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Relative Age Effect in Costa Rican Professional Football. An Analysis by Tournaments, Playing Positions, and Competitive Participation Indicators

Efecto relativo de la edad en el fútbol profesional costarricense. Un análisis por torneos, posiciones de juego e indicadores competitivos de participación

Efeito relativo da idade no futebol profissional da Costa Rica. Uma análise por torneios, posições em campo e indicadores competitivos de participação

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ABSTRACT

Objective: To analyze the distribution of Costa Rican professional football players by date of birth, compare them by tournaments and playing positions, and explore the relationship between the relative age effect (RAE) and collective performance and individual participation indicators. M**ethods**: A total of 919 male players who participated in 10 tournaments across five years in Costa Rica were grouped into four quartiles, according to their date of birth (Q1= jan-mar, Q2= apr-jun, Q3= jul-sept, and Q4= oct-dec), and six playing positions: goalkeepers, central defenders, full-backs, central midfielders, wide midfielders, and forwards. The collective competitive performance indicator was the team's position in the table of classification, and individual participation indicators were the percentage of call-ups, matches played, and minutes played. **Results**: It was found a higher percentage of players were born in Q1 and Q2 across nine tournaments compared with Q4 (p< 0.05; OR: 1.46 to 1.70). Among fullbacks, the highest percentage was in Q2, while central and wide midfielders were in Q1. Among the top four teams, there was a higher number of Q1 players; no significant relationship was found between the RAE and the final table of classification (p> 0.05). Players born in Q1 and Q2 had higher percentages of call-ups, matches played during the tournaments, and minutes played per match than Q3 and Q4 (p< 0.03). **Conclusions**: There was RAE in Costa Rican professional football. It was manifested mainly in fullbacks and midfielders. RAE does not influence collective performance, but it affects individual participation indicators.

Keywords: football; age; team sport; performance.

RESUMEN

Objetivo: Analizar la distribución de los futbolistas profesionales costarricenses por fecha de nacimiento, comparando por torneos, posiciones de juego y explorando la relación entre el efecto relativo de la edad (RAE, por sus siglas en inglés) y el rendimiento colectivo e indicadores de participación individual. **Métodos**: Un total de 919 jugadores masculinos que participaron en 10 torneos a lo largo de cinco años en Costa Rica fueron agrupados en cuatro cuartiles, según su fecha de nacimiento (Q1 = ene-mar, Q2 = abr-jun, Q3 = jul-sept, y Q4 = oct-dic) y seis posiciones de juego: porteros, defensores centrales, laterales, centrocampistas centrales, centrocampistas exteriores y delanteros. El indicador de rendimiento competitivo colectivo fue la posición del equipo en la tabla de clasificación y a los indicadores de participación individual los constituyeron: el porcentaje de convocatorias, partidos y minutos jugados. **Resultados**: Se encontró un mayor porcentaje de jugadores nacidos en Q1 y Q2 en nueve torneos, comparado con Q4 (p< 0.05; OR: de 1.46 a 1.70). Entre los laterales, el mayor porcentaje correspondió a Q2, mientras que entre los centrocampistas centrales y extremos fue Q1. Entre los cuatro primeros equipos hubo un mayor número de jugadores Q1, pero no se encontró una relación significativa entre la RAE y la tabla final de clasificación (p > 0,05). Los jugadores nacidos en Q1 y Q2 tuvieron un mayor porcentaje de convocatorias, partidos en los que ejercieron participación y minutos jugados por partido (p < 0.03). **Conclusión**: En el fútbol profesional costarricense se observó RAE; se manifestó principalmente en los laterales y centrocampistas. El RAE no influye en el rendimiento colectivo, pero sí afecta los indicadores de participación individual.

Palabras claves: fútbol; edad; deportes de equipo; rendimiento.

RESUMO

Objetivo: Analisar a distribuição dos jogadores profissionais de futebol da Costa Rica por data de nascimento, comparando por torneios e posições em campo, e explorando a relação entre o efeito relativo da idade (RAE) e o desempenho coletivo, bem como indicadores de participação individual. **Métodos**: Um total de 919 jogadores do sexo masculino que participaram de 10 torneios ao longo de cinco anos na Costa Rica foram agrupados em quatro quartis de acordo com a data de nascimento (Q1 = jan-mar, Q2 = abr-jun, Q3 = jul-set e Q4 = out -dez) e seis posições de jogo: goleiros, zagueiros centrais, laterais, meio-campistas centrais, meio-campistas laterais e atacantes. O indicador de desempenho competitivo coletivo foi a posição da equipe na tabela de classificação, e como indicadores de participação individual foram: a porcentagem de convocações, partidas e minutos jogados. **Resultados**: Observou-se uma maior porcentagem de jogadores nascidos em Q1 e Q2 em nove torneios em comparação com Q4 (p < 0,05; OR: 1,46 a 1,70). Entre os laterais, a maior porcentagem correspondeu ao Q2, enquanto entre os meio-campistas centrais e laterais foi o Q1. Entre as quatro primeiras equipes, houve um maior número de jogadores do Q1, mas não foi encontrada uma relação significativa entre a RAE e a tabela final de classificação (p > 0,05). Os jogadores nascidos no primeiro e no segundo trimestres apresentaram maior porcentagem de convocações, partidas em que participaram e minutos jogados por partida (p < 0,03). **Conclusão**: No futebol profissional da Costa Rica, observou-se a RAE, manifestando-se principalmente nos laterais e nos meio-campistas. A RAE não influencia o desempenho coletivo, mas afeta os indicadores de participação individual.

Palavras-chave: futebol; idade; esportes coletivos; desempenho.

INTRODUCTION

Traditionally, in team sports such as football, the training and competition categories are formed considering players' chronological age or birth year (Helsen *et al*., 2012; Musch & Grondin, 2001). However, this can prove a heterogenetic conformation in teams of the same category, which can exist a difference of chronological age from twelve months between a player born in January and another born in December of the same year (Radnor *et al*., 2021). This phenomenon is known as the relative age effect (RAE), which can explain the overrepresentation of players born in the first months of a selection year in a team compared to those born in the last months of the same selection year (Roberts *et al*., 2021; Romann *et al*., 2020). RAE originates primarily at the moment of the first coach selection, suggesting that the earliest selection processes are the key drivers of this structural imbalance, which, once established, tends to accumulate across developmental stages (Romann *et al*., 2020).

Scientific evidence consistently shows that athletes born in the first months of the year (born early) tend to have a greater advantage in talent identification and selection processes compared to late-born peers (born late) (Kelly *et al*., 2020; Perez-Gonzalez *et al*., 2020). In children's and youth football teams, more than 70% of players were typically born in the first months of the year (Mulazimoglu, 2014) and around 68% of U17 academies report RAE (Götze & Hoppe, 2021). Although the highest prevalence of RAE is observed in adolescent and youth stages (Figueiredo *et al*., 2022; González-Víllora *et al*., 2015; Pérez-González *et al*., 2021), it has also been well documented in professional categories (Bozděch *et al*., 2023; Yagüe *et al*., 2020). For instance, in an analysis covering 54 senior European league (n= 18,429 male players), 30.9% were born in Q1 compared to only 19.6% in Q4 (Bezuglov *et al*., 2023), a pattern also found in second-division leagues and in both male and female senior categories (Rađa *et al*., 2018; Götze & Hoppe, 2021).

The RAE also manifests differently across playing positions. In professional teams, an overrepresentation of players born in Q1 has been reported for all positions, though the magnitude varies (Padrón-Cabo *et al*., 2016). Midfielders tend to show the most pronounced overrepresentation, while attackers show the least effect (Yagüe *et al*., 2018). This differential pattern may suggest that physical and developmental demands differ by position. In roles with high aerobic and physical requirements, advantages from relative age, such as greater size, strength, and endurance, can heavily impact early selection decisions. On the other hand, RAE has shown little or no impact on goalkeepers in European. leagues and the Brazilian championship (Figueiredo *et*

al., 2022; Perez-Gonzalez *et al*., 2020), suggesting that position-specific technical requirements can attenuate the effect.

The relationship between RAE and competitive performance, both collective and individual, has also been examined, though with inconsistent results. At the collective level, a higher prevalence of RAE has been observed in teams that reached the final stages of European youth tournaments (González-Víllora *et al*., 2015), while in professional leagues, Q1-born players are more frequently found in mid-table teams (Yagüe *et al*., 2018). At the individual level, indicators such as minutes played and number of participations have been used to measure RAE influence in professional leagues, with inconclusive findings (Vaeyens *et al*., 2005).

Despite decades of research, the RAE remains a persistent and difficult-to-eradicate phenomenon in football worldwide (Roberts *et al*., 2021). Its persistence reflects structural biases embedded in youth selection systems, where relatively older or physically more mature players are systematically favored, leading to potential talent loss among late-born athletes (Götze & Hoppe, 2021; Musch & Grondin, 2001). However, most of the available evidence comes from European and South American contexts, and regions such as Central America remain largely unexplored. In this sense, Costa Rica has a well-organized professional football structure, with a consistent international presence and youth development systems that support professional clubs. This context provides a significant and innovative opportunity to study RAE. Likewise, understanding how this effect manifests across tournaments, playing positions, and indicators of competitive participation can provide actionable information to guide more equitable talent development practices. Therefore, this study aimed to analyze the distribution of Costa Rican professional football players by date of birth across ten tournaments over five years, compare them distributions by playing position, and explore the relationship between the RAE and competitive participation indicators.

METHODS

Sample

A total of 919 dates of birth of male professional football players who participated in 10 tournaments held in Costa Rica during five years (2018/2019 to 2022/2023) were analyzed. This study focuses exclusively on the professional level, where players have completed the formative stages in which RAE has been most documented. Considering the players who participated in at least two tournaments or more, the total data referring

to dates of birth was 3600; there was a total of 2681 repeated data. In Costa Rica, in these years, two short tournaments were held per year. The opening tournament begins in July/August and finishes in November/December of the first year. The closing tournament starts in January and ends in April/May of the second year. Twelve teams participated in each tournament and played 22 matchdays, except in two tournaments, where 16 games were played. The opening tournament for 2020/2021 was due to COVID-19 pandemic regulations, and the opening tournament for 2022/2023, due to the preparation of the senior national team for the World Cup Qatar 2022. The player registration period between tournaments opens, allowing players to transfer between teams.

Produce

All dates were obtained from the website Transfermarkt (www.transfermarkt.com). This site offers general information about clubs and players, so no informed consent or ethical approval was required. The data was treated based on the provisions of the Helsinki Declaration. The information consulted was about the club to which the player belonged, the age and date of birth of the player, playing position, number of call-ups, matches played, and minutes played, as well as data from the season, tournament, and position in the classification table. This website has previously been used to obtain data and develop scientific studies in football and the RAE (Bezuglov *et al*., 2023; Yagüe *et al*., 2018). In addition, the information was reviewed on the official website of UNAFUT (https://www.unafut.com/), the entity that organizes professional football tournaments in Costa Rica.

RAE

Taking into account previous research (Bezuglov *et al*., 2023; Rađa *et al*., 2018; Yagüe *et al*., 2018) and the fact that in Costa Rica, the cut-off date begins on 1st January, the players were distributed into four quartiles according to their date of birth: Q1 = those born between January 1 and March 31; Q2 = those born between April 1 and June 30; Q3 = those born between July 1 and September 30; and Q4 = those born between October 1 and December 31.

Playing positions

The distribution of the players considering the playing position was made based on what was reported on the Transfermarkt and UNAFUT websites, as well as on the assignment that is commonly used to specifically analyze the players performance according to their

tactical role (Zhou *et al*., 2020), In this sense, player positions were: 1) goalkeepers, 2) central defenders, 3) fullbacks, 4) central midfielders, 5) wide midfielders, and 6) attackers.

Collective performance

Collective performance was determined according to the team's final position in the classification table at the end of each tournament (de la Rubia *et al*., 2020; Yagüe *et al*., 2018), grouping teams into three categories: top four (positions 1-4), middle table (positions 5-8), and last four (positions 9-12). Players whose teams finished in different ranking categories across tournaments were assigned to the category in which they accumulated the highest number of appearances.

Individual participation indicators

Individual participation was assessed through three indicators. Given that two tournaments had fewer matchdays (n= 16) than the others (n= 22), all indicators were calculated as percentages relative to the total matchdays scheduled in each tournament.

Percentage of call-ups: Considered the number of times the player was called up for a match in the tournament in relation to the greatest possible number of call-ups that the player could have (number of matchdays). The formula used was: [(number of call-ups / number of matchdays) *100].

Percentage of matches played: Considering the number of times the player played as a starter or substitute in the tournament in relation to the greatest possible number of participations the player could have (number of matchdays). The formula used was: [(number of matches in which the player played / number of matchdays) *100].

Minutes played per match: This was calculated relatively, considering the player's number of matches. The formula used was: [total minutes played in the tournament / (number of matches played)].

Statistical analysis

First, the data were analyzed descriptively using frequency and percentages. To evaluate the differences in the distributions of the date of birth of the players according to quartiles in each of the tournaments, playing position, and position achieved in the table of classification of the tournament, Chi-square (X^2) goodness-of-fit analyses were performed. The differences were verified by calculating the odd ratio (OR), defining Q4 as the reference group, and obtaining 95% confidence intervals (IC 95%). These analyses

were carried out separately for each tournament. For the analyses within each playing position and group of classification, only the 919 unique players were considered; repeated dates of birth were not included to avoid bias in the results.

Chi-square tests (X^2) of independence were applied to determine if there was a relationship between the distribution of players by quartile and the team's performance measured by the position achieved in the table of classification (3 x 4). The effect size was assessed using the Cramer V test for Chi-square tests and classified as small: V= 0.05; medium: V= 0.15; and large: V= 0.25 (Fritz *et al*., 2012).

Kruskal-Wallis tests were performed to compare performance indicators between quartiles. Effect sizes were calculated using epsilon squared (ε2) and graded as follows: small: ε2 > 0.1, moderate: ε2 > 0.3, and large: ε2 >0.5 (Tomczak & Tomczak, 2014). When significant differences were identified, post hoc analyses were performed.

All analyses were conducted in the Package for Social Sciences (SPSS 23.0, IBM Corp., Armonk, NY, USA), considering a p-value < 0.05 to assess statistical significance.

RESULTS

RAE – tournament

The Chi-Square goodness-of-fit tests revealed the presence of RAE in nine of the 10 tournaments analyzed (Table 1). Higher percentages of players born in Q1 and Q2 were observed compared to those born in Q3 and Q4. This confirms the odds ratios statistically, showing greater probabilities that the teams will have more players born in Q1 and Q2. The effect sizes reveal a medium effect in most cases.

RAE - playing positions

Regarding the general analysis, Table 2 shows the presence of the RAE in two of the six positions analyzed. On the other hand, the highest percentage belongs to Q2 concerning Q4, while on the extremes, a greater proportion is observed in Q1 compared to Q4. This suggests that there is a greater probability that the players who occupy these positions are born in the first semester. The effect sizes indicate a medium to large impact. Goalkeepers, central defenders, central midfielders, and attackers were players who did not manifest this phenomenon.

Table 1

Quartile distribution of the players' birth dates according to season and tournament

Season	Tournament	N total	Q1	Q2	Q3	Q4	X^2	*p*	V	*OR (CI 95%)* Q1 VS Q4	*OR (CI 95%)* Q2 VS Q4	*OR (CI 95%)* Q3 VS Q4
2018-2019	Opening	367	99 27.0%	107 29.2%	76 20.6%	85 23.2%	6.30	0.09	0.13[M]	1.16 (0.84, 1.61)	1.26 (0.91, 1.73)	0.89 (0.63, 1.25)
	Closing	367	104 28.3%	108 29.4%	80 21.8%	75 20.4%	**9.07**	**0.02**	**0.15**[M]	1.40 (0.10, 1.92)	**1.44** **(1.03, 1.99)**	1.07 (0.75, 1.50)
2019-2020	Opening	366	107 29.2%	100 27.3%	90 24.6%	69 18.9%	**8.97**	**0.03**	**0.15**[M]	**1.55** **(1.10, 2.16)**	**1.45** **(1.03, 2.03)**	1.31 (0.92, 1.84)
	Closing	362	105 29.0%	111 30.7%	84 23.2%	62 17.1%	**16.40**	**< 0.01**	**0.21**[M]	**1.70** **(1.19, 2.39)**	**1.79** **(1.27, 2.52)**	1.35 **(0.94, 1.94)**
2020-2021	Opening	345	103 29.9%	93 27.0%	81 23.5%	68 19.7%	**7.96**	**0.04**	**0.14**[M]	**1.52** **(1.07, 2.13)**	1.36 (0.96, 193)	1.19 (0.83, 1.69)
	Closing	350	99 28.3%	103 29.4%	80 22.9%	68 19.4%	**9.24**	**0.02**	**0.16**[M]	**1.46** **(1.03, 2.05)**	**1.45** **(1.03, 2.05)**	1.18 (0.82, 1.67)
2021-2022	Opening	390	119 30.5%	117 30.0%	81 20.8%	73 18.7%	**17.59**	**< 0.01**	**0.21**[M]	**1.63** **(1.18, 2.25)**	**1.60** **(1.15, 2.21)**	1.11 (0.78, 1.56)
	Closing	348	99 28.4%	108 31.0%	76 21.8%	65 18.7%	**13.67**	**< 0.01**	**0.20**[M]	**1.53** **(1.07, 2.15)**	**1.66** **(1.18, 2.33)**	1.17 (0.81, 1.68)
2022-2023	Opening	340	104 30.6%	100 29.4%	73 21.5%	63 18.5%	**14.28**	**< 0.01**	**0.20**[M]	**1.65** **(1.16, 2.33)**	**1.58** **(1.11, 2.25)**	1.16 (0.80, 1.67)
	Closing	365	113 31.0%	103 28.2%	79 21.6%	70 19.2%	**13.29**	**< 0.01**	**0.19**[M]	**1.62** **(1.15, 2.25)**	**1.48** **(1.05, 2.06)**	1.13 (0.79, 1.60)

Note: X^2= Chi-square value; p= value of significance; bold= indicates statistical significance; V= effect size Cramer's V; T= effect size trivial; S=: effect size small; M= effect size medium; L= effect size large; CI 95%= Confidence Intervals 95%.

Table 2

Quartile distribution of the players' birth dates according to playing position

Playing position	N total	Q1	Q2	Q3	Q4	X^2	*p*	V	*OR (CI 95%)* Q1 VS Q4	*OR (CI 95%)* Q2 VS Q4	*OR (CI 95%)* Q3 VS Q4
Goalkeepers	106	34 32.1%	27 25.5%	21 19.8%	24 22.6%	3.50	0.32	0.18[M]	1.41 (0.78, 2.55)	1.12 (0.61, 2.07)	0.87 (0.45, 1.66)
Central defenders	158	43 27.2%	39 24.7%	39 24.7%	37 23.4%	0.48	0.92	0.05[S]	0.56 (0.31, 1.01)	1.05 (0.63, 1.17)	1.05 (0.63, 1.17)
Fullbacks	119	32 26.9%	42 35.3%	22 18.5%	23 19.3%	**8.76**	**0.03**	**0.27**[L]	1.39 (0.76, 2.51)	**1.82** **(1.03, 3.22)**	0.95 (0.50, 1.80)
Central-Midfielders	215	61 28.4%	59 27.4%	57 26.5%	38 17.7%	**6.30**	**0.04**	**0.17**[M]	**1.60** **(1.02, 2.51)**	1.55 (0.99, 2.43)	1.50 (0.95, 2.35)
Wide-Midfielders	130	45 34.6%	35 26.9%	26 20%	24 18.5%	**8.52**	**0.03**	**0.25**[L]	**1.87** **(1.08, 3.25)**	1.45 (0.82, 2.58)	1.08 (0.59, 1.98)
Attackers	191	52 27.2%	50 26.2%	43 22.5%	46 24.1%	1.02	0.79	0.07[S]	1.13 (0.75, 1.76)	1.08 (0.69, 1.70)	0.93 (0.58, 1.48)

Note: X^2= Chi-square value; p= value of significance; bold= indicates statistical significance; V= effect size Cramer's V; T= effect size trivial; S=: effect size small; M= effect size medium; L= effect size large; CI 95%= Confidence Intervals 95%. Analyses were run with 919 dates of birth. Replicate dates of birth were not included.

RAE - collective performance

According to the team's performance (Table 3), the effect of the RAE was evident in two of the three groups formed according to the position occupied by the team in the classification table at the end of the tournament. The highest proportion was concentrated in Q1 for the four top teams. The middle-table teams showed a higher percentage in Q2. The teams at the bottom of the table showed no effect of the RAE.

The Chi-square analyses of independence do not show a statistically significant relationship between the position achieved in the classification table by the team in the tournament and the quartiles analyzed, both separately by the tournament, as a general result (p> 0.05). This suggests that the teams' performance could be independent of the RAE.

Table 3
Quartile distribution of the players' birth dates according to collective competition performance

Classification Table	N total	Q1	Q2	Q3	Q4	X^2	*p*	V	*OR (CI 95%)* Q1 VS Q4	*OR (CI 95%)* Q2 VS Q4	*OR (CI 95%)* Q3 VS Q4
Top four (1 to 4)	277	85	78	60	54	**9.28**	**0.02**	**0.16** M	**1.57**	1.44	1.11
		30.7%	28.2%	21.7%	19.5%				**1.07, 2.30**	0.98, 2.12	0.74, 1.66
Middle table (5 to 8)	296	83	88	70	55	**8.83**	**0.03**	**0.17** M	1.09	**1.60**	1.27
		28%	29.7%	23.6%	18.6%				0.73, 1.62	**1.10, 2.23**	0.86, 1.87
Last four (9 to 12)	346	99	86	78	83	2.78	0.42	0.10 S	1.19	1.03	0.94
		28.6%	24.9%	22.5%	24%				0.86, 1.65	0.74, 1.45	0.66, 1.32

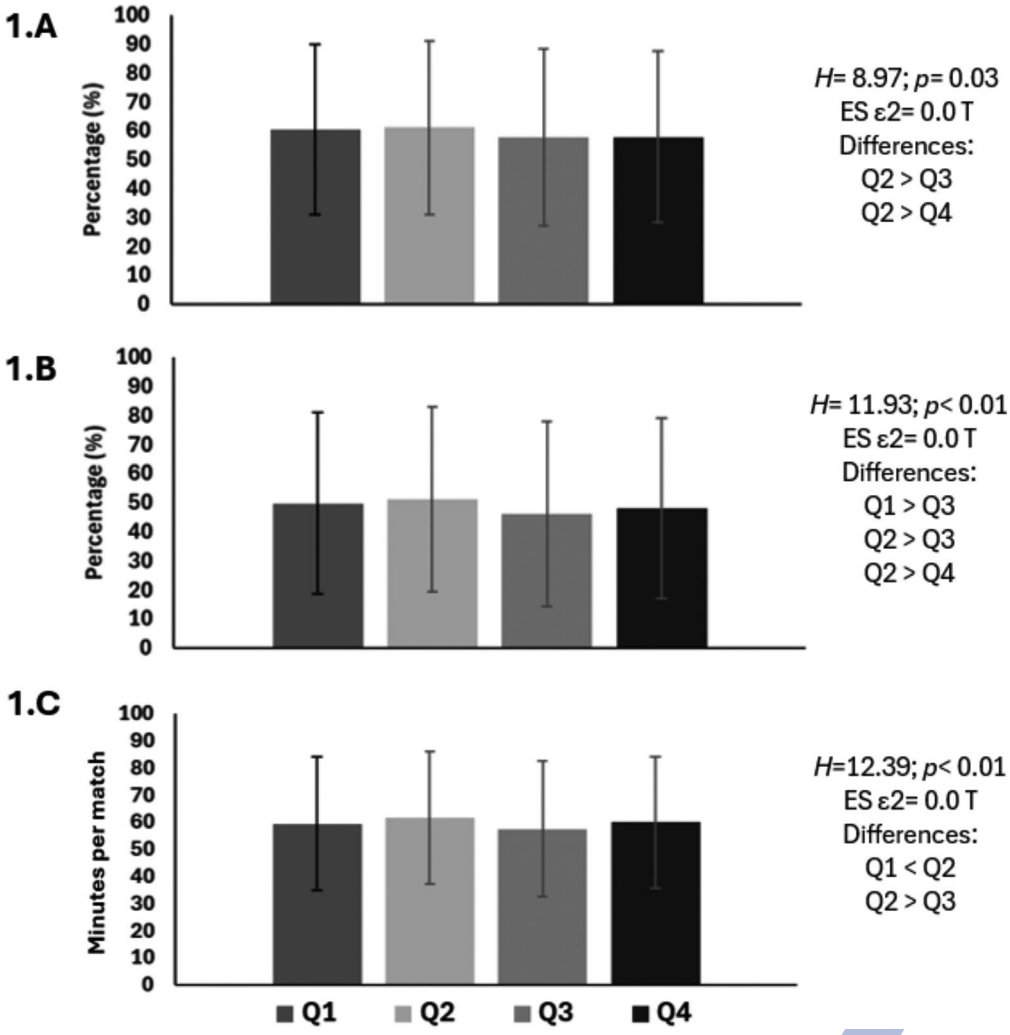
Note: X^2= Chi-square value; p= value of significance; bold= indicates statistical significance; V= effect size Cramer's V; T= effect size trivial; S=: effect size small; M= effect size medium; L= effect size large; CI 95%= Confidence Intervals 95%. Analyses were run with 919 dates of birth. Replicate dates of birth were not included.

RAE - individual participation indicators

Comparative analyses of individual performance indicators show differences concerning birth quartiles. Figures 1A and 1B show that the percentage of call-ups and games played was higher for Q2 compared to Q3 and Q4. Players born in Q2 were called ups and played more than 60% and 50%, respectively, of all matches of the tournaments. Figure 1.C shows that the players born in Q2 played more minutes per match than quartiles Q1 and Q3. This suggests that players born in Q2 participated more during the tournaments analyzed.

Figure 1

Percentage of individual participation during the tournament according to different indicators. 1. A: average percentage of call-ups during the tournament, 1. B: average percentage of matches played during the tournament, 1.C. average minutes played per match



Note: H= Kruskal-Wallis's value; p= value of significance; ES ε2= effect size epsilon squared; T= effect size trivial; S=: effect size small; M= effect size moderate; L= effect size large. Analyses were run with all dates of birth.

DISCUSSION

Based on the objective, Costa Rican football teams have a greater representation of players born in the first quartile of the year. This trend has been observed in other professional football leagues in different countries in the world, such as Spain (Yagüe *et al*., 2020), Germany (Götze & Hoppe, 2021), Brazil (Figueiredo *et al*., 2022), Turkey (Mulazimoglu, 2014), Italy (Lupo *et al*., 2019), and even in other team sports such as rugby, volleyball, and water polo (Lupo *et al*., 2019).

In nine of the 10 tournaments analyzed, an overrepresentation of players born in Q1 compared to Q4 is found (Table 1). These results align with prior studies covering multiple seasons, which have shown that the RAE is a stable phenomenon in football rosters (Helsen *et al*., 2012). This persistent overrepresentation throughout the seasons may be because the probability of becoming a professional footballer are double for those who do so in the first months of the year (Rađa *et al*., 2018), and that standards continue to endure over time (Roberts *et al*., 2021; Romann *et al*., 2020). Consequently, relatively older players are more likely to join senior professional teams in a shorter timeframe (Lupo *et al*., 2019).

Selection biases generated during formative stages, driven by the preference for relatively older or biologically more mature players, can account for the overrepresentation of Q1 and Q2 players in professional teams. It has been determined that players' biological maturity at a young age plays an important role in the selection process and explains much of the differences in physical and anthropometric characteristics between players born in the same year but in different months (Parr *et al*., 2020; Radnor *et al*., 2021). The selection can be based on the advantages of some conditional capacities (e.g., anaerobic performance) and anthropometric attributes in which players born in the first months of the year stand out at the youth stage (Duarte *et al*., 2019; Lovell *et al*., 2015). Players born in the first months of the year who also reach early maturity have a greater chance of being selected than peers classified as late maturers (Duarte *et al*., 2019). Supporting the above, it has been discussed that "late" football players can face selection biases based on physical abilities (Bezuglov *et al*., 2023).

In Costa Rica, the presence of RAE was identified specifically in fullbacks (overrepresentation in Q2 vs. Q4) and central and wide midfielders (overrepresentation in Q1 vs. Q4). These findings are novel compared to European and South American evidence, where RAE has been more consistently reported for defenders and midfielders (Figueiredo *et al*., 2022; Salinero Martín *et al*., 2013; Yagüe *et al*., 2018, 2023). The pattern

observed for specific positions likely reflects the cumulative effect of selection biases operating during formative stages, in which relatively older or physically more mature players were systematically favored for roles with high physical and athletic demands (Figueiredo *et al*., 2022; Salinero Martín *et al*., 2013). It is important to note, however, that this study's observational design does not allow us to determine whether coaches in the Costa Rican first division were aware of the RAE or whether they deliberately applied or disregarded criteria related to relative age when making selection and call-up decisions. This represents a relevant limitation and an open question for future research in the Costa Rican football context.

Regarding the collective performance indicators, there was no statistically significant association between the position achieved in the standings by the team or having been a finalist with the distribution of players according to their date of birth. Regarding this, scientific evidence systematically reviewed does not show clear associations between the RAE and performance in competition (de la Rubia *et al*., 2020). Few studies directly reflect the association between performance indicators and player conformation considering the players' date of birth. Despite this, teams that were better positioned at the end of tournaments had more players born in Q1 and Q2. In the semifinal and final teams of the European Young Championship, most players were born between January and June (González-Víllora *et al*., 2015).

Regarding collective performance indicators, no statistically significant association was found between the team's final position in the classification table and the distribution of players by birth quartile. This is consistent with a systematic review that found no clear associations between RAE and competitive performance (de la Rubia *et al*., 2020). Nevertheless, teams that were better positioned at the end of tournaments tended to have more players born in Q1 and Q2, a trend also observed in European youth championships (González-Víllora *et al*., 2015). The RAE manifested in two of the three classification categories, coinciding with findings from Spanish leagues (Yagüe *et al*., 2023) and other European studies showing that the RAE is less pronounced in lower-ranked teams (Bezuglov *et al*., 2023; Yagüe *et al*., 2018). These variations across countries may also reflect differences in the management and regulation of football, economic conditions, and awareness of RAE in selection processes (Padrón-Cabo *et al*., 2016).

For individual participation in Costa Rican football, players born in Q2 showed higher participation rates across the tournaments analyzed (Figure 1). Although the number of studies examining these indicators was minimal, this result differs from that reported in a study carried out in the Belgian football league, in which the average

number of selections and playing minutes did not vary between players born at the beginning or the end of the year of selection (Vaeyens *et al*., 2005). In other team sports such as handball, RAE has been found to significantly affect playing minutes only among senior female players, where younger players also made more errors (de la Rubia *et al*., 2021). These are aspects that coaches can consider when giving them opportunities in matches. Likewise, relatively older players who have matured early may have better physical, technical, and tactical conditions and experience to play, which influences the decision to align them with the coaches (Grossmann & Lames, 2013). However, it becomes necessary to explore whether individual physical, technical, or tactical performance is affected by the RAE.

Finally, the presence of RAE in Costa Rican professional football is consistent with findings worldwide (Roberts *et al*., 2021). This study was based on the idea that grouping athletes solely by chronological age, without accounting for relative age differences within a group, can disadvantage late-born players over time (Musch & Grondin, 2001; Roberts *et al*., 2021). The overrepresentation of Q1-born players in professional rosters is largely a product of selection and development systems that inadvertently reward biological maturity. The results of this study confirm that this mechanism operates in Costa Rica and that its effects are observable not only in the composition of professional rosters but also in players' individual participation during official competitions. Based on these findings, it is necessary to propose actions and changes across the different institutions and federated entities that operate in football.

CONCLUSIONS

The distribution of Costa Rican professional football players, considering their date of birth in the tournament analyzed, reflects a greater presence of relatively older players born in Q1. Likewise, this effect was observed in playing positions, being noticeable in fullbacks, and central and wide midfielders. Playing positions in which an overrepresentation of players born in Q1 and Q2 was found.

RAE manifested itself in the teams that occupied first and middle places of the final classification at the end of the tournament; however, the RAE is not associated with collective performance. On the other hand, at an individual level, an influence was found in the number of call-ups, games played, and accumulated minutes per match. In this sense, players born in the first quartiles are shown to be more likely to participate in matches than in quartiles 3 and 4.

PRACTICAL APPLICATIONS

This information can serve as a starting point to establish criteria that can be implemented in Costa Rican football's player selection processes, mainly in the childhood and youth stages. Integrating aspects from different areas (maturation, anthropometric, physiological, physical, psychological) to offer equal opportunities and not fall into biased selections.

In this regard, it is important to invest in the training of coaches and scouts on topics related to the RAE, with the aim of raising awareness and guiding them to conduct talent detection and selection processes based on criteria and guidelines that prevent or minimize the discrimination of talented players.

Likewise, it can guide the implementation of monitoring strategies that can help better understand the evolution of players selected in youth stages until they reach the highest level.

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