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ORIGINAL ARTICLE

Relative age effect in Mexican professional and youth soccer

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ABSTRACT

In youth football, categories are defined by the players' year of birth. In one category, there can be an age difference of almost 12 months, which may manifest itself in considerable physical differences. The impact of this "*relative age*" is reflected in elite teams by an overrepresentation of players born in the first months of the year, called "*Relative Age Effect*" (RAE). In the present study, this bias was analyzed among the 4499 Mexican players (3531 men, 968 women), registered by the 18 professional clubs for the 2022 season in men's First Division, their U20, U18, U17, U16, U14 categories, women's First Division, and their U17 categories. From every player were collected: birthday, playing position, minutes played for their teams, and their teams' final rank in the National Championships. In all categories, except women's First Division, a statistically significant RAE was found, whose size was greater in the lower categories than in the major ones. The playing positions that presented a higher size of RAE were not the same in the different categories. A positive correlation was found between RAE and individual and team performances. These results indicate the need to take a deeper look at the selection and development processes of talented players in Mexico, because players initially favored by their greater relative age do not reach the professional soccer teams in the same proportion.

Keywords: Performance analysis, Talent selection, Birth dates, Sports performance, Team sport.

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INTRODUCTION

Children's learning groups are generally constituted according to the chronological age of their members, with the aim of reducing possible differences from the biological and psychological development points of view (Gutiérrez Díaz Del Campo, 2013). Also in children's and youth football, categories are established by chronological age. In 1997, the International Federation of Football Association (FIFA) determined January 1 as the cut-off date for all minor national teams (Helsen et al., 2005). In this way, each category is made up of players born in the same year.

However, among players in a category there can be a chronological age difference of almost 12 months when some have a birthday in January and others in December. "*This age difference between individuals of the same age group is called relative age, and its consequences are known as the Relative Age Effect (RAE)*" (Musch and Grondin, 2001, p. 147). This age difference may result in a considerable biological difference. You may find "*cases of athletes who, at the age of 14, will differ from each other by more than 10 cm in height and 10 kg in weight, having been born in the same calendar year*" (Lesma et al., 2011, p. 38). Among 10-years-old children, those born at the beginning of the year already have a lifespan 10% longer than their peers born at the end of the year. This advantage can translate into greater experience in playing and training, which increases the probability of "*being chosen for selective teams and high skill groups*" (Musch and Grondin, 2001, p. 159). These authors concluded, based on the results of research related to a wide range of factors, that RAE is explained only through a complex network of physical, cognitive, emotional and motivational characteristics.

Since the first publications on RAE in youth ice hockey players in Canada (Grondin et al., 1984) and in the United States (Barnsley et al., 1985), the number of scientific investigations on this topic increased considerably. The best-known review articles (e.g., Musch and Grondin, 2001; Gutiérrez Díaz Del Campo, 2013) report studies on a wide variety of sports (soccer, ice hockey, basketball, tennis) and countries (United States, Canada, Australia, Germany, France, Spain).

Helsen et al. (2005) compared the RAEs in the national teams of 10 countries that participated in the U15, U16, U17 and U18 European Championships. Their results show the great impact of the RAE on talent selection processes, because basing them on physical characteristics at an early age "*could be problematic when after the maturation process this advantage is no longer present and technical ability could be the decisive factor for the achievement of sporting success. […Thus,] a significant amount of talent could be lost*" (p. 634).

Different causes of RAE are discussed in the publications. González Aramendi (2007) mentions the greater physical (weight, height, muscle mass), physiological (speed, endurance, strength) and psychological maturation (self-esteem, psychological resistance) of relatively older players. The author compared the RAE in four Spanish football leagues of different performance levels and observed that "*the presence of the RAE is more important among highly competitive teams, which supports the theory of competition as one of its main causes*" (p . 11).

The RAE not only has consequences for children and young people who are disadvantaged in the talent selection processes, it can also have negative consequences for the sports clubs themselves, as it may be the cause of a not well identified drain of talents (González Aramendi , 2007). If the RAE in professional teams is smaller than in youth teams, the talent selection process cannot be effective.

For this reason, the purpose of this study was the analysis of the RAE in the 18 professional Mexican soccer clubs, comparing the sizes of this effect between the First Division and the youth teams in general and with respect to playing positions and the individual and collective performance levels.

MATERIAL AND METHODS

Selection of samples

The Technological Innovation Center (CITEC) of the Mexican Football Federation (FMF) offered the following data from 3531 men's players, registered by the 18 professional clubs for the 2022 tournament (January-May 2022) in the First Division and U20, U18, U17, U16, and U14 teams: date of birth, playing position (goalkeeper, defender, midfielder, forward) and minutes played during the corresponding championship. In addition, the ranking obtained by each team at the end of their tournament were recorded. The same data was obtained from 968 players of the women's First Division and U17 teams.

Players of foreign nationality were excluded, because they may have been selected by different criteria of sports talents as in Mexico. Table 1 shows the number of players included in the study population, divided into subgroups formed by categories and positions.

The analysis of the collected data was carried out without knowing in advance what the relationships between the different variables would be. For this reason, no specific hypotheses were established about the expected results.

Table 1. Distribution of the total sample of 3531 Mexican male and 968 female players, registered by categories and playing positions.

Position	Men's Categories						Women's Categories	
	1st Div.	U20	U18	U17	U16	U14	1st Div.	U17
Goalkeeper	63	72	46	69	48	52	52	50
Defender	193	190	171	202	168	165	141	171
Midfielder	238	260	197	274	234	196	186	178
Forward	97	138	99	137	113	109	101	89
Total	591	660	513	682	563	522	480	488

Procedure

All data were transferred to an Excel database for subsequent statistical analysis. The distributions of the players' birthdays by month were determined, according to the subgroups defined by the categories and playing positions. To determine the statistical significance of the RAE, the chi-square test was applied to the distribution of those born in the four quarters of the year, considering that the percentage should be approximately the same for each quarter.

In order to compare the RAE between different groups of players, a parameter must be determined that reflects its size in a single number. In studies about the RAE, different parameters have been proposed, such as the percentage of those born in the first trimester (Helsen et al., 2005) or in the first semester of the year (Lesma et al., 2011); the median number of birthdays (Augste and Lames, 2011) or the value of the chi-square statistic when comparing the empirical distribution of birth dates with the uniform distribution (e.g., Iglesias-Caamaño et al., 2016).

For this research, the percentage of those born in the first semester was used, because it is more common than the first and facilitates comparison with other studies. To determine the significance of the size of an RAE and to be able to compare our results with those of previous studies, the percentages of births by quarter of the year were also calculated.

As an indicator for the individual performance of the players, the minutes played in the teams for which they were registered were taken, considering that greater participation is based on greater performance of the player. The greater or lesser collective performance was determined according to the final ranking of the teams in their national championship.

RESULTS

The size of RAE by categories

Figure 1 presents the relative frequency (percentages) of birth months, grouped by quarters. It can be seen that the percentage of those born in the first trimester increases and the percentage of those born in the last trimester decreases as the age of the categories decreases. Only the U14 presents percentages very similar to those of the U17 and U18.

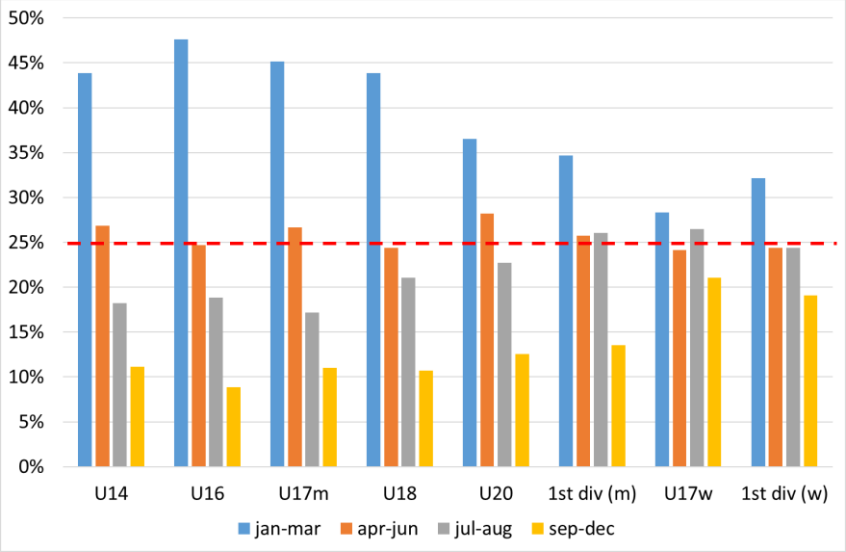

Figure 1. Distribution of months of birth, grouped by quarters and expressed by percentages, of the Mexican players registered in eight national categories of Mexican soccer (men's and women's teams). The red line indicates the percentage expected for a uniform distribution (1/4 = 25%).

Table 2 shows the results of the chi-square test, applied to evaluate whether these distributions differ from a uniform distribution. All men's categories and women's U17 presented highly significant differences (χ^2 > 16.3, p < .01); only for the women's First Division this difference was not significant (p > .1). A higher value of the chi-square test means a higher RAE size.

Table 2. Values of the chi-square test to evaluate the statistical significance of the RAE size.

Categories	Men						Women	
	1st Div.	U20	U18	U17	U16	U14	1st Div.	U17
χ^2 values	53.6	79.8	118.1	181.9	182.2	125.0	5.7	17.1

Figure 2 compares the percentages of players born in the first semester of each category. It shows that the RAE decreases almost linearly as the age of the categories increases. Only the U14 category is again located between the men's U17 and U18, similar to the values of the chi-square test (see Table 2). The RAE of both women's categories are lower than those of all men's categories. However, it repeats the finding of the male categories that the RAE is higher in the youth category.

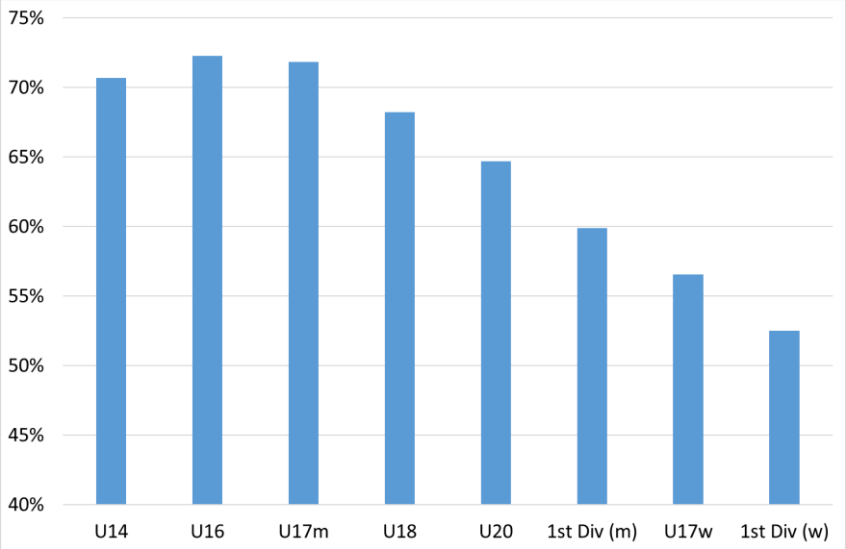

Figure 2. Percentages of players born in the first semester of the eight categories as a parameter for the size of RAE.

The size of RAE by playing positions

Table 3 presents the values of the chi-square test, applied to the distribution of births by quarters, to determine the statistical significance of the RAE with respect to the playing positions of each category. Almost all positions in the men's categories present a significant RAE, except the forwards of the First Division and the U16 goalkeepers. For all positions in both female categories, the distributions do not differ from a uniform distribution; only U17 defenders and midfielders present a significant RAE ($p < .05$).

Table 3. Determination of the statistical significance of the RAE by playing positions in the eight categories studied. Chi-square test calculations are based on the distribution of births by quarter.

Position	1st Div.	U20	U18	U17	U16	U14	1st Div.	U17
Goalkeeper	**12.7**	**10.2**	**19.2**	**38.2**	3.8	**27.8**	4.2	0.4
Defender	**17.3**	**20.6**	**49.5**	**63.1**	**50.2**	**53.0**	2.7	**10.6**
Midfielder	**29.7**	**33.0**	**24.0**	**50.5**	**92.4**	**28.7**	3.7	**12.7**
Attacker	2.2	**21.6**	**32.7**	**37.6**	**43.3**	**23.9**	0.7	3.3

Note. Values in bold are statistically significant. For $\chi^2 > 7.8$, the level of significance is $p < .05$; for $\chi^2 > 11.3$, it is $p < .01$; and for $\chi^2 > 16.3$, it is $p < .001$.

Figure 3 presents the percentage of those born in the first semester for the positions of each category. Trends found for the categories in general are not completely reproduced for the positions. For example, U16 goalkeepers have the lowest RAE, even though this category has the highest RAE; midfielders and forwards carry "*the weight*" of the RAE in this category. However, globally, a trend of increasing RAE with decreasing category can be recognized.

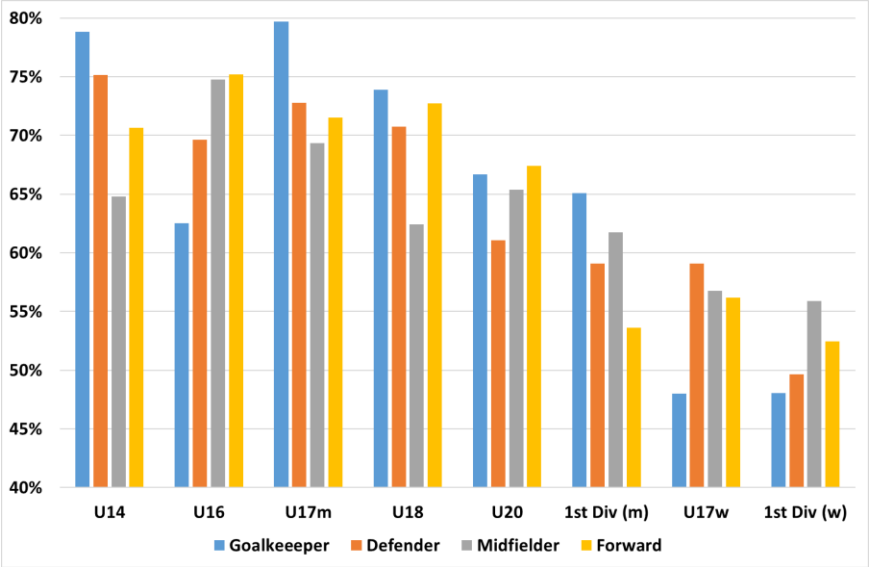

Figure 3. Comparison of the RAE of each category by playing positions, expressed by the percentage of those born in the first semester.

Female teams present a lower RAE than male teams in the different positions. However, the U17 defenders have a RAE very similar to that of men's 1st Division and U20, and the non-significant RAE of the forwards of both women's categories corresponds to the same level of RAE of the men's First Division.

In men's teams, the goalkeeper is the position with the highest RAE for each category (except U16). It is interesting that the situation in the women's categories is reversed, since the goalkeepers have the lowest RAE. The other positions have a very irregular behaviour in the comparison between the different categories, without being able to identify any trend.

Relationship between RAE and individual performance

As indicator of individual performance, the minutes each player participated in all games in his category were considered. To analyse the relationship of this indicator with RAE, the group of players in each category was splitter into two halves: those who played more minutes than the median and those who played less. Subsequently, the percentages of those born in the first semester of both groups were compared. If there was no relationship between RAE and individual performance, both percentages should be similar.

Figure 4 shows that, in men's teams, higher level players have a higher RAE, with a tendency to decrease this difference from the 1st Division to U16; only in U14, the difference is almost the same as in 1st Division. The differences for 1st Division, U20 and U14 are statistically significant, applying the test for the comparison of proportions (Daniel, 1995).

In women's teams, the situation is the other way around: the differences are in favour of the players with a lower level of performance and the difference in U17 is greater than in 1st Division, although these differences are minimal and not significant.

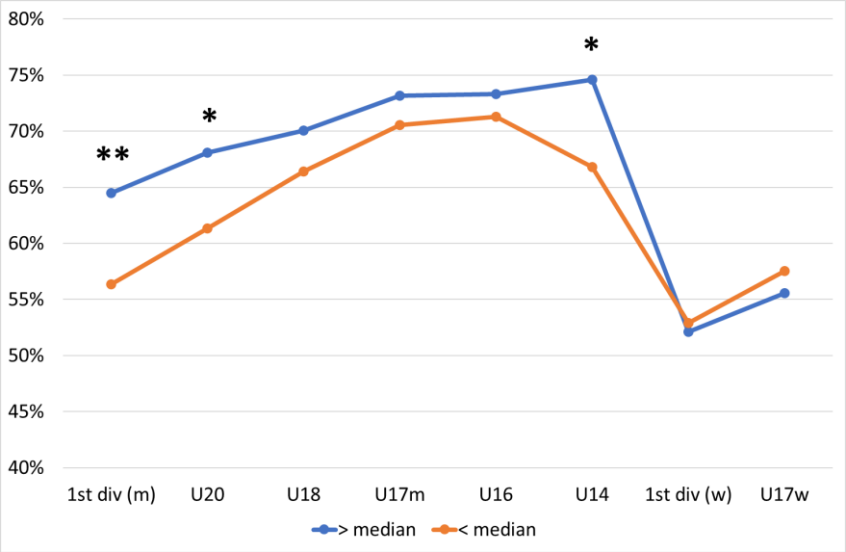

Figure 4. RAE size, expressed for each category by the percentage of those born in the first semester, for the group of players with more minutes played than the median (>median) and the group with fewer minutes played (< median). * $p < .05$; ** $p < .01$.

Relationship between the size of RAE and collective performance

Figure 5 compares the average percentages of those born in the first half of the teams in the first and second half of the final ranking for each category. In the youth categories, the highest level teams have a higher RAE, with a statistically significant difference for U16, U18 and U20, evaluated by Student's t-test. However, no pattern can be identified between them either. For the First Division teams the differences are reversed, although they are not statistically significant. That may mean that the RAE is less important for collective performance in professional teams than in youth teams.

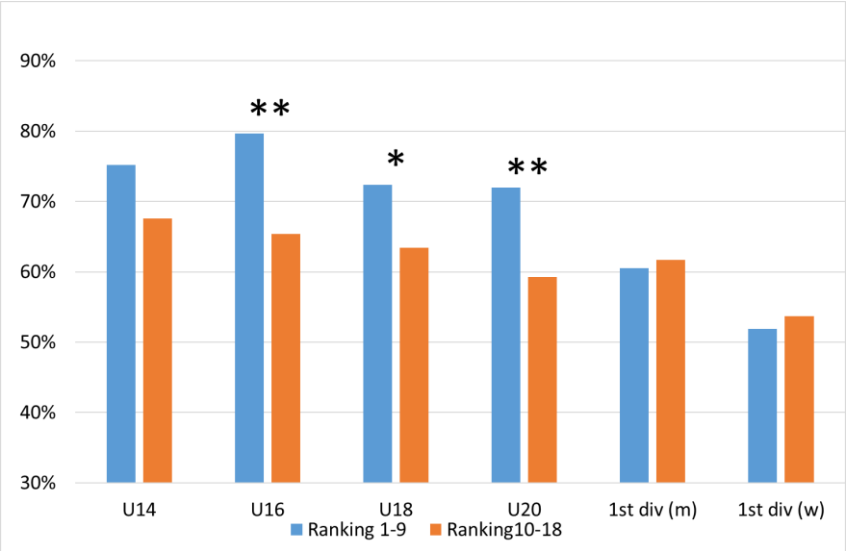

Figure 5. Comparison of the mean RAE sizes (measured by the percentage of those born in the first semester) between the teams in the first and second half of the final ranking in each category. * $p < .05$; ** $p < .01$.

DISCUSSION

The size of RAE by categories

With respect to the professional leagues (First Division), the results of the present study on the existence and size of RAE (60.4% of those born in the first semester; see Figure 2) coincide with the findings in several previous studies from other countries. Lesma et al. (2011) indicated that, in the 2009/10 season, 61.1% of the 481 players in the Spanish First Division were born in the first half of the year, confirming a trend of increasing RAE, since in the season 2002/03 the corresponding data was 54.7% (n = 461, according to González Aramendi, 2007) and in 2004/05, 56.3% (without indication of the sample size; according to Martín-Acero et al., 2005).

In more recent studies, Salinero et al. (2013) analysed five professional leagues in Europe from the 2009-2010 season and found similar values in Spain (n = 482) with 61.5%, in Italy (n = 603) and France (n = 574), both with 59.0%. Germany and England presented lower percentages with 54.0% (n = 515) and 50.5% (n = 589), respectively. Finally, the Brazilian First and Second Division leagues reported, in the 2019 season, 61.5% (n = 1399) and 63.4% (n = 1261), respectively (Figueiredo et al., 2022).

Comparing the RAE in youth leagues, González Aramendi (2007) found in Spain, similar to the results of the present study (see Figure 2), sizes greater than in the professional league: of a total of 301 youth players between 17 and 19 years of age from the Basque, National and Honor Division, registered in the 2002/03 season, 65.4% were born in the first semester, against 54.7% in the Spanish First Division. Grossmann and Lames (2013) compared the RAE between the German national teams of U15, U17, U19, U20 and U21 categories and concluded that "*in all teams a significant RAE was found with the tendency for older teams to present a lower RAE*" (p. 131), mentioning that "*it is widely accepted that in younger age groups there are more pronounced RAE sizes than in older teams*" (p. 131).

In other studies, international tournaments were analysed. According to Helsen et al. (2005), of the players of the teams participating in the European championships, 49.0% (U16, n = 288; in present study 47.6%), 29.9% (U18, n = 144; in present study 43.9%), 27.7% (U21, n = 159; in present study U20, 36.5%) were born in the first; that is, the size of the RAE decreased as the age of the participants increased. In the U17 and U19 European championships of the years 2019-2022, Andrew et al. (2022) determined in the men's teams, a percentage of 70.5% and 67.1%, respectively, of those born in the first semester. Regarding the women's teams, the U17 presented a percentage of 55.9% and the U19 59.0%, again very similar to our percentage of 56.6% for the U17 category (see Figure 2). Isin (2021) studied the teams that finished among the first three places in six World Championships in men's U17 and U20 categories between 2009 and 2019, obtaining averages of 66.7% and 63.2%, respectively, of those born in the first semester.

With these comparative data it can be seen that the RAE sizes in Mexican professional and youth teams behaves very similar to those in other countries. Above all, it is shown that RAE size is considerably higher in the youth categories than in professional soccer. Andrew et al. (2022) concluded in their study that "*male soccer players who competed at the U17 and U19 levels were overrepresented by players born at the beginning of their selection year. This bias did not transfer to the professional level, thus questioning the effectiveness of this (un)conscious bias.*" (p. 8)

The reduction of RAE sizes in older categories implies that, throughout the talent development process, initially favoured players are lost in a greater proportion than those born in the second half of the year who initially had more problems entering the national teams.

With respect to women's teams, it is observed (see Figure 2) that RAE sizes in both categories analysed are lower than in the corresponding male categories. Even the RAE of the women's First Division is minimal and insignificant. In a comparative study between women's and men's football, Andrew et al. (2022) have found the data presented in Table 4. U17, U19 and Senior national teams of 55 countries that participated in the qualifying phases of their corresponding European Championships in 2021 were considered. The RAE was statistically significant only for both U17 and U19 categories of men's soccer and for no women's category. In the youth categories, the RAE was higher in men's soccer, while in the Senior category only a small difference was found between both sexes. In each case, the RAE in the youth categories was higher than in the Senior categories.

Table 4. RAE in the women's and men's teams of the national teams of the European countries that participated in the qualifying phases of the U17, U19 and Senior European championships in 2021, expressed by the percentages of those born in the first trimester and in the first half of the year (Andrew et al., 2022).

Categories	Women's soccer			Men's soccer		
	Sample	1st trim.	1st sem.	Sample	1st trim.	1st sem.
U17	n = 324	26.9%	55.0%	n = 1187	43.2%	70.5%
U19	n = 293	33.1%	59.0%	n = 1229	39.6%	67.1%
Senior	n = 1770	24.9%	54.2%	n = 1743	30.1%	55.0%

In a second study, Brustio et al. (2023) analysed the RAE among women players in U17, U19, and Senior categories, registered by the Italian National Federation in November 2022. Their results presented a distribution of births per quarter significantly different from a uniform distribution for both U17 and U19, but not for the Senior category. Specifically, the RAE decreased as the age of the categories increased (see Table 5), which is a similar result to that of the men's teams, but less pronounced. The authors conclude that "*as the development of women's football continues to advance, it is important to learn from the many mistakes along talent trajectories [towards professionalism…]. The talent selection and deselection processes should take into account and favour the potential of the players instead of the current performance to reduce the temporary disadvantage of relatively younger players.*" (p.9)

Table 5. RAE in Italian women's teams, expressed by the percentages of those born in the first quarter and in the first semester of the year (Brustio et al., 2023).

Category	Sample (n)	Born in 1st trimester	Born in 1st semester
U17	416	36.3%	61.3%
U19	265	32.8%	57.0%
Senior	93	25.8%	57.0%

This conclusion coincides with the result of the present study regarding the female categories. It should be noted that the development of women's soccer in Mexico has begun with the first National Championship in 2017. This suggests that there are still much fewer players competing for places in professional soccer than in men's teams. The lower pressure in the selection of talented women players may explain the lower RAE size.

The size of the RAE by playing positions

Table 6 compares the data from the present study of men's U17 players born in the first half of the year, with the same data from the U17 World Championship 2013 (Sallaoui et al., 2014). The data show a big difference for goalkeepers who have the highest RAE in Mexico, but the lowest in the World Championship. Considering

the importance of height, you can expect that this position would have the highest RAE in youth teams. Despite this difference, the mean RAEs of both entire groups of players are the same: 71.8% vs 71.7%.

Table 6. Comparison of percentages of male players born in the first semester, according to playing positions, between the present study and the U17 World Championship 2013 (according to Sallaoui et al., 2014).

Categories	Goalkeeper	Defender	Midfielder	Forward	All
U17 men	79.7	72.8	69.3	71.5	71.8
U17 WCh	65.0	71.3	73.4	74.1	71.7

In their study, Sallaoui et al. (2014) concluded that "*birth date distribution of the position of soccer players differed significantly [from a uniform distribution] in three positions (defender (DF), midfielder (MF) and striker (FW)). Moreover, there was no influence of age class on the position of goalkeeper (GK)...*" (p. 38).

Lesma et al. (2011) concluded in their study, with respect to the RAE by positions in the professional teams of Spain, that "*in all cases there is a significant RAE, being lower in the forwards (55.4% born in the first semester) and highest in defenders (64.2%), midfielders (61.0%) and goalkeepers (62.2%)*" (p. 43). This corresponds to the results of the present study (see Figure 3, men's 1st div.).

Gutiérrez Díaz del Campo et al. (2010) did not find significant differences between the percentages of goalkeepers, defenders, midfielders and forwards born in the first half of the year, which indicates that there is no reason to confirm that playing positions have a systematic influence in the size of RAE.

Considering the very varied results of these investigations and the present study, one must be cautious with the comparison of the RAE by playing positions. The trend found in Mexican soccer that goalkeepers are relatively younger than players in other positions and that forwards in all categories have a lower relative age than midfielders requires a deeper analysis and continuous monitoring to be able to find possible patterns.

Relationship between relative age and individual and team performance

If the RAE is a consequence of the selection of the best players at this time, then there must be a relationship between RAE size and the level of performance of the players and teams. This would imply that relatively older players and teams with older average ages would have more sporting success in their competition categories.

Vaeyens et al. (2005) analysed the birthdays of 498 players from the semi-professional Second and Third Divisions of Belgium and found "*a significant relationship between birth months and the number of games played […] and minutes played*" (p. 749). This meant that higher individual performance was related to higher RAE, confirming the results of the present study (see Figure 4).

However, Figure 4 shows that the difference between the RAE of the group of players with more playing time and the group with less playing time increases with increasing age of the male categories. The largest and highly significant difference between the First Division players indicates that the RAE impacts more on the group of players with the highest level, which is a result that would be expected for the minor categories. Therefore, it would be important to conduct more analyses of this type in the future; in the past, no research has been found that has reported comparative results.

With respect to the women's categories, the RAE of the groups of First Division players with higher and lower level are practically the same. In the case of U17 category, the lowest level group presented a higher RAE

than the highest level group, although this difference was small and statistically non-significant. This shows that in the women's teams a relationship between the individual level and RAE size could not be verified. Also in this case, no previous publications were found to verify or refute this conclusion.

Augste and Lames (2011) analysed the birthdays of 911 players from the 41 best German youth teams in the U17 category in the 2008/09 season and found a positive and statistically significant relationship between the final classification of the teams in the three German First Youth Divisions and the median birthdays of its players. Therefore, they concluded that "*the higher the RAE of a team, the greater the probability of finishing in a better place in its league. Teams with a higher RAE are better classified, score more goals (although not significantly) and concede fewer goals*" (pp. 985-986).

Grossmann and Lames (2013) compared the RAE of the Germany's First Youth Division teams (U17) between professional and amateur clubs and found a significant difference in the number of players born in the first three months of the year between both team groups: 50.6% (n = 603) and 37.4% (n = 257), respectively. This indicated that the greater competition of being selected in professional clubs caused a greater RAE in these teams. In the U19 category, the corresponding percentages were 43.1% (n = 677) and 35.6% (n = 348), respectively; the difference between the median birthdays was not significant. That is, the relationship between the competitive level and RAE size decreased by increasing age. These results are consistent with those of the present study, where a positive, although irregular, relationship could be established between the level of performance of the youth teams and the average RAE of their players (see Figure 5). This relationship disappears in the professional categories in both men and women, which indicates that the impact of the players' relative age on collective performance decreases as the physical and technical-tactical differences between the players of the same team (or the same category) decrease.

This observation substantiates, once again, that in the selection of talented players their current performance should not be the most important criterion, but rather their projection into the future, that is, their potential to become an extraordinary professional player. It is clear that the determination of potential is much more complex and difficult than the evaluation of performance at a given moment, which should not discourage selectors and coaches from finding possible solutions and, much less, from deselecting too quickly the relatively younger players.

CONCLUSIONS

The results of the present study can be summarized in the following conclusions:

- In all male categories studied there is a statistically significant RAE.
- The size of RAE in the minor categories was greater than in the major categories.
- The RAE is not the same for the different playing positions, this means that a trend was not observed as to which positions present greater RAE sizes.
- Players with a higher level of performance have a higher RAE than players with a lower level of performance. This is valid only for men's categories; in the female teams, this relationship could not be evidenced.
- Teams with a higher level of collective performance tend to have a higher RAE, although this correlation is not statistically significant for all categories.

On the other hand, the diminishing impact of relative age on professional teams indicates the need to analyse the processes of selection and development of talented players, as it appears that many of the players more

deeply initially favoured by their older relative age, they do not reach professional soccer teams in the same proportion. For this reason, follow-up studies will have to be carried out on Academy players throughout their football careers to detail the degree and reasons for a possible inefficiency in the development process of talented soccer players.

In the literature, different propositions have been discussed to counteract RAE in youth teams. The most important is to raise awareness among youth soccer coaches and spectators about RAE and its negative consequences. In this way, it would be possible to unify criteria for the selection and monitoring of sporting talents, as well as to offer those not selected opportunities to continue training and competing in order not to lose the most biologically retarded and, therefore, disadvantaged talents. Helsen et al. (2005) clearly demand that "*the philosophy of future coaches in general and, specifically, of those involved in professional clubs, should be guided more by the premise that 'there is more to what training is better than just winning'*" (p. 635).

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author.

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