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ORIGINAL

RELATIVE AGE EFFECT IN BRAZILIAN BASKETBALL OVER TIME

EFECTO EDAD RELATIVA EN EL BALONCESTO BRASILEÑO A LO LARGO DEL TIEMPO

Ribeiro Junior, D.B.[1]; Werneck, F.Z.[2]; Oliveira, H.Z.[3]; Ibáñez, S.J.[4]; Vianna, J.M[5].

[1] Adjunct Professor at the Faculty of Physical Education and Sports. Federal University of Juiz de Fora (Brazil) dilsonborges@hotmail.com

[2] Adjunct Professor at Physical Education School –Federal University of Ouro Preto (Brazil) franciscozacaron@yahoo.com.br

[3] Professor at Salgado de Oliveira University – Universo Juiz de Fora (Brazil) helderzimmermann@yahoo.com.br

[4] Catedrático de Universidad· Faculdad de Ciencias del Deporte. Universidad de Extremadura (España) sibanez@unex.es

[5] Associate Professor at the Faculty of Physical Education and Sports. Federal University of Juiz de Fora (Brazil) jeferson.vianna@ufjf.edu.br

English translator: Insight® Language Expertise in publication, info@ilepub.com

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ABSTRACT

The aim of this study was to analyses the relative age effect in Brazilian basketball over a 15-year period by investigating possible intervening variables. 10,856 records of athletes from youth selection championships U15, U17, U22 and the professional league from 2004 to 2018 were analysed. The birth date, height, game position, geographic region, and team performance were analysed. We observed that the relative age effect is present from the U15 to the high-performance level. It was observed that relative age effect differs depending on

region and game position. To conclude the RAE is an evident phenomenon in Brazilian basketball from the U15 up to the professional league. It varies according to the geographic region of the team and the player position. This trend has perpetuated over the years.

KEYWORDS: Relative age effect, basketball, career.

RESUMEN

El objetivo de este estudio fue analizar el efecto edad relativa en el baloncesto brasileño durante un período de 15 años mediante la investigación de posibles variables intervinientes. Se analizaron 10856 registros de deportistas de los campeonatos de selección estatales U15, U17, U22 y la liga profesional de 2004 a 2018. Se analizaron la fecha de nacimiento, la altura, la posición en el juego, la región geográfica y el rendimiento del equipo. El efecto edad relativa está presente desde el nivel U15 hasta el nivel de alto rendimiento. Se observó que el efecto edad relativa difiere según la región y la posición del juego. Para concluir, el efecto de la edad relativa es un fenómeno evidente en el baloncesto brasileño desde la Sub15 hasta la liga profesional. Varía según la región geográfica del equipo y la posición del jugador. Esta tendencia se ha perpetuado a lo largo de los años.

PALABRAS CLAVES: Efecto de la edad relativa, baloncesto, carrera.

1. INTRODUCTION

Children's and youth competitions are divided by age groups in order to provide equal opportunities for each young athlete to properly develop physical, perceptual-cognitive, motor, and psychological skills necessary for success (Tribolet, Watsford, Coutts, Smith, & Fransen, 2019). Even so, differences in chronological age among youth people who compete within a same age group can provide participation and performance advantages for those born at the beginning of the selection year (Cobley, Baker, Wattie, & McKenna, 2009).

Scientific evidence reveals a bias in the selection process of youth athletes in different collective sports. There is a greater proportion of chronologically older athletes in relation to younger ones within a same age category (Wattie, Cobley, & Baker, 2008). Thus, the birth date of the athlete is a selection factor, especially at high-competitive levels. When the distribution of birth date of a group of selected athletes differs from the expected normal distribution, with a greater representation of athletes born in the first months of the year of selection, there is a phenomenon known as the relative age effect (RAE) (Musch & Grondin, 2001; Prieto-Ayuso y Matínez-Gorroño, 2017). RAE implies exposure to better training, greater access to resources through talent development programs, and greater exposure to coaches that select athletes (De Subijana & Lorenzo, 2018; Tribolet et al., 2019). Therefore, younger players who are at a temporary disadvantage generally perform less, are

not selected, and drop out of talent development programs more often, thus limiting their opportunities to progress in their sports career (Delorme, Chalabaev, & Raspaud, 2011).

Obtaining information that optimizes the development of athletes' sports potential from youth categories to the high-performance level is relevant so that teams, coaches, and managers can intervene in the best possible way in training and competition processes, balancing opportunities for all athletes, especially those with a potential to achieve high performance (Ibáñez, Sáenz-López, Feu, Giménez, & García, 2010; Tribolet et al., 2019).

In most sports, the presence of RAE is confirmed, especially those where height, body mass, and strength are important for performance (Delorme & Raspaud, 2009; Furley & Memmert, 2016; Rubajczyk & Rokita, 2020), as in basketball. The anthropometric factor related to height and size is decisive in the selection process of youth basketball players (Delorme & Raspaud, 2009). Some studies have highlighted that in junior categories, the highest athletes are those born in the first semester of the year (Ramos, Volossovitch, Ferreira, Fragoso, & Massuça, 2019; Ribeiro Junior, Lobão, Oliveira, Viana, & Werneck, 2020; Torres-Unda et al., 2013; Mendes et al., 2021). In basketball, RAE has been systematically observed at the early stages of careers. It occurs in U17 and U19 championships of both sexes of the International Basketball Federation (FIBA) (García, Aguilar, Gallati, & Romero, 2015), in the men's FIBA Americas national team championship in 2015 (Corsino et al., 2019), as well as in the *Adidas Next Generation Tournament, the top* European competition in U18 category, between 2013 and 2015 (Ibáñez, Mazo, Nascimento, & García-Rubio, 2018).

In addition, some studies have reported an association between the RAE and the players position in basketball (guards, forward, and centers) between 14 and 21 years of age (Arrieta, Torres-Unda, Gil, & Irazusta, 2016; García, Aguilar, Romero, Lastra, & Oliveira, 2014; te Wierike, Elferink-Gemser, Tromp, Vaeyens, & Visscher, 2015), in addition to enumerating indicators of performance that differentiate actions performed by players according to their position and date of birth (Ibáñez et al., 2018). This evidence suggests that the interaction of these factors is relevant in the selection and development of youth basketball players.

In Brazilian basketball players, the existence of RAE has been demonstrated in state teams of male athletes from the U15 and U17 categories in Brazilian championships, as well as in the Basketball Development League (U22) and in the New Brazilian Basketball (NBB), the main adult male competition (Oliveira, Ribeiro Junior, Vianna, Figueiredo, & Werneck, 2019; Oliveira, Ribeiro Júnior, Vianna, & Werneck, 2017; Oliveira, Ribeiro Júnior, Werneck, & Tavares, 2017). According to these studies, there is a greater presence of RAE in certain geographic regions of Brazil in the upper divisions and in teams that had better performances in competitions.

Recently, Ribeiro Junior *et al.* (2020) reported the existence of RAE in youth Brazilian Club Championships by analyzing 1,015 male athletes from different categories promoted by the Brazilian Basketball Confederation (CBB). The authors demonstrated the existence of RAE mainly in tall athletes compared to normal-height basketball players. Maciel et al. (2021) reported that players born in the early months of the year had a greater chance of being drafted to state U13 teams tan those born late.

In adults, the RAE remains evident in the career development period. There is an inversion at the consolidation phase, which disappears in Brazilian basketball players over 35 years old (Oliveira et al., 2019). Schorer, Roden, Büsch, and Faber (2020) emphasized the importance of continuous investigation on RAE for a better understanding of this phenomenon in the development process of athletes. However, studies on RAE, especially regarding basketball, have been conducted observing only a one-year period, that is, one year of competition (Oliveira et al., 2019; Oliveira, Ribeiro Júnior, Vianna, et al., 2017; Oliveira, Ribeiro Júnior, Werneck, et al., 2017), except for the study of García *et al.* (2015), who analyzed retrospectively the RAE in the FIBA World Cups in the categories U17, U19, and U21 between 1979 and 2011.

Given the above, the need to investigate the RAE in Brazilian basketball over time is evident. The establish of relationships with different intervening variables is essential for a better understanding of this phenomenon. Therefore, the aim of the present study was to retrospectively analyze the RAE in Brazilian basketball over a period of 15 years in the U15, U17, U22, and NBB categories and investigate possible differences depending on the game position, geographic region, collective performance, and height of athletes.

2. METHODOLOGY

2.1. STUDY DESIGN

This study presents a prospective associative strategy design (Ato, López-Garcia & Benavente, 2013) that considering four competitive categories over 15 years of national competitions of Brazilian male basketball. It analyzes characteristics of RAE and this association with geographical region, game position, collective performance, and stature of players.

2.2. PARTICIPANTS

10.856 records were obtained from basketball players who competed in national competitions between 2004 and 2018. The athletes participating in the U15 and U17 categories were the athletes selected to represent their respective state teams in the Brazilian Youth Championships organized by the Brazilian Basketball Confederation (CBB). The athletes participating in the U22 category competed in the Basketball Development League (LDB) for their respective clubs. This league is

organized by the National Basketball League (LNB). The athletes of the New Brazilian Basketball (NBB) competed in Brazilian professional basketball league, which is organized by the LNB. The data from U15 and U17 are until the last championship organized form the CBB and the data from U22 / NBB are from the period of this championships were raised.

2.3. VARIABLES

The athletes' information (date of birth, body mass, height, category, geographic region of the team, game position, and collective performance of the team) was taken from the CBB's website (http://www.cbb.com) for the U15 and U17 competitions. For the U22 and NBB categories, data were obtained from the National Basketball League (LNB) website (http://www.lnb.com.br). The use of publicly available data on the internet for RAE analysis has been described in other studies without the need for ethics committee research approval (Côté, Macdonald, Baker, & Abernethy, 2006; Werneck et al., 2016).

2.4. DATA ANALYSIS

To analyze data, the month of birth of each player was categorized into quartiles. The 1st quartile (Q1) consisted of athletes born between January 1st and March 31; the 2nd quartile (Q2) consisted of athletes born between April 1st and June 30; the 3rd quartile (Q3) consisted of athletes born between July 1st and September 30; and the 4th quartile (Q4) consisted of athletes born between October 1st and December 31. They were also organized by semester of birth: the 1st semester comprised athletes born between January 1st and June 30, and the 2nd semester comprised athletes born between July 1st and December 31 (Cobley et al., 2009; Werneck et al., 2016). The equitable distribution in quartiles and semesters is based on the dates of birth of the reference population of live births in Brazil between 1994 and 2003 and on the Live Birth Information System (SINASC) of the Ministry of Health (http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sinasc/cnv/nvuf.def), the following proportions are observed for the quartiles of birth: Q1 = 25,7%, Q2 = 26,3%, Q3 = 24,8% y Q4 = 23,2%..

For analysis of RAE by geographic region, we considered the location of the team of the athlete in the competition (regions: North, South, Southeast, Northeast, and Midwest). The RAE was also analyzed by the player position as informed by the technical team (positions: point guard, small-forward, forward, power-forward, and center). In turn, for the analysis of RAE and collective performance, athletes who were medalists or not were considered. Finally, the height of each athlete informed by his respective team was considered in the registration form sent to each institution organizing the competition (Oliveira et al., 2019; Oliveira, Ribeiro Júnior, Vianna, et al., 2017; Oliveira, Ribeiro Júnior, Werneck, et al., 2017). Statistical analysis was performed descriptively using mean ± standard deviation (quantitative variables). For the distribution of quartiles and semesters of birth, a descriptive

analysis of frequency and percentages for qualitative variables was performed. To investigate the RAE in the categories evaluated, the Chi-Square test (X^2) was used for quartiles. The odds ratio (OR) was calculated with a confidence interval (CI) of 95%. The OR was used to compare the distribution of the first three quartiles of birth (Q1, Q2, and Q3) with the last quartile (Q4), according to the recommendations of Cobley *et al.* (2009). To verify the association of RAE (semester) in geographic regions, player position, and collective performance, a bivariate analysis was performed using a crosstab and the Pearson's Chi-square test (X^2). The odds ratio (OR) was calculated with a 95% confidence interval (CI) between semesters. Then, the effect size for the Chi-square test was calculated and interpreted as follows: OR < 1.23 (very small), OR between 1.23 and 1.85 (small), OR between 1.86 to 2.99 (medium), and OR > 2.99 (large) (Olivier & Bell, 2013). Finally, to assess the difference in athlete height between the semesters of birth, an ANCOVA was used assuming the year of birth and the year of competition as covariables. The effect size (ES) was evaluated by Cohen's d (Cohen, 1992). All statistical tests were performed using the software SPSS version 26.0 (IBM Corp., Armonk, NY) at a significance level of 5%.

3. RESULTS

The athletes presented the following characteristics by age group (years), height (m) and body mass (kg), table 1.

Table 1. Descriptive characteristics of the participants, data with mean ± standard deviation.

Category	Age (years)	Heigth (meters)	Body mass (kg)
U15	15.5 ± 0.4	1.82 ± 0.10	73.4 ± 13.1
U17	17.3 ± 0.5	1.85 ± 0.10	77.3 ± 12.5
U22	19.4 ± 1.7	1.92 ± 0.10	89.1 ± 12.8
NBB	24.8 ± 5.7	1.96 ± 0.10	94.8 ± 13.1

There was a greater distribution of athletes born in Q1 in all categories, with decreasing OR values in the relationships between Q4 and Q1, Q2 and Q3. When analyzing the OR values of Q1 x Q4, the greatest effect occurred for category U15 (Table 2).

Table 2. Assessment of birth quartiles by category of athlete's participants on national championship during 2004 and 2018: U15, U17, U22 (LDB) and NBB.

Competition	N	Number (%) of athletes per quartile				X^2	*p*	OR (95% Confidence Interval)		
		Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)			Q1xQ4	Q2xQ4	Q3xQ4
Total	10856	4000 (36.9)	3084 (28.4)	2186 (20)	1604 (14.8)	1223.6	<0.001*	2.49(2.30-2.69)	1.92(1.77-2.08)	1.36(1.25-1.48)
U15	2974	1216 (40.9)	861 (29.0)	539 (18.1)	358 (12.0)	574.9	<0.001*	3.39(2.90-3.96)	2.40(2.04-2.82)	1.50(1.27-1.78)
U17	3439	1256 (36.5)	958 (27.9)	702 (20.4)	523 (15.2)	345.7	<0.001*	2.40(2.09-2.75)	1.83(1.58-2.11)	1.34(1.15-1.55)
U22	2032	750 (36.9)	605 (29.8)	368 (18.1)	309 (15.2)	250.3	<0.001*	2.42(2.02-2.90)	1.95(1.62-2.35)	1.19(0.97-1.44)
NBB	2411	778 (32.3)	660 (27.4)	559 (23.2)	414 (17.2)	118.7	<0.001*	1.87(1.59-2.21)	1.59(1.34-1.88)	1.35(1.13-1.60)

X^2: chi-square test; 1º quartile (Q1): Jan-Mar; 2º quartile (Q2): Apr-Jun; 3º quartile (Q3): Jul-Sep; 4º quartile (Q4): Oct-Dec; Effect size: OR< 1.23 (very small), OR between 1.23 e 1.85 (small), OR between 1.86 a 2.99 (medium) e OR > 2.99 (large). *p<0.05

The analysis of distribution of semester of birth over time for each competitive category revealed a higher proportion of athletes born in the first semester than in the second semester in all categories over time (Figure 1). The greatest difference was for the U15 category. The percentages of the first semester were more than double compared to those of the first semester, with a decrease in this difference in the NBB.

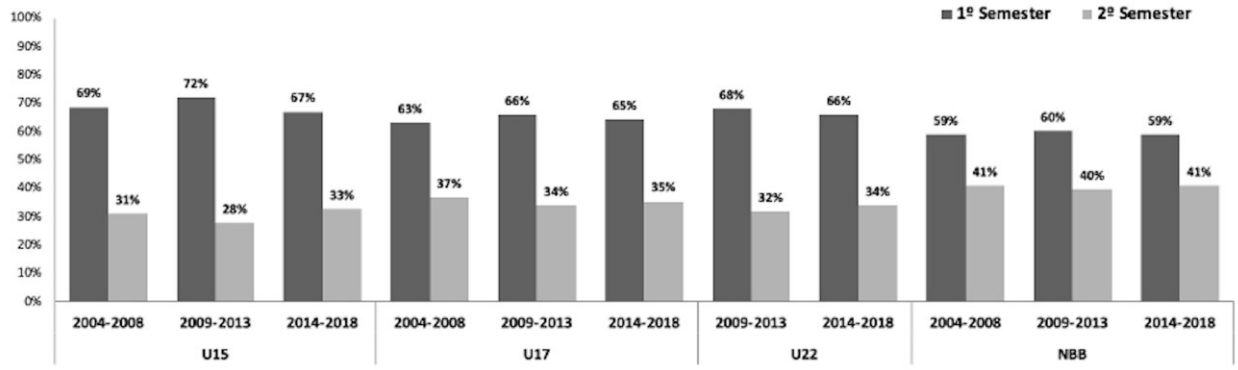

Figure 1. Distribution of semesters of birth for all categories (U15, U17, U22 and NBB), by period of years, during 2004 and 2018.

The RAE differs depending on the geographic region of the teams. For U15, the greatest representation of athletes born in the first semester occurred in the Southeast and Midwest regions. In U17, the RAE was higher in the south and southeast regions. In U22 there was no relationship between RAE and geographic region. For the NBB, the RAE was lower for athletes from the Northeast region (Table 3).

Table 3. Evaluation of the Birth semesters of athlete's participants in national championship during 2004 and 2018: U15, U17, U22 (LDB) and NBB by **geographic region of the team.**

Region	Number (%) of athletes per semester			X^2	p	OR (95% Confidence of Interval)	
	1º semester	2º semester	Total			1º semester x 2º semester	Effect size
U15							
North	474(67.9)	224(32.1)	698			2.11(1.75-2.56)	Medium
South	251(69.5)	111(30.5)	362			2.26(1.67-3.06)	Medium
Southeast	334(74.2)	116(25.8)	450	14.383	0.006*	2.88(2.17-3.80)	Medium
Northeast	620(66.8)	308(33.2)	928			2.01(1.67-2.43)	Medium
Midwest	418(74.3)	138(25.7)	556			3.03(2.34-3.91)	Large
U17							
North	457(60.6)	296(39.4)	753			1.54(1.23-1.93)	Small
South	327(69.7)	142(30.3)	469			2.30(1.76-3.00)	Medium
Southeast	394(70.6)	164(29.4)	558	22.810	<0.001*	2.40(1.88-3.07)	Medium
Northeast	672(61.9)	413(38.1)	1085			1.63(1.37-1.93)	Small
Midwest	364(63.6)	210(36.4)	574			1.73(1.37-2.19)	Small
U22							
South	214(62.7)	127(36.3)	341			1.68(1.24-2.28)	Small
Southeast	937(68.1)	440(31.9)	1377	5.223	0.156	2.13(1.82-2.48)	Medium
Northeast	146(66.9)	72(33.1)	218			2.02(1.37-2.98)	Medium
Midwest	58(60.4)	38(39.6)	96			1.52(0.68-2.70)	Small
NBB							
South	144(62.1)	88(37.9)	232			1.63(1.31-2.36)	Small
Southeast	1120(60.1)	743(39.9)	1863	10.471	0.015*	1.51(1.32-1.71)	Small
Northeast	70(47.3)	78(52.7)	148			0.90(0.57-1.41)	Very small
Midwest	104(61.9)	64(38.1)	168			1.62(1.05-2.50)	Small

X^2: Pearson's chi-square test; *p<0.05; Effect size: OR< 1.23 (Very small), OR between 1.23 e 1.85 (small), OR between 1.86 a 2.99 (medium) e OR > 2.99 (large).

The proportion of athletes' semester of birth was different between game positions in the U15, U17, and NBB categories (Table 4). In U15, the highest proportion of athletes born in the first semester was for centers (great importance). The RAE is low among point guards in all categories, while among centers the importance of the RAE decreases over time. It is very low in the U17 and NBB categories.

Table 4. Evaluation of the birth semesters of athlete's participants in national championship during 2004 and 2018: U15, U17, U22 (LDB) and NBB by **game position**.

Game position	Number (%) of athletes per semester			X^2	p	OR (95% Confidence of interval)	
	1º semester	2º semester	Total			1º semester x 2º semester	Effect size
U15							
Point Guard	339(65.5)	248(35.5)	518			1.36(1.08-1.73)	Small
Small forward	589(71.5)	235(28.5)	824			2.50(2.04-3.07)	Medium
Forward	554(70.7)	233(29.3)	797	11.103	0.025*	2.38(1.93-2.92)	Medium
Power forward	152(74.5)	52(25.5)	204			2.92(1.92-4.43)	Medium
Center	115(76.6)	35(24.4)	150			3.28(2.00-5.39)	Large
U17							
Point Guard	391(62.7)	233(37.3)	624			1.68(1.33-2.10)	Small
Small forward	718(66.3)	365(33.7)	1083			1.97(1.65-2.34)	Medium
Forward	629(61.6)	392(38.4)	1021	9.414	0.050*	1.60(1.34-1.91)	Small
Power forward	173(69.9)	75(29.1)	248			2.30(1.59-3.33)	Medium
Center	77(66.9)	38(33.1)	115			2.02(1.20-3.45)	Medium
U22							
Point Guard	238(63.1)	139(36.9)	377			1.71(1.28-2.29)	Small
Small forward	279(70.5)	75(29.5)	254			3.72(2.61-5.30)	Large
Forward	340(66.9)	168(33.1)	508	4.226	0.76	2.02(1.57-2.60)	Medium
Power forward	94(64.3)	52(35.6)	146			1.80(1.13-2.89)	Small
Center	227(67.6)	109(32.4)	336			2.08(1.52-2.84)	Medium
NBB							
Point Guard	326(63.6)	187(36.5)	513			1.74(1.36-2.23)	Small
Small forward	174(63.7)	99(36,3)	273			1.75(1.25-2.47)	Small
Forward	465(58.3)	332(41.7)	797	18.797	0.001*	1.40(1.15-1.70)	Small
Power forward	155(66.3)	79(33.7)	234			1.96(1.39-2.76)	Medium
Center	321(53.6)	274(46.4)	591			1.17(0.93-1.47)	Very small

X^2: Pearson's chi-square test; *p<0.05; Effect size: OR< 1.23 (Very small), OR between 1.23 e 1.85 (small), OR between 1.86 a 2.99 (medium) e OR > 2.99 (large).

The association between RAE and collective performance was significant only for NBB, but with little effects in practice (Table 5). The degree of importance between the semester of birth and the collective performance for the U15, U17, and U22 categories was very small. This confirms that there seems to be no association between semester of birth and collective performance.

Table 5. Evaluation of the birth semesters of athletes who were medalists or not, participants in national championship during 2004 and 2018: U15, U17, U22 (LDB) and NBB..

Semester	Number (%) of athletes Medalist			X^2	p	OR (95% Confidence of interval)	
	Yes	No	Total			Medalist x Non-Medalist	Effect size
U15							
1º semester	916(44.1)	1161(55.9)	2077	3.375	0.066	1.16(0.99-1.36)	Very Small
2º semester	363(40.5)	534(59.5)	897				
U17							
1º semester	927(41.9))	1287(5.1)	2214	2.964	0.085	1.13(0.98-1.31)	Very Small
2º semester	476(38.9)	749(61.1)	1225				
U22							
1º semester	239(17.6)	1116(82.4)	1355	0.379	0.538	1.08(0.84-1.38)	Very Small
2º semester	112(17.5)	565(83.5)	677				
NBB							
1º semester	301(20.9)	1137(79.1)	1438	11.162	0.001	1.44(1.16-1.78)	Small
2º semester	151(15.5)	822(84.5)	973				

X^2: Pearson's chi-square test; *p<0.05; Effect size: OR< 1.23 (Very small), OR between 1.23 e 1.85 (small), OR between 1.86 a 2.99 (medium) e OR > 2.99 (large).

By comparing athlete height and semester of birth, in the U15 category the athletes born in the first semester are taller than those born in the second semester. However, this relationship is reversed in the NBB: athletes born in the second semester are taller than those born in the first semester (Figure 2). From a practical point of view, the differences observed in the height of athletes born in the first and second semesters, presented a low effect size: U15 (183.3 ± 9.0 vs. 181.8 ± 9.0; *p*= 0.001; ES = 0.17), U17 (185.7 ± 10.0 vs. 185.0 ± 10.0; *p*= 0.013; ES = 0.07), U22 (193.1 ± 9.0 vs. 192.3 ± 9.0; *p*= 0.10; ES = 0.09), and NBB (195.7 ± 9.0 vs. 196.6 ± 9.0; *p*= 0.02; ES = 0.09).

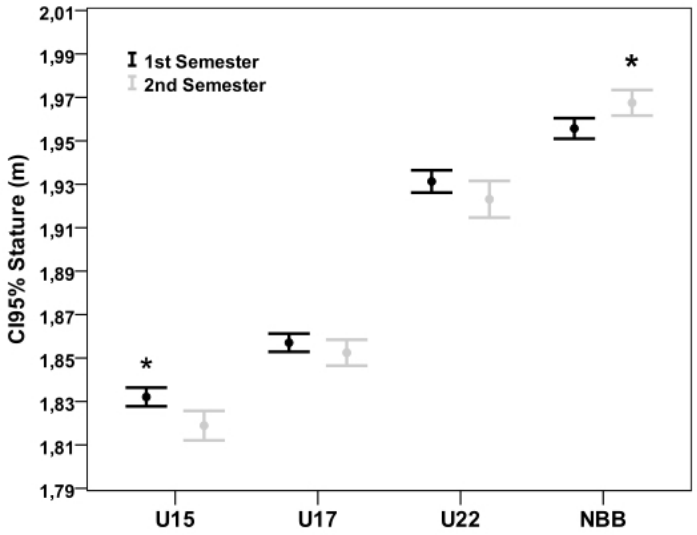

Figure 2. Comparison of the confidence interval of height on average for each category by semester of birth.

4. DISCUSSION

The aim of the present study was to retrospectively observe the RAE in Brazilian basketball during a 15-year period considering different categories, player positions, geographic regions, performance of teams, and athlete height. The results show that in all categories, the RAE affect athletes participating in the respective championships, with a predominance of those born in the first quartile.

When observing the distribution of births over the 15 years analyzed, there was a predominance of athletes born in the first semester throughout the analyzed period. Generally, older athletes (within a same age cohort) are biologically more mature compared to those who were born later. Thus, they have favorable performance characteristics specific to the sport, such as greater height, body mass, speed, strength, aerobic endurance, and power (Coelho e Silva et al., 2010; Figueiredo, Coelho-e-Silva, Cumming, & Malina, 2019; Till, Cobley, O'Hara, Cooke, & Chapman, 2014).

In upper categories the RAE also occurs, but gradually decreases. These results corroborate other authors when data are reported for a specific year cut (García et al., 2015; Oliveira et al., 2019; Ribeiro Junior et al., 2020). This suggests that the athletes' advantages arising from being born in the first months of the year decrease over the years of competitions. The numerical values in relation to the OR for U15 can be explained by a greater biological variability associated with these ages (Cumming, Lloyd, Oliver, Eisenmann, & Malina, 2017).

On the other hand, from the U17 category, even with the presence of RAE, the differences caused by this effect due to biological maturation begin to decrease due to the lower variability of biological age and greater homogeneity of the sample, that is, other valences begin to make a difference (greater competitive experience) (Malina, Bouchard, & Bar-Or, 2004). Even so, the results still show the presence of RAE in this category, in the U22 category, and in NBB over time. This may be associated with a possible natural selection process demanded by the competition itself (Cobley et al., 2009; Rubia, Lorenzo-Calvo, & Lorenzo, 2020).

In a way, not considering the RAE phenomenon can influence early abandonment and consequently an early loss of possible sports potentials during the sports training processes. Early dropout is greater in athletes born in the second half of the year. Many of these athletes are left out of the selection process at early ages (Delorme et al., 2011). This process becomes more worrying when it is perpetuated over time, as the results of the present study show.

It is important to highlight that the sample of our study comprised the best athletes from their states in the U15 and U17 categories, which are the highest-performance players in Brazil at the final stage of transition from junior to adult (U22) and professional athletes of high performance in Brazil (NBB). This qualifies our sample as a sample of previously selected athletes belonging to the highest level of youth and at the highest level of Brazilian basketball.

Thus, the scenario found in maintaining the RAE over time can and ends up being influenced by the competitive factor. According to Cobley *et al.* (2009), it is necessary to consider the competition itself as one of the explanatory factors for the RAE. Therefore, in a group of athletes considered “talented,” the very selection process to compete becomes a good reason to observe and intervene on the RAE, thus reducing losses due to this phenomenon in the long-term.

The results show the presence of RAE in all game positions and all analyzed categories. This also corroborates data on athletes of U17, U19, and U22 World Championships (García et al., 2015) and U16, U18, and U20 European Championship (Arrieta et al., 2016). However, in Brazilian basketball there are still no reports on the relationship of RAE and game position that can be compared with the present results.

As for the association between the RAE and a specific position, point guards had a small effect size in all categories, that is, in general point guards are the athletes of smaller stature compared to those in other positions. With that, the size relation with the month of birth is not decisive for this position. On the other hand, in the U15 category the centers showed an important effect on the association with birth in the first semester, ratifying once again the relationship of RAE with high statures.

The results on the association of RAE in the studied categories and geographic regions point out that the southeast and south regions have more players born in the first semester of the year in all categories. These results confirm the findings of Oliveira *et al*., (2019), Oliveira, Ribeiro Júnior, Vianna, *et al*., (2017), however, in an analysis carried out for several years. This fact occurs because these regions are more populous and economically more influential, even though the regions with the highest number of states are not (see the northeastern region with nine states and consequently a greater number of athletes participating in the U15 and U17 categories).

As Cunha *et al.* (2017) highlighted, the southeast region is the center of basketball in Brazil. It concentrates the largest number of teams in the NBB and is considered as a central region for the development of Brazilian basketball. In this way, the association observed between these regions and RAE can once again indicate the competitive process as a negative and positive influences on RAE. Therefore, coaches, federations, clubs, and sports organizations in the southeastern and southern regions should be more careful not to select athletes aiming momentary physical advantages.

The team performance was associated with RAE (semester) only in NBB. This result is somewhat contradictory (even though the association is small) compared to the results Oliveira *et al.* (2019) found. The authors reported that there was no RAE, either for medalists or non-medalists in the 2015 NBB.

Sáenz-López, Ibáñez, Giménez, Sierra, and Sánchez (2005) observed that Spanish players from cadets and junior national teams were in general not part of adult teams, considering that the collective performance at younger ages leads to greater possibilities of selections or drafts to national teams. The results found in this study do not support that RAE alone influences this process.

Oliveira, Ribeiro Júnior, Vianna, *et al.* (2017) and Oliveira, Ribeiro Júnior, Werneck *et al.* (2017) reported RAE in all classifications that indicated collective performance in U15 and U17 in 2015. However, they did not observe associations of team performance with RAE. In the present study, there was no association between the semester of birth and team performance. There does not seem to be a direct association between RAE and team performance. This suggests new studies that may consider the association of RAE and individual performance.

The relationship between RAE and stature is highlighted in Figure 2. There are athletes of the U15 category born in the first semester higher than those born in the second semester; there are also athletes of the second semester of the NBB higher than those born in the first semester.

Therefore, it is possible to state that for the U15 category the tallest athletes suffer the greatest interference from RAE, that is, the tallest athletes born in the first semester participated the most in U15 championships. Thus, athletes who had a

late growth may not have the opportunity to develop their skills either by not playing or by participating less in national level championships (Penna, Ferreira, Costa, Santos, & Moraes, 2012; Ribeiro Junior et al., 2020).

However, the results of the present study show that in the NBB the RAE is reversed, that is, the predominance of those born in the second semester are of taller athletes. Ribeiro Junior *et al.* (2020) reported no differences between tall and normal-height athletes in the U18 category. This can suggest that the tallest athletes in the youth categories born in the first semester present this characteristic because they are biologically more advanced, and because over time they stop being the tallest and remain in the training process; or late maturation athletes are not selected at such early stages of competition and take a different path until they reach the top level. The data confirm the observation of Ramos *et al.* (2019) according to which in youth categories there is a trend in the selection of young basketball players related to their high stature.

The results show height as a determining factor in athletes born in the first semester for the U15 category; in youth categories, body size makes a difference in performance (Delorme & Raspaud, 2009; Furley & Memmert, 2016; Ramos et al., 2019). Coelho and Silva *et al.* (2010) found results consistent with those of the present study for the U14 category. They noted that the maturation stage of youth basketball players (aged 12.0 to 13.9 years) explained a significant portion of variation in body size. In a way, according to the findings of Sáenz-López *et al.* (2005), this trend of valuing anthropometric results is not the opinion of 26 coaches, who listed the context (environment) and psychological, technical, and tactical aspects as determinants to achieve sporting excellence in basketball.

To obtain more information to confirm the suggestions above, it is necessary to conduct further studies analyzing the relationship of RAE, biological maturation, and career progression in a longitudinal way, and not just in a descriptive cross-section. It is also necessary to consider longitudinally possible influencing and explanatory factors for the relationship of RAE and career progression, such as the number of categories disputed until reaching professionalism, the path within regions and states until reaching the high level, if the athlete evolved in game positions, and athlete competitive performance.

The RAE is present in all geographic regions and in all game positions. It is more evident in youth categories of the southeastern and southern regions and in athletes who act as centers in the U15 category. In addition, in the U15 category the tallest athletes are usually those born in the first semester, while in the NBB the tallest athletes are born in the second semester. This means that the month of birth is a determining factor in the selection of athletes for the main basketball competitions in Brazil. These statements claim that the selection process of youth Brazilian basketball players over the years is predominant for obtaining immediate results and not for the development of youth talents.

This study does not present data referring to the individual performance of athletes in national junior competitions in years prior to 2004, nor does it provide more detailed information on the sports trajectory of each athlete. However, the results indicate that in the coaches' decision-making regarding the selection of sports potentials, the RAE deserves special attention, especially when associated with biological maturation aspects, thus avoiding overestimating and/or underestimating potential sports talents for Brazilian basketball.

5. CONCLUSION

In conclusion, the results showed that there was RAE in Brazilian basketball from the U15 category up to the NBB during the years 2004 to 2018. The RAE differs in geographical regions, especially in categories U15 and U17, with a predominance of southeast region. The centers present important differences with the RAE in U15. There does not appear to be an association between birth semester and collective performance. In the U15 category, athletes born in the first semester ate higher tan those born in the second semester, however, this relationship is reversed in the NBB. Therefore, understanding and improving the intervention of Brazilian basketball coaches and managers based on the selection, progression, and career development processes are crucial in search for better decision-making that influences the resources invested in/for the future of Brazilian basketball.

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