth date of their athletes (Ferragut et al., 2021; Sá et al., 2020). In addition, it is necessary to incorporate a sense of participation into amateur competitions, which can help minimize the importance of immediate results that lead to the identification of RAE in sport (Herrero-Molleda et al., 2023).

Conclusion

The results of this study indicate that the relative age effect manifests itself in a punctual way in the U17 category, being mainly associated with the selection processes for state call-ups, in which athletes born in the first quartile of the year were more likely to be called up to represent the state of Santa Catarina in national competitions. This finding suggests that, in younger categories, performance and selection criteria may be influenced by maturational differences resulting from the date of birth, favoring relatively older athletes within the same age category.

In contrast, the absence of statistically significant differences between birth quartiles in the U19 category points to an attenuation of this effect throughout the formative process, possibly due to greater maturational homogenization and the retention of only those athletes who managed to overcome initial disadvantages. Thus, the main contribution of this study lies in the evidence that the relative age effect in male basketball in Santa Catarina is not uniform across the training categories, being more relevant in the initial phases of sports development and less evident in more advanced categories. These findings reinforce the importance of longitudinal analyses and a cautious approach in the processes of talent identification and development, especially in youth categories, in order to minimize possible biases associated with relative age and promote more equitable sporting trajectories.

A limitation of this study is that it was not possible to include all youth categories of Santa Catarina basketball, given that U13 and U15 competitions were not held in 2021 owing to the COVID-19 pandemic. It was decided not to include

female athletes because of their low numbers across age categories. For instance, the U19 category comprised only 11 female athletes aged 18 to 19 years. Another limitation is that it was not possible to select only athletes aged 17 years in the U17 category and those aged 19 years in the U19 category for statistical analysis. The age categories generally span two years, and such sample specificity would significantly reduce the number of eligible athletes for analysis.

Practical Applications

The results of this study and the discussions with the literature presented indicate the need for coaches and sports managers, both in clubs and in basketball federations, to adopt pedagogical and organizational strategies that consider the maturational differences resulting from the birth quartile, especially in the younger youth categories, such as the U17. The fact that athletes born in the first quartile have a higher frequency of call-ups to state teams suggests that performance and selection criteria may be, albeit indirectly, favoring athletes with greater biological maturation and competitive experience.

Therefore, it is recommended that the processes of talent identification, selection, and development be conducted with caution, incorporating assessments that go beyond immediate physical, technical, and tactical performance, also valuing the potential for medium- and long-term development. Strategies such as the flexibility of selection criteria, the creation of more inclusive training environments, rotation in call-ups, and the organization of competitions or training sessions adjusted by maturational level can contribute to reducing possible inequalities.

Therefore, it is crucial that coaches pay attention to providing a balanced range of competitive opportunities, avoiding the premature exclusion of athletes born in the last quartiles, who may show less maturity in the short term but have high future potential. Such actions can encourage these young people to remain in the sport, reducing early dropout rates and expanding the pool of athletes, contributing to a more sustainable and efficient development process in youth basketball.

Acknowledgements

The authors thank the Santa Catarina State Research Foundation (FAPESC, grant No. 2023TR272), the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES, Finance Code 001), the Brazilian National Council for Scientific and Technological Development (CNPq), and the Santa Catarina State University (UDESC) for the financial support.

Author Contributions: "Conceptualization, A.F., M.F., L.S and M. B.; methodology, A.F., M.F., L.S and M. B.; manuscript preparation, A, A.F., M.F., L.S and M. B.; writing - review and editing, A.F., M.F., L.S and M. B; supervision, A.F.

References

Almeida, M.B., Oliveira-Neto, J.L., & Nascimento, R.S. (2024). Relative age effect on national basketball teams around the world: analysis by sex, age, location and world ranking. *Journal of Physical Education, 35*, e3528. 10.4025/jphyseduc.v35i1.3528

Antoranz, Y., Vecino, J. C., Durán-Rodriguez, H., Jiménez-Reyes, P., & Jiménez-Saiz, S. L. (2025). Correlation among repeated sprint ability, vertical force-velocity profile, and 30-15 IFT performance in elite youth basketball players. *E-Balonmano.com: Revista de Ciencias del Deporte,* 21(1), 13-26. https://doi.org/10.17398/1885-7019.21.13.

Arrieta, H., Torres-Unda, J., Gil, S.M., & Irazusta. J. (2016). Relative age effect and performance in the U16, U18 and U20 European Basketball Championships. *Journal of Sports Science, 34*(16),1530-1534. https://doi.org/10.1080/02640414.2015.1122204.

Ato, M., López, J.J., & Benavente, A. (2013). Un sistema de clasificación de los diseños de investigación en psicología. *Anales de Psicología, 29*(3), 1038-1059. 10.6018/analesps.29.3.178511

Babić, M., Macan, I., Bešlija, T., Kezić, A., Tomljanović, M., Subašić, L., & Čular, D. (2022). Relative age effect and gender differentiation within sport - a systematic review. *Acta Kinesiologica, 16*(1), 20-29. 10.51371/issn.1840-2976.2022.16.1.3

Bilgiç, M., & Işın, A. (2023). Embarking on a journey: a bibliometric analysis of the relative age effect in sport science. *German Journal of Exercise and Sport Research, 53,* 325-332. 10.1007/s12662-021-00792-w

Bonal, J., León-Quismondo, J., Fernández-Luna, Á., Burillo, P., & Pérez-González, B. (2024). Relative age effect on basketball: the case of Chinese professional basketball players. *Journal of Sport and Health Research, 16*(2), 227-238. https://doi.org/10.58727/jshr.97522

Buekers, M., Borry, P., & Rowe, P. (2014). Talent in sports. Some reflections about the search for future champions. *Movement & Sport Science, 88*(2), 3-12. 10.1051/sm/2014002

Brustio, P.R., Boccia, G., De Pasquale, P., Lupo, C., & Ungureanu, A.N. (2022). Small relative age effect appears in professional female Italian team sports. International Journal Environment *Research and Public Health, 19*, 1-9. https://doi.org/10.3390/ijerph19010385

Castro, H., Oliveira, V., Rocha, M., Souza, W., Ribeiro, L., Gomes, S. & Figueiredo, L. (2024). The Relative Age Effect based on playing-positionand performance on Brazilian elite men's basketball. *Cuadernos de Psicología del Deporte, 24*(3), 94-107. doi:10.6018/cpd.612221

Cotta-Ortega, A., Gutiérrez-Capote, A., Contreras, J.M. & Piñar, M. I. (2025). Ball reversal as performance indicator in female basketball. E-Balonmano.com: Revista de Ciencias del Deporte, 21(1), 49-64. https://doi.org/10.17398/1885-7019.21.49

Delorme, N., Boiché, J., & Raspaud, M. (2010). Relative age effect in elite sports: methodological bias or real discrimination? *European Journal of Sport Science, 10*, 91-96. https://doi.org/10.1080/17461390903271584

Díaz-Aroca, A., & Arias-Estero, J.L. (2022). Relative age effect in U12 Spanish basketball: the past decade analysis. *International Journal of Medicine and Science of Physical Activity and Sport, 22*, 243-254.

Ferragut, C.; Vila, H.; Fernández-Romero, J. J.; & García, M. S. (2021). Efecto de la edad relativa en la élite del balonmano femenino español y su relación con aspectos antropométricos, de rendimiento y velocidad de lanzamiento. *Cuadernos de Psicología del Deporte, 21*(2), 213-226. 10.6018/cpd.438671

Gil, S.M., Bidaurrazaga-Letona, I., Larruskain, J., Esain, I., & Irazusta, J. (2021). The relative age effect in young athletes: a countywide analysis of 9–14-year-old participants in all competitive sports. *Plos One, 16*, e0254687. https://doi.org/10.1371/journal.pone.0254687

Gonçalves, C.E., & Carvalho, H.M. (2021). Revisiting the relative age effect from a multidisciplinary perspective in youth basketball: a Bayesian analysis. *Frontiers in Sports and Active Living, 2*, 1-11. https://doi.org/10.3389/fspor.2020.581845

González, G., Madinabeitia, I., Ureña, N., & Alarcón, F. (2021). Relative age effect and biological maturation on inhibitory control of motor response in basketball. *Revista de Psicología del Deporte, 30*(2), 273-279. http://hdl.handle.net/10045/117185

Gottlieb, R., Shalom, A., Alcaraz, P.E., & Calleja-González, J. (2023). Differences in aerobic capacity of basketball players by gender, age, and relative age effect. *Journal of Human Sport and Exercise, 18*(4), 763-774. https://doi.org/10.14198/jhse.2023.184.02

Hassan, N.A., Kahar, Z.A., Nadzalan, A.M., Low, J. F.L., Azmi, A.M.N., Pratama, R.S., & Purwoto, S.P. (2025). Efecto de la edad relativa (RAE) entre los atletas universitarios de Malasia. *Retos*, *63*, 251-261. https://doi.org/10.47197/retos.v63.105308

Herrero-Molleda, A., Zubiaur, M., Yagüe, J.M., González-Sánchez, V., & Molinero, O. (2023). Efecto de la edad relativa en el fútbol amateur de Cantabria (España). E-Balonmano.com: *Revista de Ciencias del Deporte, 9*(3), 219-230. doi: https://doi.org/10.17398/1885-7019.19.219

Ibáñez, S.J., Mazo, A., Nascimento, J., & García-Rubio, J. (2013). The relative age effect in under-18 basketball: effects on performance according to playing position. *Plos One, 13*, e0200408. https://doi.org/10.1371/journal.pone.0200408

Irid, Y., Pineay, J-C., Larochelambert, Q, Toussaint, J-F, & Sedeaud, A. (2025). Impact of athletic profiles and the relative age effect on the future achievement levels of young basketball players. *Frontiers in Sports and Active Living, 7*, 1-8. 10.3389/fspor.2025.1616800

John, J.M., & Thiel, A. (2022). Talent as a social construction: Proposing a constructivist conceptualization of athletic talent. *Zeitschrift für Erziehungswissenschaft, 25*, 1199-1220. https://doi.org/10.1007/s11618-022-01110-2

Joyner, P.W., Lewis, J.S., Dawood, R.S., Mallon, W. J., Kirkendall, D. T., & Garrett Jr., W.E. (2017). Relative age effect: beyond the youth phenomenon. *BMJ Open Sports & Exercise Medicine, 4*, 429-436. 10.1136/bmjsem-2020-000857ret

Kalén, A., Lundkvist, E., Ivarsson, A., Rey, E., & Pérez-Ferreirós, A. (2021). The influence of initial selection age, relative age effect and country long-term performance on the re-selection process in European basketball youth national teams. *Journal of Sports Sciences, 39*(4), 388-394. https://doi.org/10.1080/02640414.2020.1823109

Kelly, A.L., Sáiz, S.L.J., Calvo, A.L., Rubia, A., Jackson, D.T., Jeffreys, M.A., Ford, C., Owen, D., & Santos, S.D.L. (2021). Relative age effects in basketball: exploring the selection into and successful transition out of a national talent pathway. *Sports, 9*(7), 1-11. https://doi.org/10.3390/sports9070101

Maciel, L.F.P., Flach, M.C., Nascimento, R.K., Dallegrave, E.J., Nascimento, J.V., & Folle, A. (2021). Relative age effect on basketball: implications for the selection of successful players. *Retos, 42*, 266-275. https://doi.org/10.47197/retos.v42i0.83847

Maciel, L.F.P., Folle, A., Flach, M.C., Silva, S.C., Silva, W.R., Beirith, M.K., & Collet, C. (2022). The relative age effect on athletes of the Santa Catarina Basketball Federation. *Montenegrin Journal of Sports Science and Medicine, 11*, 29-35. https://doi.org/10.26773/mjssm.220303

Oliveira, H., Ribeiro Junior, D., Viana, J. M., &Werneck, F.Z. (2017a). Relative age effect in Brazilian Basketball Championship: Under 15 players. *Revista Brasileira de Cineantropometria e Desempenho Humano, 19*(5):526-534. https://doi.org/10.5007/1980-0037.2017v19n5p526

Oliveira, H., Ribeiro Junior, D., Werneck, F., & Tavares, F. (2017b). Efeito da idade relativa nos jogadores do campeonato brasileiro de basquete da categoria sub-17. *Revista Portuguesa de Ciências do Desporto, 17*(S1.A), 90-99. 10.5628/rpcd.17.S1A.90

Oliveira, J.R., Werneck, F.Z., Oliveira, H.Z., Coelho, E.F., & Bara Filho, M. G. (2025). Multidimensional indicators of sporting talent in young male volleyball athletes. International *Journal of Sports Science & Coaching, 1*, 1-12. https://doi.org/10.1177/17479541251359622

Ortega, J.A.F., Buitrago, J.A.R., & Rodriguez, D. A. S. (2021). Aspectos centrales de la identificación y desarrollo de talentos deportivos: revisión sistemática. *Retos, 39*, 915-928. 10.1007/s12662-021-00792-w

Pereira, M.N.R., Werneck, F.Z., Silva, G.T., Oliveira, H.Z., Souza, L.C.D.R., Carvalho, P.S., Alves, D.R.S., & Ribeiro Junior, D.B. (2026). The relative age effect in Brazilian national basketball teams over time. *Frontiers in Sports and Active Living, 6*(7):1-9. 10.3389/fspor.2025.1716826

Riaza, A.R., Calvo, J.L., Mon-López, D., & Lorenzo, A. (2020). Impact of the relative age efect on competition performance in basketball: a qualitative systematic review. *International Journal of Environmental Research and Public Health, 17*(22), 1-31. https://doi.org/10.3390/ijerph17228596

Ribeiro Junior, D.B., Lobão, P.H.F., Oliveira, H.Z., Viana, J.M., & Werneck, F.Z. (2020). O efeito da idade relativa em indivíduos normoestaturais e de elevada estatura no basquetebol de base do Brasil. *E-Balonmano.com: Revista de Ciencias del Deporte, 16* (1), 1-10.

Ribeiro Junior, D.B., Werneck, F.Z., Oliveira, H.Z., Panza, P.S., Ibáñez, S.J., & Vianna, J.M. (2021). From talent identification to Novo Basquete Brasil (NBB): multifactorial analysis of the career progression in youth Brazilian elite basketball. *Frontiers in Psychology, 12*, 617563. https://doi.org/10.3389/fpsyg.2021.617563

Ribeiro Junior, D.B., Werneck, F.Z., Oliveira, H.Z., Ibáñez, S.J., & Vianna, J.M. (2023). Relative age effect on Brazilian basketball over time. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 23*, 25-43. https://doi.org/10.15366/rimcafd2022.89.003

Ribeiro, E., Barreira, J., Carraco, D., Galatti, L., Götze, M., & Cal Abad, C.C. (2023). The relative age effect in under-17, under-20, and adult elite female soccer players. *Science and Medicine in Football, 8*, 153-160. https://doi.org/10.1080/24733938.2022.2164608

Rubajczyk, K., Świerzko, K., & Rokita, A. (2017). Doubly disadvantaged? The relative age effect in Poland's basketball players. *Journal of Sports Science and Medicine, 16*, 280-285.

Sá, P., Resende, R., Gomes, A.R., Saavedra, M., & Fenández, J.J. (2020). A idade relativa nos jogadores de andebol em Portugal. *E-Balonmano.com: Revista de Ciencias del Deporte, 6*(2), 93-102.

Silva, L.A., Leonardo, L., Rodrigues, H.A., & Krahenbühl, T. (2022). The relative age effect in invasion team sports: a systematic review in youth sports. *Retos, 46*, 641-652. 10.47197/retos.v46.94211

Tascioglu, R., Atalag, O., Yuksel, Y., Kocaeksi, S., Güven, G., Akyildiz, Z., & Nobari, H. (2023). Relative age effect and performance in elite youth male basketball. *Scientific Reports, 13*, 4544. 10.1038/s41598-023-31785-4

Werneck, F.Z., Coelho, E.F., Oliveira, H.Z., Ribeiro Junior, D.B., Almas, S.P., Lima, J.R.P., Matta, M.O., & Figueiredo, A.J. (2016). Relative age effect in Olympic basketball athletes. *Science & Sports, 31*(3), 158-161. https://doi.org/10.1016/j.scispo.2015.08.004