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The relative age effect in under-17, under-20, and adult elite female soccer players

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ABSTRACT
To investigate the RAE in elite female soccer players, the absolute and relative birthdate distributions of players who disputed the Women's World Cup were assessed. Differences between observed and expected distributions were analyzed using chi-square and effect sizes. The birthdates of 1224 female soccer players were assessed in Under-17 ($N = 336$), Under-20 ($N = 336$) and adult ($N = 552$) categories. There was no significant RAE in adult category for different playing positions and players in general (including all playing positions per age category). There was significant RAE for midfielders and players in general with mainly small effect sizes for the U-17 and U-20. In both age categories, players born in Q1 were over-represented with the highest quartile ratio for midfielders. In regard of RAE and success defined by final ranking at the World Cup, we found no significant differences between the birthdate distributions of players who participated in either the group stages or finally the knockout phases. Coaches should consider this information to avoid bias in talent programs designed to promote and select female soccer players independently of their birthdates. Young female players should be encouraged to learn to play in different field positions before to reach high-level performance.

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Birthdate; female; football; playing position

Introduction

Several official sports institutions have promoting women rights and empowerment Fédération Internationale de Football Association (2021), https://www.fifa.com/womens-football/strategy/strategy-details; International Olympic Committee (IOC) https://olympics.com/ioc/gender-equality), and the interest for female sports performance has grown exponentially in recent years. Despite the increased popularity and professionalization of female soccer all over the world, there is still a scarcity of scientific research specifically addressing female players in relation to their male counterparts (Martínez-Lagunas et al. 2014; Okholm Kryger et al. 2021). The relative age effect (RAE), for example, has been reported as a significant bias in talent selection (Sarmento et al. 2018), sociological and psychological factors (Musch and Hay 1999) and long-term consequences of success of male soccer players (Helsen et al. 1998). However, it has not yet been sufficiently investigated in female soccer players (Cobley et al. 2009). In addition, the few studies on RAE in women bring some contradictory results concerning age categories, competitive level, and playing positions (Korgaokar et al. 2018; Götze and Hoppe 2021; Barreira et al. 2021). Therefore, examining RAE in female players may help to better understand the factors that could be related to female soccer performance.

The FIFA, maximum organization that manages and promotes soccer all over the world, uses birthdates (chronological age) as an exclusive criterion for grouping players into competition categories (for example, Under (U)-17 and U-20). These categories are composed of groups, in periods of 2 years, comprising players born between January of a certain year and December of the subsequent year (Fédération Internationale de Football Association 2021). The purpose of this organization is to balance the competition and promote championships that are more competitive. However, this division system can generate age differences of about 24 months between players who are in the same category, leading to distortions in the standards of identification, selection, and promotion of players. Therefore, it is common to find a higher frequency of players born in the first months of the year (Smith et al. 2018). This phenomenon is known as RAE (Helsen et al. 2005).

RAE and its consequences have recently been investigated in several individual and collective sports such as surf (Redd et al. 2018), weightlifting (Kollars et al. 2021), basketball (Pino-Ortega et al. 2020), hockey (Bezuglov et al. 2020), and futsal (Carraco et al. 2020). In male soccer players, for example, the RAE has been studied since the 1980s pointing RAE in players of several nationalities (for example, USA (Hurley et al. 2019), England (Lovell, Towlson, Parkin, Portas, Vaeyens & Cobley), Germany (Augste and Lames 2011), Portugal (Folgado et al. 2006), Spain (Del Campo et al. 2010), Australia (Van den Honert 2012), and Brazil (Da Costa et al. 2012)) as well as different age categories and playing positions (Salinero et al. 2013). Overall, the results indicate a prevalence of high-performance players born in the first half of the year highlighting the influence of the birthdate in the soccer player's career.

Although different mechanisms may explain the reasons for the player's RAE occurrence, one possible explanation is based on biological maturation, with short-term physical differences among youth players and coaches who do not taking into

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account the long-term process of talent development when selecting players (Cobley et al. 2009; Sierra-Díaz et al. 2017). Obviously, relatively older, and advanced matured players may have higher physical, technical, psychological, and behavioral advantages, promoting better performance and visibility compared to later maturing players. Given the pressure for short-term results, these players often may have greater chances of being selected, leading to more incentives and practical opportunities (Helsen et al. 2005). Despite the negative consequences for the player's development, there are no observations concerning changes in RAE in male soccer players, even after 10 years of investigation over this phenomenon (Helsen et al. 2012). However, it is important to emphasize that the equation of RAE with biological maturity has recently been questioned, because relationships between RAE and biological maturity demonstrate that they are independent constructs (Radnor et al. 2021). For instance, while RAE is determined by birth date and cut-off date, biological maturation is determined by a combination of both genetic and environmental factors (Cumming et al. 2018). In addition, it is possible that the oldest boy in an age group would also be the least mature as well as the youngest boy would also be the most mature (Towlson et al. 2021). Therefore, a deeper comprehension about RAE is required.

Although there is a considerable number of studies on RAE in men's soccer, few studies investigated the same phenomenon in women's soccer. In addition, due to the scarcity of studies, some of them present contradictory results. As an example, the RAE was observed in female players of different age groups in the French Football Federation (Delorme et al. 2010), in the second league of the German national championship (Götze and Hoppe 2021) and in Spanish professional female soccer players (Sedano et al. 2015). However, RAE was not found in female players of elite Swiss soccer team (Pino-Ortega et al. 2020), German national teams (Götze and Hoppe 2021), national teams at the Olympic Games (Barreira et al. 2021) and there were marginal and trivial effects on the RAE in women's soccer in the United States compared to men (Vincent and Glamser 2006). When analyzing the RAE by game position, there were significant differences in the RAE between female defenders and goalkeepers of the Swiss national team in relation to the other positions on the field (Pino-Ortega et al. 2020). Same results were found in female goalkeepers and defenders of Spanish regional teams (Sedano et al. 2015). Researchers have also investigated the RAE phenomenon in elite international championships such as World Cup and Olympic Games (Romann and Fuchslocher 2013; Silva et al. 2018; Barreira et al. 2021). Romann and Fuchslocher (2013), for example, found RAE in players who participated in the U-17 Women's Football World Cup between 2008 and 2010. The authors pointed out the RAE in female defenders and goalkeepers from Europe and North and Central America (Romann and Fuchslocher 2011). However, Silva et al. (2018) recently analyzed the RAE throughout all editions of the Women's Football World Cup in the adult category and U-20 players from 1991 to 2015, and they did not find RAE in those players who participated in each edition or between different positions on the field. In general, the contradictory findings indicate the need for further studies on the RAE in elite female soccer players to contribute to increase the number of samples, clarify moderating factors, and provide a better understanding of the global RAE comprehension.

Given that prospect, the aims of this study were fourfold: i) to analyze the RAE in female elite soccer players of different age categories (U-17, U-20, and adult) who disputed in the last editions of the Women's Football World Cup from 2018 to 2019; ii) to analyze the RAE according to the playing position on the field; iii) to check if there are any differences between the birthdate distributions of players who participated in either the group stages or finally the knockout phases; and iv) to analyze the RAE according to the different continental football confederations. We hypothesized that RAE could vary in female elite soccer players according to age categories, playing position, final ranking and football confederations.

Methods

This work is a retrospective and descriptive study with a cross-sectional design.

Participants

Overall, 1224 birthdates of U-17 ($N = 336$), U-20 ($N = 336$) and adult ($N = 552$) elite female soccer players were assessed.

Protocol

The dates of birth, playing positions and national teams of female players who disputed in the Women's Football World Cup from 2018 to 2019 in their age categories (U-17, U-20, and adult) were collected from the FIFA's official website (https://www.fifa.com/womens-football/). National teams were subgrouped according to their continental football confederations, considering AFC – Asian Football Confederation in Asia and Australia, CAF – Confédération Africaine de Football in Africa, CONCACAF – Confederation of North, Central American and Caribbean Association Football in North America and Central America, CONMEBOL – Confederación Sudamericana de Fútbol in South America, OFC – Oceania Football Confederation in Oceania, and UEFA – Union of European Football Associations in Europe.

The months of birth of the players were grouped into quartiles where each quarter of the year is represented by a quartile (Q). The first quartile (Q1) represents the months January, February, and March; the second quartile (Q2) represents April, May, and June; the third quartile represents July, August, and September (Q3); and the last quartile (Q4) represents October, November, and December. All data were tabulated and stored in Microsoft® Excel.

Statistical analysis

The relative and absolute frequencies were used to summarize the collected data. The chi-square and the odds ratio tests were used to analyze the differences between the expected and observed distributions in the months of birth. The expected frequencies were based on the equitable distribution of birth rates throughout the year (25% per quartile). This decision was

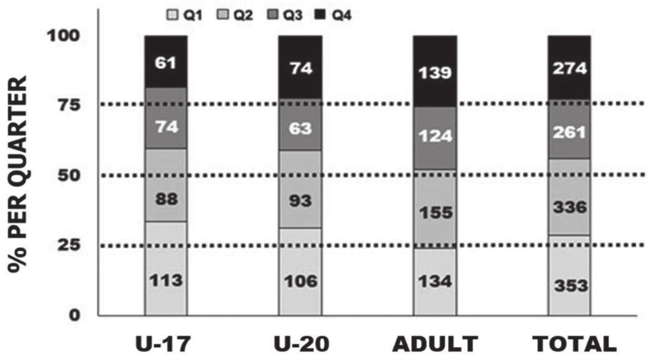

Figure 1. Birth frequency per quartile (Q) of female players who competed in Women's Football World Cups from 2018 to 2019 in the U-17, U-20 and adult categories.

made due to the difficulty of accessing the birth distributions of each studied population (Cobley et al. 2009). To measure the magnitude of the effect size of the values found in the chi-square test, we used the Cramer's V (*V*) (Redd et al. 2018; Pino-Ortega et al. 2020). To interpret the results, we considered *V* of 0.06 to 0.17 as small effect, 0.18 to 0.29 as moderate effect and above 0.30 as large effect (7). We complemented our analysis by normalizing the birth dates from 0 to 1, considering the first day (01–01) and the last day (31–12) of the year. We compared the observed mean and the expected mean (0.5) using the one-sample t-test.

Results

The birthdates of 1224 female soccer players were assessed in U-17 ($N = 336$), U-20 ($N = 336$) and adult ($N = 552$) categories.

Figure 1 shows the birth frequency per quarter and age category. Tables 1, 2 and 3 show the frequencies and inferential statistics of birth quartiles per age category and player position.

We found no statistically significant RAE in the adult category for different playing positions and players in general (including all playing positions per age category). However, for the U-17 and U-20 categories, there were statistically significant RAEs with small effect sizes for midfielders and players in general. In both age categories, players born in Q1 were over-represented with the highest quartile ratio for midfielders. The analysis of the normalized birth date also showed statistically significant RAEs for the U-17 and U-20 categories and no significant RAE for the adult category (Tables 2 & 3, Figure 2).

In regard of final ranking at the World Cup, we found no statistically significant differences between the birthdate distributions of players who participated in either the group stages or finally the knockout phases (Table 4).

The analysis of RAE considering the different continental football confederations revealed varying patterns among the continents (Figure 3). While there is no statistically significant RAE in CAF and CONMEBOL, players from other confederations (AFC, CONCACAF, OFC, and UEFA) showed a significant skewed birth rate compared to the expected mean value (0.5).

Discussion

The aim of the present study was to analyze the RAE in elite U-17, U-20, and adult female soccer players. We hypothesized that RAE could vary according to age categories, playing position, final ranking (group stages or knockout phases), and continental football confederation. Overall, our results suggest no statistically significant differences in adult players, neither by playing position nor between group versus knockout stages. On the other hand, youth players (U-17 and U-20) show significant RAE for playing position of midfielders and for all included players per age category. We found differences among the continental football confederations. Players from AFC, CONCACAF, OFC, and UEFA showed a significant RAE, whereas players from CAF and CONMEBOL showed no significant RAE.

Table 1. Birthdate distribution per quartile (Q) and mean normalized birth of adult female soccer players who competed in the Women's Football World Cup 2019.

Adult Category	Q1 N (%)	Q2 N (%)	Q3 N (%)	Q4 N (%)	X^2	*P*	QR Q1/Q4	*V*	Effect Size	Normalized Mean (SD)	t-value	p-value
DF	45 (25%)	45 (25%)	43 (24%)	47 (26%)	0.17	0.98	0.96	0.02	Small	0.49 (0.28)	0.30	0.76
FW	37 (27%)	40 (29%)	24 (17%)	38 (27%)	4.56	0.20	0.97	0.10	Small	0.47 (0.28)	0.97	0.33
GK	14 (19%)	24 (33%)	17 (24%)	17 (24%)	3.00	0.39	0.82	0.12	Small	0.49 (0.26)	0.28	0.78
MF	38 (24%)	46 (29%)	40 (25%)	37 (23%)	1.21	0.75	1.03	0.05	Small	0.49 (0.27)	0.36	0.72
Total	134 (24%)	155 (28%)	124 (22%)	139 (25%)	3.63	0.30	0.96	0.05	Small	0.48 (0.28)	0.96	0.33

X^2 = Chi-square analysis; QR = Quartile ratio; *V* = magnitude of the effect size the Cramer's V; t-value = one-sample t-test; DF – Defenders; FW – Forwards; GK – Goalkeepers; MF – Midfielders.

Table 2. Birthdate distribution per quartile (Q) and mean normalized birth of U-20 female soccer players who competed in the Women's Football World Cup 2018.

U-20 Category	Q1 N (%)	Q2 N (%)	Q3 N (%)	Q4 N (%)	X^2	*P*	QR Q1/Q4	*V*	Effect Size	Normalized Mean (SD)	t-value	p-value
DF	30 (28%)	35 (32%)	20 (18%)	24 (22%)	4.79	0.19	1.25	0.12	Small	0.45 (0.30)	1.73	0.08
FW	24 (32%)	13 (17%)	20 (26%)	19 (25%)	3.26	0.35	1.26	0.11	Small	0.48 (0.30)	0.45	0.65
GK	13 (27%)	15 (31%)	7 (15%)	13 (27%)	3.26	0.39	1.00	0.11	Small	0.47 (0.28)	0.60	0.54
MF	39 (38%)	30 (29%)	16 (16%)	18 (17%)	13.54	<0.01*	2.17	0.20	Moderate	0.40 (0.29)	3.32	<0.01#
Total	106 (32%)	93 (28%)	63 (19%)	74 (22%)	13.17	<0.01*	1.43	0.11	Small	0.46 (0.29)	2.72	<0.01#

X^2 = Chi-square analysis; QR = Quartile ratio; *V* = magnitude of the effect size the Cramer's V; t-value = one-sample t-test; DF – Defenders; FW – Forwards; GK – Goalkeepers; MF – Midfielders. * - Statistically significant difference between birth frequencies in each quartile in Chi-square analysis ($P < 0.05$). # Statistically significant difference between the mean normalized birth and the expected mean (0.5) in one-sample t-test ($P < 0.05$).

Table 3. Birthdate distribution per quartile (Q) and mean normalized birth of U-17 female soccer players who competed in the Women's Football World Cup 2018.

U-17 Category	Q1 N (%)	Q2 N (%)	Q3 N (%)	Q4 N (%)	X^2	*P*	QR Q1/Q4	*V*	Effect Size	Normalized Mean (SD)	t-value	p-value
DF	29 (30%)	29 (30%)	26 (27%)	14 (14%)	6.24	0.10	2.07	0.14	Small	0.42 (0.27)	2.85	<0.01#
FW	30 (37%)	18 (22%)	18 (22%)	16 (20%)	6.00	0.11	1.88	0.15	Small	0.42 (0.27)	2.47	0.01#
GK	15 (31%)	14 (29%)	6 (13%)	13 (27%)	4.16	0.24	1.15	0.17	Small	0.45 (0.32)	1.04	0.29
MF	39 (36%)	27 (25%)	24 (22%)	18 (17%)	8.66	0.03*	2.17	0.16	Small	0.41 (0.28)	2.99	<0.01#
Total	113 (34%)	88 (26%)	74 (22%)	61 (18%)	17.69	<0.01*	1.85	0.13	Small	0.42 (0.28)	4.82	<0.01#

X^2 = Chi-square analysis; QR = Quartile ratio; V = magnitude of the effect size the Cramer's V; t-value = one-sample t-test; DF – Defenders, FW – Forwards, GK – Goalkeepers, MF – Midfielders. * - Statistically significant difference between birth frequencies in each quartile in Chi-square analysis ($P < 0.05$). # Statistically significant difference between the mean normalized birth and the expected mean (0.5) in one-sample t-test ($P < 0.05$).

The identified decreasing RAE with increasing age categories from youth (U-17 and U-20) to adult level is in line with the literature on RAE in several female sport context (Smith et al. 2018), while the current results related to female soccer are inconsistent (Baker et al. 2009; Delorme et al. 2010; Romann and Fuchslocher 2011; Götze and Hoppe 2021). The reduction of RAE at adult level can be associated with multifactorial causes (Pierson et al. 2014; Wattie et al. 2015; Smith et al. 2018; Gil et al. 2021).

Despite biological maturation has been considered the most frequent variable related to RAE (Müller et al. 2016), this belief has recently been challenged since there is some evidence that talent practitioners do not consider enhanced maturity or relative age characteristics as a desirable factor when selecting players for talent development programmes (Towlson et al. 2019). Moreover, talent practitioners are also less consistent in monitoring and assessment of growth and maturity (Till et al. 2022) and new bio-banding strategies, not based solely on players' age, have been proposed to minimize RAE occurrence (Helsen et al. 2021). However, the long-term effect of these practices in elite adult players remains unclear and most of these suggestions were performed in male players. Therefore, a deeper discussion about the mechanisms to explain RAE in the present study is, at least in part, restricted, suggesting that studies with females are still necessary to enlarge the comprehension about this topic.

Thus, early maturing females tend to be taller, heavier, have more body mass for their stature than late maturing females and have early athletic performance advantages in puberty (Vincent and Glamser 2006). Under the pressure of immediate results, coaches could tend to select relatively older players because they may achieve higher performance in the short term. At adult level, the short-term advantage of early physical maturity is likely no longer present. However, it is important to note that even players who mature late are also able to develop technical and decision-making skills resulting in a larger repertoire of skills at an adult age (Sedano et al. 2015). On the other hand,

From a social perspective, pressures that encourage adolescents to conform to gender-based stereotypes could inhibit females from achieving excellence in competitive sport, especially early maturing females (Guillet et al. 2006). The physical characteristics needed for athletic accomplishment are sometimes opposite to the representation of the ideal female body and may be for some girls the reason to drop out from sport practice during puberty (Romann and Fuchslocher 2011). Thus, such role conflicts could lead outstanding female players to drop out from soccer or to renounce to an elite practice until the adulthood reducing the RAE (Delorme et al. 2010).

Another explanation for the absence of RAE found in elite adult female soccer players could be the depth of competition hypothesis. The hypothesis describes how the ratio of players available for playing rosters and positions could influence an individual's likelihood of participating or being selected for team membership (Smith et al. 2018). The more players competing for a limited number of places on teams or a single team, the more likely it is that the characteristics of relatively older athletes may appear to optimally align with environmental and task demands and the stronger the size of the RAE (Schorer et al. 2015). For instance, while there are over 200 million male soccer players, comparatively about 30 million females play soccer worldwide (Herrero et al. 2014). Therefore, a lower RAE is expected when fewer players participate in the sport (Musch and Grondin 2001; Baker et al. 2009; Delorme and Raspaud 2009; Cobley et al. 2011; Reed et al. 2017; Barreira et al. 2021; Gil et al. 2021).

Concerning the RAE by playing position, we found the RAE in midfielders for both U-17 and U-20 players. Our result is in agreement with a recent report on female soccer players who disputed in the National Chinese Championship (Li et al. 2020). However, it is contrary to the others that found RAE in goalkeepers and defenders from Spain (Sedano et al. 2015), Swiss (Romann and Fuchslocher 2011), Europe, and North and Central America (Romann and Fuchslocher 2013). These differences seem to be justified by local characteristics since different RAE distributions by playing position may be explained by the model to identify, select, and promote female soccer talents in each country. Future studies could take into account tactical functions and different playing systems besides the FIFA's subscription list. Likewise, a more precise distinction between central and wing midfielders (not performed in the present study) could also help to better understand RAE in elite female midfielders.

In terms of RAE and success defined by final ranking at the World Cup, we found no statistically significant differences between the birthdate distributions of players who participated in either the group stages or finally the knockout phases. This result suggests that reaching the knockout phase is based on other factors, such as the quality of training (Baker, Côté & Abernethy, 2003), national talent promotion system (Augste and Lames 2011), and psychological and social assistance of the players (Ericsoon, 2014). In contrast, for German elite male U-17 players, there is a significant relationship between RAE and success (Augste and Lames 2011). However, Augste and Lames (2011) investigated the range correlation between RAE and final rankings of the teams in national championships, which provides a more precise differentiation compared to our study.

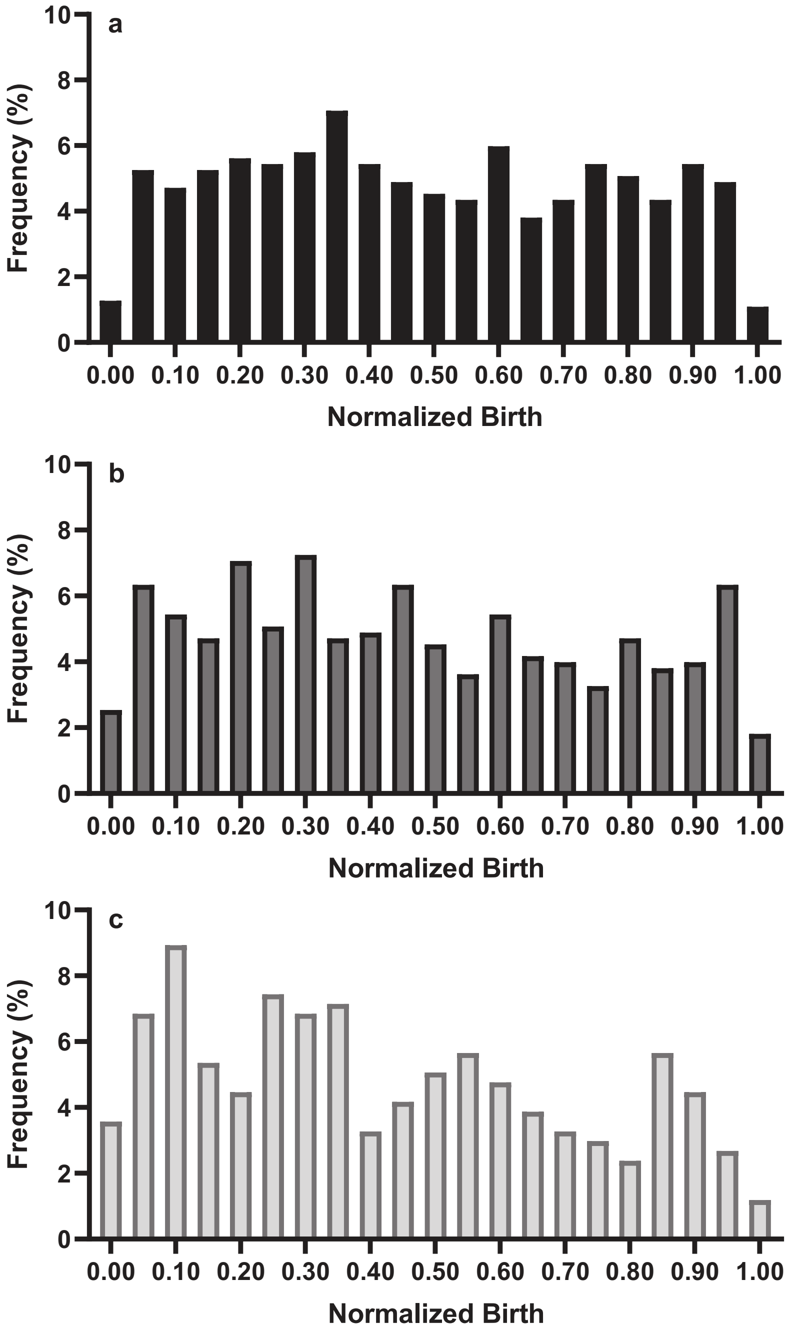

Figure 2. Normalized birth dates of female players who competed in Women's Football World Cups from 2018 to 2019 in the adult (A), U-20 (B) and U-17 (C) categories.

The analysis of RAE of the continental football confederations revealed differences among them. While no RAE was found in CAF and CONMEBOL, we found an over-representation of players born at the beginning of the year of the players in AFC, CONCACAF, OFC, and UEFA. This result is in line with previous findings showing a significant RAE in Europe and North and Central America (Romann and Fuchslocher 2013). According to the authors, the development programmes are carried out more often and the sport is more popular among girls and women in these continents. We may include Asia and Oceania in this scenario nowadays. This increasing popularity and opportunities of practice could lead to more talent-development programmes and to an increased RAE. On the other hand, the South-American and African confederations are those with the lowest number of member associations with a national top women's football league and with the lowest number of registered female players (Fédération Internationale de Football Association 2014).

The most important limitation of our study is the transversal design, which does not allow us to comprehend a longitudinal effect of the RAE in female players. Another limitation is the absence of maturational status information, which should be considered in future longitudinal studies. In this sense, future studies are still necessary to check the long-term RAE from early

Table 4. Birthdate distribution per quartile (Q) of female soccer players who competed in group stages or knockout phases in the Women's Football World Cup from 2018 to 2019.

Category		Q1 N (%)	Q2 N (%)	Q3 N (%)	Q4 N (%)	Inferential statistics
Adult	Group stage	42 (23%)	48 (25%)	44 (24%)	50 (27%)	$X^2 = 1.32$, $P = 0.72$, $V = 0.05$
	Knockout phase	92 (25%)	107 (29%)	80 (22%)	89 (24%)	
U-20	Group stage	61 (32%)	50 (26%)	38 (20%)	40 (21%)	$X^2 = 0.87$, $P = 0.83$, $V = 0.05$
	Knockout phase	45 (31%)	43 (29%)	25 (17%)	34 (23%)	
U-17	Group stage	43 (34%)	27 (21%)	27 (21%)	29 (23%)	$X^2 = 4.41$, $P = 0.22$, $V = 0.11$
	Knockout phase	70 (33%)	61 (29%)	47 (22%)	32 (15%)	

X^2 = Chi-square analysis.

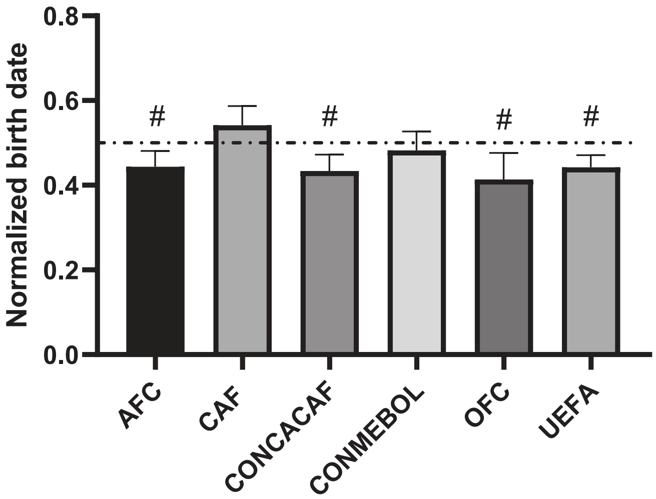

Figure 3. Normalized birth dates of female players who competed in Women's Football World Cups from 2018 to 2019 from different continental football confederations. Legend: data presented as mean and 95%C.I. Broken line represents the expected mean of 0.5. # Statistically significant difference between the mean normalized birth and the expected mean (0.5) in one sample T test ($P < 0.05$).

to adult age-categories in elite female soccer players. Together with the contradictory results found in the literature, this finding makes the RAE an issue that should be better explored and explained in future studies. Another limitation is the comparison of the observed distribution of birthdays of the female players with an equal theoretical expected distribution of birthdays per quarter. This method was applied due to the international sample but may lead to distorted results. At last, although we recognize the differences between countries regarding their sport system and cut-off dates, we chose to use FIFA's categories that comprise players born between January of certain year and December of the subsequent year. This method was also used by previous studies on women's football allowing our comparison with them (Helsen et al. 2005; Vincent and Glamser 2006; Romann and Fuchslocher 2013; Götze and Hoppe 2021).

Summarizing, the RAE in U-17 and U-20 players of this study is based on an over-representation of players born at the beginning of the year and the RAE in elite female soccer decreases from youth to adulthood. For the age groups studied, there is no significant relationship between RAE and success, defined by the final ranking. In conclusion, coaches should know that RAE may enable a bias in the player's identification and selection process and they should create tools and use strategies (Helsen et al. 2005; Mann and van Ginneken 2017) to give opportunity for all players, independently of their birthdates. Midfielders of both U-17 and U-20 categories show significant differences in their quartile birthdate distributions. In order to limit dropouts and non-selection of talents, coaches should enable long-term development of young female soccer players. To this end, youth players must be encouraged to learn to play in several playing positions before specializing in only one playing position and reaching their high-level performance.

Disclosure statement

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References

Auguste C, Lames M. 2011. The relative age effect and success in German elite U-17 soccer teams. J Sports Sci. 29(9):983–987. doi:10.1080/02640414.2011.574719.

Baker J, Cote J, Abernethy B 2003. Sport-specific practice and the development of expert decision-making in team ball sports. J Appl Sport Psychol. 15(1):12–25.

Baker J, Schorer J, Cobley S, Bräutigam H, Büsch D. 2009. Gender, depth of competition and relative age effects in team sports. Asian J Exercise Sports Sci. 6(1):1–7.

Barreira J, Bueno B, Chiminazzo JGC. 2021. Relative age effect and age of peak performance: an analysis of women's football players in the Olympic games (1996-2016). Motriz: Revista de Educação Física. 27:27. doi:10.1590/s1980-65742021006921.

Bezuglov E, Shvets E, Lyubushkina A, Lazarev A, Valova Y, Zholinsky A, Waśkiewicz Z. 2020. Relative age effect in Russian elite Hockey. J Strength Cond Res. 34(9):2522–2527. doi:10.1519/JSC.0000000000003687.

Carraco DDS, Galatti LR, Massa M, Loturco I, Abad CCC. 2020. Centesimal age and relative age effect in elite futsal players. Int J Exerc Sci. 13 (6):329–341.

Cobley S, Baker J, Wattie N, McKenna J. 2009. Annual age grouping and athlete development: a meta-analytical review of relative age effects in sport. Sports Med. 39(3):235–256. doi:10.2165/00007256-200939030-00005.

Cobley S, Wattie N, Baker J, McKenna J. 2011. Relative age effects in female contexts. Sports Med. 41(1):88–90. doi:10.2165/11583970-000000000-00000.

Cumming SP, Searle C, Hemsley JK, Haswell F, Edwards H, Scott S, Gross A, Ryan D, Lewis J, White P, et al. 2018. Biological maturation, relative age and self-regulation in male professional academy soccer players: a test of the underdog hypothesis. Psychol Sport Exerc. 39:147–153. doi:10.1016/j.psychsport.2018.08.007.

Da Costa IT, Albuquerque MR, Garganta J. 2012. Relative age effect in Brazilian soccer players: a historical analysis. Int J Perform Anal Sport. 12(3):563–570. doi:10.1080/24748668.2012.11868619.

Del Campo DGD, Vicedo JCP, Villora SG, Jordan ORC. 2010. The relative age effect in youth soccer players from Spain. J Sports Sci Med. 9(2):190–198.

Delorme N, Boiché J, Raspaud M. 2010. Relative age effect in female sport: a diachronic examination of soccer players. Scand J Med Sci Sports. 20 (3):509–515. doi:10.1111/j.1600-0838.2009.00979.x.

Delorme N, Raspaud M. 2009. The relative age effect in young French basketball players: a study on the whole population. Scand J Med Sci Sports. 19(2):235–242. doi:10.1111/j.1600-0838.2008.00781.x.

Ericsson KA. 2014. The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games. New York: Psychology Press. doi:10.4324/9781315805948.

Fédération Internationale de Football Association. 2014. Women's Football survey 2014. Zurich.

Fédération Internationale de Football Association. (2021). *Women's football strategy*. Retrieved November 03, 2021, from https://www.fifa.com/womens-football/strategy/strategy-details.

Folgado HA, Caixinha PF, Sampaio J, Maças V. 2006. Efeito da idade cronológica na distribuição dos futebolistas por escalões de formação e pelas diferentes posições especificas. Revista Portuguesa de Ciências do Desporto. 6(3):349–355. doi:10.5628/rpcd.06.03.349.

Gil SM, Bidaurrazaga-Letona I, Larruskain J, Esain I, Irazusta J, Gonçalves B. 2021. The relative age effect in young athletes: a countywide analysis of 9–14-year-old participants in all competitive sports. PLoS One. 16(7): e0254687. doi:10.1371/journal.pone.0254687.

Götze M, Hoppe MW. 2021. Relative age effect in elite German soccer: influence of gender and competition level. Front Psychol. 11. doi:10.3389/fpsyg.2020.587023.

Guillet E, Sarrazin P, Fontayne P, Brustad RJ. 2006. Understanding female sport attrition in a stereotypical male sport within the framework of eccles's expectancy–value model. Psychol Women Q. 30(4):358–268. doi:10.1111/j.1471-6402.2006.00311.x.

Helsen WF, Baker J, Michiels S, Schorer J, van Winckel J, Williams AM. 2012. The relative age effect in European professional soccer: did ten years of research make any difference? J Sports Sci. 30(15):1665–1671. doi:10.1080/02640414.2012.721929.

Helsen WF, Starkes JL, Van Winckel J. 1998. The influence of relative age on success and dropout in male soccer players. Am J Hum Biol. 10 (6):791–798. doi:10.1002/(SICI)1520-6300(1998)10:6<791:AID-AJHB10>3.0.CO;2-1.

Helsen WF, Thomis M, Starkes JL, Vrijens S, Ooms G, MacMaster C, Towlson C. 2021. Leveling the playing field: a new proposed method to address relative age-and maturity-related bias in soccer. Front Sports Act Living. 3:24. doi:10.3389/fspor.2021.635379.

Helsen WF, van Winckel J, Williams AM. 2005. The relative age effect in youth soccer across Europe. J Sports Sci. 23(6):629–636. doi:10.1080/02640410400021310.

Herrero H, Salinero JJ, Del Coso J. 2014. Injuries among Spanish male amateur soccer players: a retrospective population study. Am J Sports Med. 42(1):78–85. doi:10.1177/0363546513507767.

Hurley E, Comstock BA, Haile L, Beyer KS. 2019. Relative age effect in collegiate soccer: influence of nationality, playing position, and class. J Strength Cond Res. 33(12):3295–3301. doi:10.1519/JSC.0000000000003356.

Kollars JM, Taber CB, Beyer KS. 2021. Relative age effects in elite Olympic weightlifters. J Strength Cond Res. 35(5):1223–1228. doi:10.1519/JSC.0000000000003882.

Korgaokar AD, Farley RS, Fuller DK, Caputo JL. 2018. Relative age effect among elite youth female soccer players across the United States. Sport Mont. 16(3):37–41. doi:10.26773/smj.181007.

Li Z, Mao L, Steingröver C, Wattie N, Baker J, Schorer J, Helsen WF, Capraro V. 2020. Relative age effects in elite Chinese soccer players: implications of the 'one-child'policy. PLoS One. 15(2):e0228611. doi:10.1371/journal.pone.0228611.

Mann DL, van Ginneken PJMA. 2017. Age-ordered shirt numbering reduces the selection bias associated with the relative age effect. J Sports Sci. 35 (8):784–790. doi:10.1080/02640414.2016.1189588.

Martínez-Lagunas V, Niessen M, Hartmann U. 2014. Women's football: player characteristics and demands of the game. J Sport Health Sci. 3 (4):258–272. doi:10.1016/j.jshs.2014.10.001.

Müller L, Müller E, Hildebrandt C, Raschner C, Sandbakk Ø. 2016. Biological maturity status strongly intensifies the relative age effect in alpine ski racing. Plo*PLoS One*. 11(8):e0160969. doi:10.1371/journal.pone.0160969.

Musch J, Grondin S. 2001. Unequal competition as an impediment to personal development: a review of the relative age effect in sport. Dev Rev. 21(2):147–167. doi:10.1006/drev.2000.0516.

Musch J, Hay R. 1999. The relative age effect in soccer: cross-cultural evidence for a systematic discrimination against children born late in the competition year. Sociol Sport J. 16(1):54–64. doi:10.1123/ssj.16.1.54.

Okholm Kryger K, Wang A, Mehta R, Impellizzeri FM, Massey A, McCall A, Glendinning R, McCall A. 2021. Can we evidence-base injury prevention and management in women's football? A scoping review. Sci Med Footb. 1–10. doi:10.1080/15438627.2022.2038161.

Pierson K, Addona V, Yates P. 2014. A behavioural dynamic model of the relative age effect. J Sports Sci. 32(8):776–784. doi:10.1080/02640414.2013.855804.

Pino-Ortega J, Gómez-Carmona CD, Nakamura FY, Rojas-Valverde D. 2020. Setting kinematic parameters that explain youth basketball behavior: influence of relative age effect according to playing position. J Strength Cond Res. 36(3):820–826. doi:10.1519/JSC.0000000000003543.

Radnor JM, Staines J, Bevan J, Cumming SP, Kelly AL, Lloyd RS, Oliver JL. 2021. Maturity has a greater association than relative age with physical performance in English male academy soccer players. Sports. 9(12):171. doi:10.3390/sports9120171.

Redd MJ, Fukuda DH, Beyer KS, Oliviera LP. 2018. No observable relative age effects in professional surfers: a constraints-based evaluation. Int J Exerc Sci. 11(6):355–363.

Reed KE, Parry DA, Sandercock GR. 2017. Maturational and social factors contributing to relative age effects in school sports: data from the London Youth Games. Scand J Med Sci Sports. 27(12):2070–2079. doi:10.1111/sms.12815.

Romann M, Fuchslocher J. 2011. Relative age effects in Swiss Women`s Soccer. Talent Dev Exc. 3(2):239–247.

Romann M, Fuchslocher J. 2013. Influences of player nationality, playing position, and height on relative age effects at women's under-17 FIFA World Cup. J Sports Sci. 31(1):32–40. doi:10.1080/02640414.2012.718442.

Salinero JJ, Pérez B, Burillo P, Lesma ML. 2013. Relative age effect in European professional football. Analysis by position. J Hum Sport Exerc. 8(4):966–973. doi:10.4100/jhse.2013.84.07.

Sarmento H, Anguera MT, Pereira A, Araújo D. 2018. Talent identification and development in male football: a systematic review. Sports Med. 48 (4):907–931. doi:10.1007/s40279-017-0851-7.

Schorer J, Cobley S, Bräutigam H, Loffing F, Hütter S, Büsch D, Wattie, N, Helsen, W, Baker J. 2015. Developmental contexts, depth of competition and relative age effects in sport: a database analysis and a quasi-experiment. Psychol Test Assess Model. 57(1):126.

Sedano S, Vaeyens R, Redondo JC. 2015. The relative age effect in Spanish female soccer players. Influence of the competitive level and a playing position. J Hum Kinet. 46(1):129. doi:10.1515/hukin-2015-0041.

Sierra-Díaz MJ, González-Víllora S, Pastor-Vicedo JC, Serra-Olivares J. 2017. Soccer and relative age effect: a walk among elite players and young players. Sports. 5(1):5. doi:10.3390/sports5010005.

Silva SP, Silva DP, Albuquerque MR. 2018. Efeito da idade relativa no Futebol feminino: uma análise no decorrer das edições das Copas do Mundo feminina FIFA. Revista Brasileira de Futsal e Futebol. 10 (37):116–123.

Smith KL, Weir PL, Till K, Romann M, Cobley S. 2018. Relative age effects across and within female sport contexts: a systematic review and meta-analysis. Sports Med. 48(6):1451–1478. doi:10.1007/s40279-018-0890-8.

Till K, Lloyd RS, McCormack S, Williams G, Baker J, Eisenmann JC, Piacentini MF. 2022. Optimising long-term athletic development: an investigation of practitioners' knowledge, adherence, practices and challenges. PLoS One. 17(1):e0262995. doi:10.1371/journal.pone.0262995.

Towlson C, Cope E, Perry JL, Court D, Levett N. 2019. Practitioners' multidisciplinary perspectives of soccer talent according to phase of development and playing position. Int J Sports Sci Coach. 14(4):528–540. doi:10.1177/1747954119845061.

Towlson C, MacMaster C, Parr J, Cumming S. 2021. One of these things is not like the other: time to differentiate between relative age and biological maturity selection biases in soccer? Sci Med Footb. 6(3):1–4. doi:10.1080/24733938.2021.1946133.

Van den Honert R. 2012. Evidence of the relative age effect in football in Australia. J Sports Sci. 30(12):1365–1374. doi:10.1080/02640414.2012.707329.

Vincent J, Glamser FD. 2006. Gender differences in the relative age effect among US Olympic development program youth soccer players. J Sports Sci. 24(4):405–413. doi:10.1080/02640410500244655.

Wattie N, Schorer J, Baker J. 2015. The relative age effect in sport: a developmental systems model. Sports Med. 45(1):83–94. doi:10.1007/s40279-014-0248-9.