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Original Article

WHAT REALLY MATTERS TO REACH THE HIGHEST LEVEL: AN APPROACH TOTHE RELATIVE AGE EFFECTS ON BRAZILIAN BASKETBALL PLAYERS

O QUE REALMENTE IMPORTA PARA CHEGAR AO ALTO NÍVEL: UMA ABORDAGEM DO EFEITO DA IDADE RELATIVA NO BASQUETEBOL BRASILEIRO

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ABSTRACT
The relative age effect (RAE) is a phenomenon that provides participation and performance advantages to athletes born in the first months of the year compared to other athletes within the same age category. The aim of the study was to investigate the effects of relative age in the in the major leagues of Brazilian basketball: *Liga de Desevolvimento do Basquete* (LDB), *Liga de Basquetebol Feminino* (LBF) and the *Novo Basquete Brasil* (NBB) considering the geographic region, the final classification of the teams, and the career period. The sample consisted of 831 athletes from the main leagues of Brazilian basketball during the 2014-2015 season. Information for the survey was obtained from the Brazilian Basketball Confederation website (www.cbb.com.br) and the National Basketball League website (www.lnb.com.br). The RAE was found in the Southeast and South LDB teams and in the Southeast NBB teams, and was not related to the teams' final classification. In addition, the RAE was reversed in the career consolidation phases of NBB athletes. We conclude that the RAE is present in LDB and NBB basketball players. An inverse RAE is observed in athletes aged 25-34 years, and there is an absence of this phenomenon in athletes who are at the final phase of their career.
Keywords Relative age effect. Sports performance. Basketball. Athletes.

RESUMO
O efeito da idade relativa (EIR) refere-se a um fenômeno que proporciona vantagens de participação e desempenho aos atletas nascidos nos primeiros meses do ano, em relação aos demais atletas dentro de uma mesma categoria etária. O objetivo do estudo foi investigar o efeito da idade relativa na Liga de Desenvolvimento do Basquete (LDB), Liga de Basquete Feminino (LBF) e Novo Basquete Brasil (NBB), considerando a região geográfica, a classificação final das equipes e o período da carreira. A amostra foi constituída por 831 atletas das principais ligas do basquetebol brasileiro, temporada 2014-2015. As informações para a pesquisa foram obtidas através do site da Confederação Brasileira de Basketball (www.cbb.com.br) e do site da Liga Nacional de Basquete (www.lnb.com.br). O EIR foi encontrado nas equipes das regiões Sudeste e Sul da LDB, nas equipes do Sudeste do NBB e não apresentou relação com a classificação final das equipes. Além disso, o EIR mostrou-se invertido nas fases de consolidação da carreira nos atletas do NBB. Conclui-se que o EIR está presente nos basquetebolistas da LDB e NBB, sendo observado um EIR inverso nos atletas de 25 a 34 anos e ausência deste fenômeno naqueles que se encontram na fase final da carreira.
Palavras-chave Efeito da idade relativa. Desempenho esportivo. Basquetebol. Atletas.

Introduction

Identifying, selecting and training young athletes aiming a high performance has been the aim of high investments in several sports.[1-3] Therefore, analyzing and understanding variables that determine success in sports can significantly contribute to a better training process and a more assertive selection, maximizing the investment of time and resources.[4] In the sports context, a widely studied variable has been relative age, defined as the difference in the chronological age of athletes competing in a same age category.[5]

When the distribution of the date of birth 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, there is a phenomenon known as the relative age effect (RAE), which is associated with participation and performance advantages for chronologically older athletes over younger athletes within the a same age category.[5,6] The RAE is mainly observed in

sports modalities in which performance is related to strength, power and body size. It is more frequent in young athletes and in teams of a higher competitive level.[7]

Despite the higher prevalence of RAE in young athletes, some studies have investigated this phenomenon in adult basketball. Werneck et al.[8] analyzed this effect on players of the London 2012 Olympic Games and found a RAE only in the French men's team. Esteva et al.[9] investigated RAE in Spain's top adult basketball divisions and in the United States Major League (NBA, *National Basketball Association*) and found a RAE only in Spain's three most prevalent professional divisions in the top division teams. In addition, the RAE was found in Germany's[10] and Japan's[11] male adult basketball, and in Israel's main women's league.[12]

In Brazilian basketball, so far, there is evidence of the presence of RAE in both the base categories[13,14] and the adult category[15,16]. At the base category, the results were associated with males, with the Southeast, Midwest and North regions in the upper divisions, and with the best ranked teams[13,14]. In adult male professional basketball, a RAE was found in New Brazilian Basketball (NBB)[15] in the 2010/2011 season, and was not found in Women's Basketball League (LBF).[16] However, some intervening factors in the RAE, such as gender, geographical region and team performance, have not yet been analyzed in the adult categories of Brazilian basketball.

In addition, some researches[17-19] reported that the athlete's career period in adult categories is an important variable to consider. Schorer et al.[17] demonstrated that, in advanced periods of the career of national level athletes, the RAE becomes inverted, that is, the highest concentration of athletes happens to be those born in the last months of the selection year. The inverted RAE was also reported by Ford and Williams[18] for award-winning professional soccer, baseball and ice hockey athletes. Other studies also found a higher proportion of the number of adult athletes born in the final months of the year of selection[19-22].

Given this context, the RAE needs to be better investigated as for adult categories of Brazilian basketball. Thus, the aim of the study is to investigate the RAE in the top three basketball league: *Novo Basquete Brasil* (NBB), *Liga de Basquete Feminino* (LBF) and *Liga de Desenvolvimento de Basquete* (LDB) considering the geographic region, the final classification of the teams, and the career period. It should be noted that the NBB were disputed by adults male athletes and the LBF by female adults athletes. In turn, LDB was disputed by men under 22 years old.

Methods

The sample consisted of 821 basketball athletes. Participants were 127 female athletes (24.3 ± 6.0 years; 1.78 ± 0.09 m; 72.9 ± 12.0 kg) enrolled in the LBF in the 2014/2015 season; 293 athletes (24.8 ± 5.7 years; 1.96 ± 0.09 m; 94.6 ± 13.6 kg) enrolled in the NBB in the 2014/2015 season; and 401 athletes (19.4 ± 1.8 years; 1.93 ± 0.09 m, 88.1 ± 13.8 kg) enrolled in the LDB. The survey was performed in 2015 with male athletes with an age limit of 22 years.

For the analysis of the RAE by geographic region, the location of the team in which the athlete participated in the competition was considered. In turn, for the analysis of the RAE in the final classification of the teams, we considered the specificity of the dispute formats of each competition: in the referred LBF season, ten teams played in the first round, in which all teams played against each other twice. Subsequently, the top eight teams advanced to the quarterfinals. The 7th edition of the NBB was played by 16 teams, with games between all participants in two rounds. At the end of the qualifying phase, the top four teams qualified directly for the quarterfinals. The teams that qualified from 5th to 12th place played a qualifying round of the quarterfinals in a play-off format. The 2015 LDB was played by 23

teams and the Brazilian under-17 team (U17). All played in a single round, and the top eight teams progressed to the second round. Subsequently, the teams were divided into two groups and the top two teams in each group advanced to the semifinals and the finals. It is noteworthy that the Brazilian under-17 team ranked 18th in the first round, and had its athletes excluded from the sample because they characterized a RAE from another category.

The information from the LBF athletes was obtained from the Brazilian Basketball Confederation (CBB) website (http://www.cbb.com.br) and the NBB and LDB information was obtained from the National Basketball League (LNB) website (http://www.lnb.com.br). The use of publicly available Internet data for RAE analysis has been described in other studies without the need for an ethics committee research approval[5,8,23].

To analyze the data, the month of birth of each player was categorized into quartiles. The 1st quartile (Q1) consisted of athletes born between January 1 and March 31; the 2nd quartile (Q2) consisted of athletes born between April 1 and June 30; the 3rd quartile (Q3) consisted of athletes born between July 1 and September 30; and the 4th quartile (Q4) consisted of athletes born between October 1 and December 31. In addition, to analyze the RAE at different career periods in the NBB, the following steps were taken: developmental period (up to 24 years old), consolidation period (between 25 and 35 years old), and final period (over 35 years old).

To investigate the presence of RAE, the Chi-square test (X^2) or Fisher's exact test were used whenever appropriate, and the odds ratio (OR), at a 95% confidence interval (CI), was calculated. The OR compared the distribution of the first three quartiles of birth dates (Q1, Q2, and Q3) with the last quartile (Q4), according to the recommendations of Cobley et al.[7] All statistical tests were performed using the software SPSS, version 23.0 (IBM Corp., Armonk, NY) at a significance level of 5%.

Results

The results regarding the distribution of the birth quartiles of athletes enrolled in each of the competitions analyzed are presented in Table 1. There is a higher representation of athletes born in the first quartiles in the male NBB (X^2= 16.41; p <0.001) and LDB competitions (X^2= 60.55; p <0.001), with a higher proportion ratio for athletes born in the first and second quartiles of DL (OR_{Q1}= 2.66; OR_{Q2}= 2.07).

Table 1. Evaluation of the birth quartiles of the national (NBB and LBF) and male U22 (LDB) national championship athletes

Competition	N	Number (%) of athletes per quartile				X^2	p	OR (95% confidence interval)		
		Q1(%)	Q2(%)	Q3(%)	Q4(%)			Q1xQ4	Q2xQ4	Q3xQ4
LBF	127	43(33.9)	33(26.0)	22(17.3)	29(22.8)	7.27	0.064	1.48(0.75-2.93)	1.14(0.56-2.29)	0.76(0.66-1.59)
NBB	292	95(32.5)	81(27.7)	68(23.3)	48(16.5)	16.41	0.001*	1.98(1.23-3.18)	1.68(1.04-2.73)	1.41(0.87-2.31)
LDB	401	154(38.4)	120(29.9)	69(17.2)	58(14.5)	60.55	<0.001*	2.66(1.76-4.00)	2.07(1.36-3.14)	1.74(1.16-2.61)

Source: Prepared by the authors

Table 2 shows that the distribution of athletes' quartiles by region has the highest representation in the Southeast region in the NBB (X^2 = 13.78; p = 0.003) and LDB (X^2 = 54, 78; p <0.001) and in the Southern region in the LDB (X^2 = 54.78; p <0.001).

Table 2. Evaluation of the birth quartiles of the national (NBB and LBF) and male U22 (LDB) national championship athletes per team's geographical region

Region	Number (%) of athletes per quartile					X^2	p	OR (95% confidence interval)		
	Q1(%)	Q2(%)	Q3(%)	Q4(%)	Total			Q1xQ4	Q2xQ4	Q3xQ4
LBF										
South	2(20)	4(40)	0(0)	4(40)	10	0.80	0.670	0.50(0.04-5.74)	1.00(0.11-9.34)	0(N/A)
Southeast	20(33.3)	18(23.2)	14(15.4)	14(23.1)	66	1.63	0.651	1.43(0.54-3.75)	1.29(0.48-3.41)	1.00(0.37-2.74)
Northeast	15(38.5)	9(23.1)	6(15.3)	9(23.1)	39	4.39	0.223	1.66(0.50-5.61)	1.00(0.28-3.60)	0.67(0.17-2.60)
Center-West	6(50.0)	2(16.7)	2(16.7)	2(16.7)	12	4.00	0.261	3(0.31-28.80)	1.00(0.08-12.56)	1.00(0.08-12.56)
NBB										
Southeast	82(31.8)	74(28.7)	59(22.9)	43(16.7)	258	13.78	0.003*	1.90(1.15-3.16)	1.72(1.03-2.87)	1.37(0.81-2.31)
Northeast	9(50.0)	2(11.1)	4(22.2)	3(16.7)	18	6.44	0.092	3.00(0.47-19.03)	0.67(0.07-6.11)	1.33(0.18-9.73)
Center-West	4(25.0)	5(31.3)	5(31.3)	2(12.5)	16	1.50	0.682	2(0.22-17.89)	2.50(0.29-21.40)	2.50(0.29-21.40)
LDB										
South	28(32.2)	29(33.3)	18(20.7)	12(13.8)	87	9.23	<0.001*	2.33(0.95-5.74)	2.42(0.98-5.93)	1.5(0.58-3.84)
Southeast	103(42.7)	70(29.0)	34(14.1)	34(14.1)	241	54.78	<0.001*	3.02(1.79-5.13)	2.06(1.20-3.55)	1.00(0.55-1.81)
Northeast	16(28.1)	19(33.3)	16(28.1)	6(10.5)	57	6.78	0.079	2.67(0.81-8.78)	3.17(0.98-10.26)	2.67(0.81-8.78)
Center-West	7(43.8)	2(12.5)	1(6.3)	6(37.5)	16	6.50	0.090	1.17(0.20-6.80)	0.33(0.04-2.77)	0.17(0.01-2.09)

Source: Prepared by the authors

The results presented in Table 3 showed that the distribution of athletes in their respective quartiles of birth did not interfere with the final classification of the team in the competitions analyzed.

Table 3. Evaluation of the birth quartiles of the national (NBB and LBF) and male U22 (LDB) national championship athletes per team's classification in the championship

Classification	Number (%) of athletes per quartile					X^2	p	OR (95% confidence interval)		
	Q1(%)	Q2(%)	Q3(%)	Q4(%)	Total			Q1xQ4	Q2xQ4	Q3xQ4
LBF										
Top 3	16(37.2)	6(14.0)	13(30.2)	8(18.6)	43	5.84	0.120	2.00(0.60-6.67)	0.75(1.19-2.91)	1.63(0.48-5.61)
4th to 7th	16(34.8)	15(32.6)	6(13.0)	9(19.6)	46	6.00	0.112	1.78(0.56-5.47)	1.67(0.52-5.33)	0.67(1.79-2.49)
7th to 10th	11(28.9)	12(31.6)	3(7.9)	12(31.6)	38	6.00	0.112	0.92(0.27-3.10)	1.00(0.30-3.33)	0.25(0.05-1.18)
NBB										
Top 4	23(31.5)	23(31.5)	16(21.9)	11(15.1)	73	5.63	0.131	2.09(0.79-5.50)	2.09(0.79-5.50)	1.45(0.53-3.97)
5th to 12th	49(31.6)	43(27.7)	35(22.6)	28(18.1)	155	6.52	0.089	1.75(0.92-3.33)	1.54(0.80-2.95)	1.25(0.64-2.44)
13th to 16th	23(35.9)	15(23.4)	17(26.6)	9(14.1)	64	6.25	0.100	2.56(0.90-7.20)	1.67(0.57-4.90)	1.89(0.65-5.48)
LDB										
Top 8	56(38.9)	38(26.3)	24(16.7)	26(18.1)	144	18.00	<0.001*	2.15(1.12-4.15)	1.46(0.74-2.88)	0.92(0.45-1.90)
9th to 16th	51(37.5)	39(28.7)	30(22.0)	16(11.8)	136	19.24	<0.001*	3.18(1.53-6.65)	2.44(1.15-5.17)	1.88(0.87-4.05)
17th to 23rd	47(38.8)	43(35.5)	15(12.5)	16(13.2)	121	29.05	<0.001*	2.94(1.38-6.27)	2.69(1.25-5.77)	0.94(0.39-2.23)

Source: Prepared by the authors

Figure 1 and Table 4 show the birth quartiles of NBB athletes divided by career period. The presence of the RAE in the athletes between 17 and 24 years old (X^2= 26.31; p <0.001) and an inverse RAE in the 25 to 34 years-old athletes (X^2= 10.08; p <0.018) was observed. In this case, there was a greater representation of athletes born in the third quartile. In athletes who are at the final phase of the career (≥35 years), the RAE was not observed (X^2= 1.38; p = 0.709).

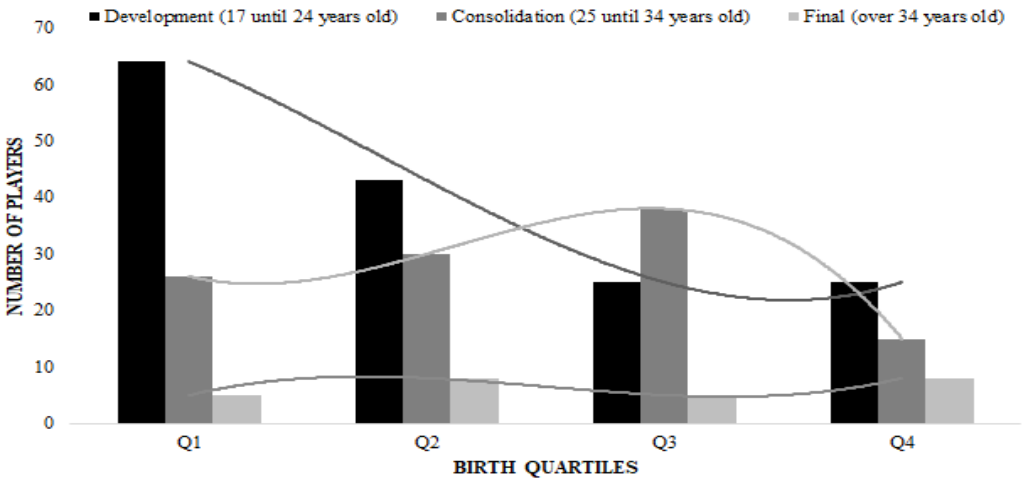

Figure 1. Distribution of the number of NBB athletes per quartile divided by career period
Source: Prepared by the authors

Table 4. Assessment of birth quartiles of NBB athletes categorized by career period

Division	Number (%) of athletes per quartile					X^2	p	OR (95% confidence interval)		
	Q1(%)	Q2(%)	Q3(%)	Q4(%)	Total			Q1xQ4	Q2xQ4	Q3xQ4
NBB										
Development period	64(40.8)	43(27.4)	25(15.9)	25(15.9)	157	26.312	<0.001*	2.56(1.35-4.85)	1.70(0.89-3.34)	1.00(0.49-2.03)
Consolidation period	26(23.9)	30(27.5)	38(34.9)	15(13.8)	109	10.08	0.018*	1.67(0.73-3.82)	2.0(0.88-4.52)	2.53(1.14-5.64)
Period final	5(19.2)	8(30.8)	5(19.2)	8(30.8)	26	1.38	0.709	0.63(0.13-2.97)	1.00(0.23-4.32)	0.63(0.13-2.97)

Source: Prepared by the authors

Discussion

The aim of the present study was to identify and analyze the RAE in athletes participating in the main basketball competitions in Brazil in the U22 and adult categories. The presence of RAE was verified in the Southeast and South LDB teams and in the Southeast NBB teams. The RAE was also associated with the athletes' career period since a greater representation of the athletes was identified in the first months of the career development period. However, this trend changes at the career consolidation phase and disappears in the athletes older than 35 years.

The results presented in the different basketball leagues analyzed confirm that the RAE is higher in males and extends to the adult categories of Brazilian basketball according to studies conducted in different countries[10,24]. However, it is noteworthy that in the Brazilian Base Championships in 2015, there was RAE only in the U17[13] category for females, while the RAE was found in all categories of males[13,14]. The cause of a higher RAE in male players has been related to the imbalance in the number of practitioners, clubs and popularity of basketball in the different genders[12,24]. This is confirmed in the Brazilian basketball by the absence of an intermediary championship between the U17 and the adult category for women in the years of the national research.

Although the results of the present study indicate the existence of RAE only in the championships with male athletes, the values found for female basketball seem similar as the values reported for international female basketball. In a meta-analysis of the RAE in women's sports, which considered 22 different basketball samples, Smith et al.[25] found an OR between the first and last quartile of 1.36 for basketball athletes, while in the present study, we found a value of 1.48 in the LBF.

Regarding the RAE and the geographic region, the results showed that the club's federative state influences the effect, since the existence of the effect in the Southeast and South regions in LDB, as well as in the Southeast region in NBB, were evidenced. Even with the different format of the competition in the Brazilian base championships, in which the selection of athletes happens by state federations and not by clubs as in the LDB and NBB, a RAE was also found in the Southeast region in the U15[14] category. Thus, the results of the present study in relation to the geographical region require a greater caution. However, it should be noted that even for different purposes, other studies have found an association between the date of birth, the athlete's place of birth and the location of the training club for athletes to reach the adult category or show expressive results in a sports career. Thus, Tozetto et al.[26] found a higher concentration of male athletes born in the Southeast region who play team sports by analyzing the characteristics of Brazilian Olympic athletes who won medals in the last five Summer Olympics. Darido da Cunha et al.[27] identified three clubs as top basketball player trainers, all from the Southeast region, and a lack of variety of NBB athlete-training states.

Regarding the final classification of the teams, the present study did not find any relation in the RAE, contrary to what was reported for the basic categories of Brazilian basketball[13,14]. In this regard, studies indicate that the greater representation of athletes born in the first months of the selection process may be associated with a more advanced maturity state, which provides them, among others, with physical advantages[28,29], which also ends up resulting in the abandonment of athletes born in the last months of the year[28]. These advantages and the greater representation of players born in the first months of the year are more evident in the younger categories, in which athletes have a greater biological and maturity variability. However, in older categories, such as the adult category[9], the effects of maturation cease to exist, making the RAE less evident. This in part may have affected the outcome of the present study. We found no association between the final team classification and the RAE in older categories.

Regarding the RAE found, the findings show a greater representation of athletes born in the first months of the LDB selection years and of players at the development phase of the NBB according to other studies in international basketball[9,28,30]. Therefore, it can be inferred that older athletes are momentarily favored in the selection process. Thus, a great care is recommended in the selection of young basketball players by coaches and managers in order to reduce the inequality associated with temporary maturity aspects, even though the results of research on athletic success and date of birth are insufficient[31] and do not always show physical or physiological advantages, especially during the transition to adulthood[32].

Contrary to the RAE in the categories of training and at the development phase of the athletes in the adult category, the present study found an inverted RAE at the phase of career consolidation in the main adult basketball category in the country. An inverted RAE has been reported for other sports and associated with high levels of success[18,20] and the final years of professional career[19]. This fact evidences the difference of the determining characteristics for the selection process in the base and in the adult categories. At the base category and at the period of development in the adult category, biological aspects related to maturation are probably valued. At the consolidation phase of the career of the adult basketball player in Brazil, the valued aspects are different (e.g., psychological, career, tactical ability etc.) as the physiological and anthropometric capacities become more homogeneous[18]. In this sense, Zuber et al.[33] stated that athletes at a late maturation are often superior technically and psychologically compared to their peers with an early biological maturation. However, they are usually not part of state and national teams.

The cause for this inverted effect has been mainly associated with two factors: the first refers to the permanence of athletes who have been able to compensate for the initial physical

disadvantages associated with the RAE by using other skills[19,22]. Based on this, Schorer et al.[17] showed that younger handball athletes presented better technical results compared to their older peers. In addition, the development of psychological skills related to overcoming adverse contexts during the training period may develop skills such as resilience and coping[22,34,35]. The second aspect to explain the inverse RAE is related to the interference of the context in the formation of the player, and considers aspects related to the moment and the place of the beginning of the sport practice[23,36]. Regarding this aspect applied to the reality of the present study, Darido da Cunha et al.[27] identified that the average age of onset of 86 Brazilian athletes who played in the NBB was 11.19 years, and 91% of them started practicing in clubs. Although by using this information it is not possible to establish relations with the findings of the present study, it may be an indicative for future researches in different contexts.

In the Brazilian context specifically, the results of the present study allow us to infer that the process of player selection in LDB and NBB has been influenced by biological and chronological age. It is marked up to 24 years of age, with a higher proportion of those born in the first months of the year, changing the ratio during the last months of the year for basketball players aged 25-34. This may be associated with a favoring of the most physically developed athletes in the early years of player selection. The consequences of this process remain until the developmental stage in the adult career[33].

However, at the consolidation phase, the RAE is reversed and a higher proportion of athletes in the 3rd quartile in the career consolidation phase in the NBB, as already mentioned, may be associated with a compensatory effect for the technical, tactical and psychological abilities that were not developed in athletes born in the first months of the year. This indicates that many athletes who reach the stage of career development have deficiencies that do not allow them to remain at the highest level in their adult career. These findings corroborate the study by Subijana and Lorenzo[37] on the Spanish male professional basketball. The authors identified the existence of more than twice the number of athletes in the last upper quartile compared to the number of junior athletes.

Upon finding the RAE in LDB and NBB, there is a relationship between the player selection process and chronological age in the older categories of Brazilian basketball. This scenario indicates, to some extent, a need for a greater care with the selection process of Brazilian basketball players in order to avoid losing, throughout the selection process, athletes who in the future will have more ability to perform and remain in the main league of Brazilian basketball. Thus, the greater awareness of coaches, federations and confederations about RAE could minimize the RAE found in all male categories[13,14] and the consequences of this effect affecting player selection up to LDB and NBB. In order to decrease the RAE, Andronikos et al.[38] and Collins and MacNamara[39] suggest the implementation of challenges and structured tasks through documents created by federations and confederations in order to test and improve each of the game's skills to promote the development of long-term athletes' skills.

As suggestions for future studies and in order to understand aspects still little explained about the RAE in Brazilian basketball, we suggest further studies relating this phenomenon to game statistics (e.g., court time, attempted and converted points, rebounds etc.) considering anthropometric, maturity, technical and tactical performance variables. Another indication concerns the identification of the RAE in the national base category selections, as well as longitudinal studies on RAE.

Conclusions

The RAE is present in LDB and NBB basketball players. It is associated with male teams from the Southeast region. However, the RAE is not evidenced in women's basketball (LBF) nor

was it associated with team classification, as it happened in base categories. As the main finding, there is an inverse RAE in athletes from 25 to 34 years old. There is an absence of this phenomenon in athletes who are at the final phase of their sports career. Thus, this study shows that basketball players who reach and remain at the highest level are those who, to some extent, overcome the selection process that favors physical aspects of early years. These results may contribute to a better understanding of the RAE in Brazilian basketball, as it makes clear the need to consider this phenomenon in the selection process of Brazilian basketball players in all male categories.

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