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Sports Training

Relative Age Effect in Brazilian water polo: analysis of male and female athletes from U16 to senior categories

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Abstract - Aim: To investigate the existence of relative age effect (RAE) in Brazilian water polo athletes according to sex and age category. **Methods:** The birthdate of 574 Brazilian water polo athletes were organized according to the athletes' birthdates into quarters of the year (Q1, Q2, Q3, and Q4), and classified according to sex (male and female) and age category (U16, U18, U20, and senior). To verify the existence of RAE, the Chi-Square tests (χ^2) were performed, and the effect sizes (ω) were calculated for each of the tests. We also calculated odds ratio (ORs) and 95% confidence intervals, setting the level of significance to 0.05. As post hoc analysis, multiple comparisons between quarters were performed, with Bonferroni's correction (significance level set to 0.0083 in these cases). **Results:** The results indicated an uneven distribution of birthdates for male water polo athletes (χ^2 = 12.257; p = 0.007; ω = 0.173), with an over-representation of athletes born in the first (p < 0.006) and second (p < 0.002) quarters. When sex and age category were considered, male athletes presented uneven distributions in U20 (χ^2 = 10.747; p = 0.013; ω = 0.345) and senior (χ^2 = 12.614; p = 0.006; ω = 0.383) categories. In females, no differences were found. **Conclusion:** We conclude that there is an uneven distribution of birthdates in male Brazilian water polo athletes, indicating the presence of RAE in this group.

Keywords: aquatic sports, team sports, birth-date, birth effect, talent selection.

Introduction

Water polo is characterized by a dispute between two teams in a common field where the main purpose is to score and simultaneously defend your goal[1]. Like other intermittent invasion sports, physical contact and the need for quick actions are constant. These water polo features require strength, power, and speed[2], physical qualities important for sports performance and directly related to personal growth and maturation[3,4]. Additionally, for satisfactory performance in water polo, the development of specific skills and physical conditioning is necessary, and for that, training time is needed[5].

In most competitive national teams, such as Serbia, for example, initiation in water polo occurs from 12-years-old onwards, thus, in the long-term training process, the effects of maturation must be carefully observed[6]. These factors (maturational status and training time) can result in advantages for relatively older players[7] and athletes born closer to the selection cut-off date may be over-represented in high-performance sports teams, which is an extensively researched phenomenon: the relative age effect (RAE)[8].

The scientific production involving RAE in sports has been increasing over the last few years[9]. The constraints-based model[10] proposes that RAE existence and/or dimension in the sports context is a consequence of the interaction of individual, environment, and task constraints. Regarding the individual's factors, the phase of the sports career seems to be a factor related to the existence of the RAE, since the magnitude of this effect tends to decrease as chronological age advances[11,12]. Bezuglov et al.[13] showed that elite Russian soccer athletes from senior teams exhibited a less pronounced RAE compared to youth teams. Joyner et al.[14] suggest that the advantage generated during the selection and identification phases seems to disappear over time and may even be reversed in the transition to the elite sport. Indeed, the reduction of RAE as chronological age advances has been observed for several team sports in their respective countries[12,13]. Since the criteria for identifying talents and for the progressive development of the athlete may depend on the national or local culture and/or sports philosophy[15], it is important to assess whether this relationship between age category and prevalence of RAE also occurs with sports of lesser popularity, as is the case of water polo in Brazil.

A possible difference in the magnitude of RAE between men and women has also been the subject of debate in studies involving invasion team sports[16,17]. In a study with Portuguese soccer and futsal athletes, the presence of the RAE for men was identified in all age categories of football and two categories for futsal, but only in one category for women in both modalities[12]. In a study with Brazilian national handball teams, Figueiredo et al.[18] also found that the magnitude of the RAE can be influenced by sex. On the other hand, a study analyzing youth, junior, and senior male and female Norwegian national team handball players did not identify differences in the prevalence of RAE between sexes[19]. Similarly, a study with male and female handball players in the U19, U21, and senior categories of the World Handball Championships revealed a similar prevalence of the RAE for male and female athletes[11]. These contradictory results indicate that possible differences in RAE prevalence between men and women should be further investigated in invasion team sports.

Even though RAE is a widespread phenomenon in different individual[20,21] and invasion team sports[22-27], investigations in water sports focus on swimming[28-30], being scarce in water polo[31-33]. In addition to that, the results from studies that investigated RAE in water polo are inconsistent. Barrenetxea-Garcia et al.[31] analyzed male and female participants in 2011, 2013, and 2015 World Championships and did not find RAE for this sample. Similarly, Lidor et al.[33] found that RAE was not prevalent in a sample of young male and female Israeli athletes (14-18 years). On the other hand, Lupo et al.[32] demonstrated the presence of RAE at all early stages but not in the late phase subgroups of the senior career of male water polo elite athletes.

Although these findings are important to understanding the phenomenon of RAE in water polo, none of these studies sought to compare the prevalence of RAE between different categories, leaving a gap in knowledge regarding the possible reduction of RAE with advancing of chronological age in male and female water polo athletes. Therefore, this study aims to investigate the existence of RAE in Brazilian water polo athletes according to sex (male and female) and age category (U16 to senior). We hypothesize that RAE will be more prevalent in male than in female athletes and that this effect will be present throughout the age categories investigated, based on the theoretical model proposed by Wattie et al.[10].

Methods

Participants

The sample of this retrospective and descriptive study with a cross-sectional design was composed of 574 Brazilian water polo athletes, organized according to sex and age category. Categories analyzed were: U16 (n = 192; male: n = 140, mean age = 15.2 ± 0.87 years; and female: n = 52, mean age = 14.83 ± 1.2 years); U18 (n = 134; male: n = 94, mean age = 17.56 ± 0.49 years; and female: n = 40, mean age = 17.70 ± 0.46 years); U20 (n = 117; male: n = 88, mean age = 19.32 ± 0.47 years; and female: n = 29, mean age = 19.41 ± 0.50 years); and senior (n = 131; male: n = 86, mean age = 27.19 ± 5.57 years; and female: n = 45, mean age = 25.51 ± 4.43 years). These categories were divided according to the proposal of the Brazilian Water Polo League (PAB) and the division from U16 to senior was chosen because these are the age categories of Brazilian Confederation of Water Polo (CBDA) official competitions in Brazil. Athletes participated only in their respective categories. All athletes are federated by CBDA and participated in one or more of the following competitions: Brazilian Interclub Championship (U16 to U20), Brazil Open (senior), and Brazil Cup (senior). The exclusion criteria adopted was not getting the necessary information with the CBDA and PAB official websites, federations, and/or teams. After the exclusion of the athletes with missing data we were able to analyze the following percentages from the total of athletes federated in CBDA for each of the age categories: U16 (male: 90.32%; and female: 88.14%); U18 (male: 92.16%; and female: 90.9%); U20 (male: 82.24%; and female: 65.9%); and senior (male: 94.5%; and female: 95.74%).

Data collection and procedures

This study applied similar methods to previous studies in water polo[31,32]. Data were obtained from the CBDA (https://novo.cbda.org.br/) and PAB (https://ligapab.com.br/) official websites or made available by the federations and/or teams upon request made by the researchers. All data collection procedures occurred during August and September 2021. The information included players' sex, date of birth, age categories, and teams. All information was kept confidential and was used specifically for this study, after athletes' anonymity and the teams' agreement.

For this study, we defined the birth year as beginning on 1 January, as used by the others studies in sports[32,34]. The data were tabulated in a spreadsheet, and the variables analyzed included the quarters of the year the athletes were born: Q1 = first quarter (1 January at 31 March), Q2 = second quarter (1 April at 30 June), Q3 = third quarter (1 July at 30 September), and Q4 = fourth quarter (1 October at 31 December), and were split according to sex (male and female) and age category (U16, U18, U20, and senior).

Statistical analysis

Athletes' birthdates were presented in absolute frequency. The distribution of athletes born in each quarter was compared to expected distributions, performing Chi-Square (χ^2) goodness-of-fit tests. Expected distributions were determined considering the number of days within each of the quarters of the year[35]. Effect sizes (ω) were calculated according to Cobley et al.[34] for each of the Chi-square tests, considering 0.1 a small effect, 0.3 a medium effect, and 0.5 a large effect size[36]. We also calculated the odds ratio (ORs) and 95% confidence interval for the quarter and half year's distribution according to sex and age categories. The level of significance level was set to 0.05. Analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0 (Chicago, USA). As post hoc analysis, multiple comparisons between quarters were performed, with Bonferroni's correction. In these cases, the significance level was adjusted to 0.0083.

Results

The overall analysis of Brazilian water polo athletes indicated differences according to sex (Figure 1). An uneven distribution of birthdates was found for male water polo athletes (χ^2 = 12.257; p = 0.007; ω = 0.173), with athletes born in the first (p < 0.006) and second (p < 0.002) quarters being more frequent than athletes born in the last quarter of the year. On the other hand, the distribution of female athletes' birthdates was similar to the expected (χ^2 = 5.54; p = 0.136; ω = 0.182).

The age categories analysis also indicated different birthdate distributions across categories (Table 1). While even birthdate distributions were found in U16 (χ^2 = 4.142; p = 0.247; ω = 0.147) and U18 (χ^2 = 3.905; p = 0.272; ω = 0.171) categories, uneven distributions were reported in U20 (χ^2 = 12.463; p = 0.006; ω = 0.326) and senior (χ^2 = 12.715; p = 0.005; ω = 0.311) categories. Post hoc analyses indicated that athletes born in the first quarter of the year were more frequent than athletes born in the last quarter of the year were (p < 0.002) in the senior category. As for the U20 category, post hoc analyses were unable to locate the specific differences in the birthdate distributions (p > 0.0083), although the odds

Table 1 - Birthdate observed and expected distributions according to age category.

Category	Q1 (Exp)	Q2 (Exp)	Q3 (Exp)	Q4 (Exp)	χ^2	p	ω	OR - Q1:Q4 95% IC	OR - 1st:2nd 95% IC
U16	50	58	40	44	4.142	0.247	0.147	1.45	1.65
	(47.4)	(47.8)	(48.4)	(48.4)				0.92 to 2.3	1.1 to 2.48
U18	33	35	41	25	3.905	0.272	0.171	1.42	1.06
	(33.1)	(33.4)	(33.8)	(33.8)				0.8 to 2.55	0.66 to 1.71
U20	37	40	21	19	12.463	0.006	0.326	2.39	3.71
	(28.9)	(29.1)	(29.5)	(29.5)				1.28 to 4.45	2.16 to 6.36
Senior	45^d	30	38	18	12.715	0.005	0.311	3.28	1.79
	(32.4)	(32.6)	(33)	(33)				1.78 to 6.04	1.1 to 2.93

Q1-Q4 = birth quarter; (Exp) = expected distribution; χ2 = chi square; p = level of significance; ω = effect size; OR - Q1:Q4 = odds ratio from Q1 to Q4; OR - 1st:2nd = odds ratio from 1st semester to 2nd semester; d = different from Q4.

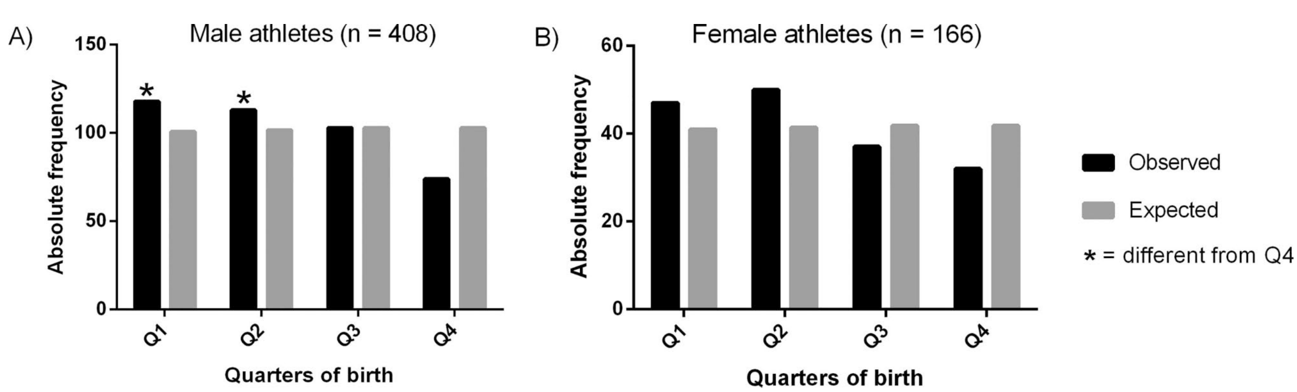

Figure 1 - For male (A) and female (B) athletes.

ratio indicates a higher proportion of athletes born in the first semester of the year compared to athletes born in the second semester (Odds Ratio 1st semester vs 2nd semester = 3.71).

Finally, when sex was considered within each age category, different birthdate distributions were also found (Table 2). In the case of male athletes, even distributions were reported in U16 (χ^2 = 2.722; p = 0.436; ω = 0.14) and U18 (χ^2 = 3.059; p = 0.383; ω = 0.18) categories. On the other hand, uneven distributions were found for male athletes in U20 (χ^2 = 10.747; p = 0.013; ω = 0.345) and senior (χ^2 = 12.614; p = 0.006; ω = 0.383) categories. Post hoc analyses indicated that athletes born in the first quarter of the year were more frequent than athletes born in the third quarter of the year were ($p < 0.002$) in the senior category. As for the U20 category, post hoc analyses were unable to locate the specific differences in the birthdate distributions ($p > 0.0083$), although the odds ratio indicates a higher proportion of athletes born in the first semester of the year compared to athletes born in the second semester (Odds Ratio 1st semester vs 2nd semester = 4.14). In female athletes, on the other hand, even distributions were reported in U16 (χ^2 = 2.471; p = 0.481; ω = 0.218), U18 (χ^2 = 1.441; p = 0.696; ω = 0.19), U20 (χ^2 = 2.938; p = 0.401; ω = 0.319), and senior (χ^2 = 1.793; p = 0.616; ω = 0.2) categories.

Discussion

This study aimed to investigate the existence of RAE in Brazilian water polo athletes according to sex (male and female) and age category (U16 to senior). The overall analysis showed an uneven distribution of birthdates for male water polo athletes, with athletes born in the first semester (Q1 and Q2) being more frequent than athletes born in the last quarter of the year (Q4). In the general age categories analyses, our results showed uneven distributions in U20 and senior categories, indicating that senior athletes born in Q1 were more frequent than those born in Q4. In addition, when we analyzed the age categories by sex, our results showed uneven distributions in male U20 and senior categories, indicating that senior athletes born in Q1 were more frequent than those born in Q4. As for the female athletes, the age categories analyses demonstrated even distributions in all age categories. These results confirm our initial hypothesis that RAE would be more prevalent in males compared to female athletes. On the other hand, we partially confirmed the hypothesis that RAE would be present throughout the age categories investigated since RAE was only prevalent in U20 and senior categories.

Our results are in line with other studies that also found RAE in other invasion team sports[15,37,38]. For instance, Lovell et al.[15] found a 5.28 greater chance of being enrolled into a player development program for relatively older (Q1) versus relatively younger (Q4) English soccer players (from U9 to U18 development programs). Likewise, RAE was found (Q1 = 41.4% vs. Q4 = 14.9%) in a sample of 7-21 years-old academy soccer players[38]. Results from handball athletes who participated in the 7th World Men's Championship in the under-19 category also showed an overrepresentation of athletes

Table 2 - Birthdate observed and expected distributions according to age category and sex.

Sex	Category	Q1 (Exp)	Q2 (Exp)	Q3 (Exp)	Q4 (Exp)	χ^2	p	ω	OR - Q1:Q4 95% IC	OR - 1st:2nd 95% IC
Male	U16	34	43	31	32	2.722	0.436	0.14	1.08	1.49
		(34.6)	(34.9)	(35.3)	(35.3)				0.62 to 1.88	0.93 to 2.39
	U18	23	23	30	18	3.059	0.383	0.18	1.37	0.92
		(23.2)	(23.4)	(23.7)	(23.7)				0.68 to 2.73	0.52 to 1.63
	U20	30	29	15	14	10.747	0.013	0.345	2.73	4.14
		(21.7)	(21.9)	(22.2)	(22.2)				1.34 to 5.59	2.21 to 7.75
	Senior	31^d	18	27	10	12.614	0.006	0.383	4.28	1.75
		(21.3)	(21.4)	(21.7)	(21.7)				1.96 to 9.36	0.96 to 3.21
Female	U16	16	15	9	12	2.471	0.481	0.218	1.48	2.18
		(12.8)	(13)	(13.1)	(13.1)				0.62 to 3.52	1 to 4.76
	U18	10	12	11	7	1.441	0.696	0.19	1.57	1.49
		(9.9)	(10)	(10.1)	(10.1)				0.54 to 4.55	0.62 to 3.6
	U20	7	11	6	5	2.938	0.401	0.319	1.53	2.68
		(7.2)	(7.2)	(7.3)	(7.3)				0.44 to 5.32	0.93 to 7.71
	Senior	14	12	11	8	1.793	0.616	0.2	2.09	1.87
		(11.1)	(11.2)	(11.3)	(11.3)				0.78 to 5.54	0.81 to 4.32

Q1-Q4 = birth quarter; (Exp) = expected distribution; χ^2 = chi square; p = level of significance; ω = effect size; OR - Q1:Q4 = odds ratio from Q1 to Q4; OR - 1st:2nd = odds ratio from 1st semester to 2nd semester; d = different from Q4.

born in the first two trimesters (Q1 and Q2)[37]. On the other hand, an investigation with different sports modalities[33] indicated that RAE was present in male athletes in one individual sport (swimming), and in three-team sports (basketball, soccer, and handball). However, RAE was not found in male athletes from six out of the 10 analysed sports, indicating that the occurrence of the RAE may be sport-dependent.

Indeed, the presence of the RAE is not a consensus in the literature[16,31,33]. Specifically, in water polo, RAE was not found in young male and female Israeli athletes[33], or for male and female athletes from five different continents who participated in World Championships[31]. Different factors may explain the discrepancies between studies. Lupo et al.[32] showed that the occurrence of the RAE can be affected by the stage of the career of athletes, so the presence of the RAE is lower in senior older athletes than in senior younger athletes. In the same way, a decline in RAE can be identified with the increasing age of athletes[11,12,19]. Nonetheless, the results of the present study indicated RAE for older male categories (U20 and Senior). Since it takes 15 years of competitive experience to reach an elite technical level in water polo[2], competitiveness can be expected to be greater in athletes from the older categories. Thus, as athletes advance to the older categories, there is an increased competition in the selection of these athletes to compose teams for high-level competitions, which agrees with our results, as represented by the overrepresentation of relatively older athletes in the U20 and senior categories.

Furthermore, the absence of the RAE in the younger categories of water polo in Brazil may be related to the low popularity of the sport in the country[8,12]. Schorer et al.[8] propose that the sport's popularity can be decisive, as most popular sports can lead to greater demand, which results in greater competitiveness and, consequently, a more rigorous selection process that would benefit athletes born close to the cut-off date of selection. This helps to explain why RAE is pervasive from youth to senior categories in certain contexts where specific sports are extremely popular (as is the case with men's soccer in Italy, for instance)[39]. However, in the Brazilian water polo context, younger categories are not formed by the selection, but by the interest in the practice. Reed et al.[40] contribute to this explanation since they found a strong indication of RAE in sports included in the school programs, which is not the case for water polo in the Brazilian school programs. Furthermore, factors related to parental encouragement, coaching reinforcement, and athletes' expectations can also influence the RAE[41]. Thus, the low popularity of water polo in Brazil associated with social and motivational factors can reduce competitiveness in younger categories and decrease the motivation of parents, athletes, and coaches, which may explain the absence of the RAE in the U16 and U18 categories in our study. Therefore, it seems clear that considering the context is essential when investigating RAE. As proposed by Wattie et al.[10], RAE is intrinsically related to sociocultural factors, which interact with another individual, environmental, and task constraints. This notion may also contribute to the understanding of the differences found between male and female athletes in this study.

Specifically, our results indicated a uniform distribution for female athletes in all categories (U16, U18, U20, and Senior). Corroborating our results, no RAE was found for female water polo athletes[33]. Similar results were found when analysing the three most competitive sports in North America and Europe, as no RAE was found in soccer[42], basketball, and team handball among elite female athletes[16]. This author argues that women's sport does not reach the same competitive level as men's sport, which makes RAE less likely in female sports contexts. This is mainly because men's sports would have more intense competitions and disputes for spots in teams and training programs since the early stages of practice. We speculate that our results are also affected by the fact that there are fewer women's water polo federations and/or teams compared to men's in Brazil[16]. However, it is important to highlight other studies have found RAE in specific female sports contexts. For example, in the study by Figueiredo et al.[12], 5,306 female Portuguese soccer players and 2,437 female Portuguese futsal players were evaluated, and RAE was identified in the U9 category. Furthermore, in the study by Bjørndal et al.[19], the effects of the RAE were identified for the juvenile and junior categories of Norwegian national handball teams. Thus, when discussing the possible effects of the RAE for females, the sociocultural context that covers the sex difference must be considered, as they may affect the opportunity to practice the observed sport.

This study has limitations, such as not comparing athletes according to the playing positions, competitive levels, and different classifications of teams. Considering the scarcity of studies that investigated RAE in water polo and the influence of multiple factors within each sports context, we suggest that future studies investigate the occurrence of RAE in water polo athletes from different playing positions, competitive levels, and selection for National Teams in different countries. In addition, it would be important to investigate whether RAE is associated with the final classification in water polo competitions of different levels.

Our results have important practical applications. We emphasize that this is the first study carried out with different age categories in water polo. Thus, we suggest that organizations (mainly National and International federations), clubs, and coaches must consider the RAE in the processes of athletes' detection and selection in water polo, especially for the older categories. According to our results, athletes who are born in the last quartile of the year

(Q4) might have less chance to play in the old categories, and even become professional players, especially in the case of male athletes. Likely, the youngest players who could become great water polo athletes are not provided with equal opportunities to succeed in the sport.

It is concluded that the RAE phenomenon is present in Brazilian male water polo athletes in the older categories (U20 and senior) but not in female athletes. Our results reinforce the importance of trying to reduce the advantage of athletes who are born in the first quartiles (Q1 and Q2) of the year, especially in selection processes that occur in older male categories (U20 and senior), to provide equal opportunities to athletes born in all birth quartiles to reach the senior and/or professional levels.

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