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Analysis of the Relative Age Effect According to Player Positions in the UEFA Champions League and UEFA Europa League: A Descriptive Study

UEFA Şampiyonlar Ligi ve UEFA Avrupa Ligi'nde Oyuncu Pozisyonlarına Göre Bağıl Yaş Etkisinin Analizi: Tanımlayıcı Araştırma

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ABSTRACT Objective: This study aimed to investigate the presence and magnitude of the Relative Age Effect (RAE) among professional soccer players included in the squads of teams participating in the Union of European Football Associations Champions League (UEFA CL) and Europa League (UEFA EL) during the 2023-2024 season. Additionally, it examined whether the distribution of players' birth quarters varied across leagues and playing positions. **Material and Methods:** The sample included 2,168 professional soccer players from 64 teams in the UEFA CL and UEFA EL group stages. Players' birthdates were categorized into four quartiles: Q1 (January-March), Q2 (April-June), Q3 (July-September), and Q4 (October-December). Data were manually collected from publicly available soccer statistics websites. A chi-square analysis was performed to examine birth quartile distributions across leagues and playing positions. **Results:** The study found a significant RAE, with 32.0% of players born in Q1 and only 19.4% in Q4. This pattern was consistent across both the UEFA CL and UEFA EL, indicating no significant difference between leagues. The distribution of birth quartiles did not significantly differ by playing positions (goalkeepers, defenders, midfielders, forwards). **Conclusion:** The findings demonstrate the persistent impact of RAE in elite European soccer, favoring players born earlier in the year. This bias is consistent across different leagues and positions, highlighting the need for equitable talent identification processes. Addressing RAE could enhance inclusivity and diversity in talent selection, ultimately improving the overall quality of professional soccer.

Keywords: Soccer; relative age effect; Union of European Football Associations Champions League; Union of European Football Associations Europe League

ÖZET Amaç: Bu çalışma, 2023-2024 sezonunda Avrupa Futbol Federasyonları Birliği Şampiyonlar Ligi (UEFA CL) ve Avrupa Ligi'nde (UEFA EL) mücadele eden takımların kadrolarında yer alan profesyonel futbolcular arasında Bağıl Yaş Etkisi'nin (BYE) varlığını ve büyüklüğünü araştırmayı amaçlamıştır. Ayrıca, oyuncuların doğum çeyreklerine göre dağılımının ligler ve oynadıkları pozisyonlara göre değişip değişmediği incelenmiştir. **Gereç ve Yöntemler:** Çalışmanın örneklemi, UEFA CL ve UEFA EL grup aşamalarında yer alan 64 takımdan 2.168 profesyonel futbolcudan oluşmuştur. Oyuncuların doğum tarihleri, dört çeyreğe ayrılmıştır: Q1 (Ocak-Mart), Q2 (Nisan-Haziran), Q3 (Temmuz-Eylül) ve Q4 (Ekim-Aralık). Veriler, kamuya açık futbol istatistik sitelerinden manuel olarak toplanmıştır. Doğum çeyreklerinin liglere ve oyuncu pozisyonlarına göre dağılımlarındaki farklılıkları incelemek amacıyla ki-kare analizi yapılmıştır. **Bulgular:** Çalışma, anlamlı bir BYE'nin varlığını ortaya koymuştur; oyuncuların %32,0'si Q1'de doğarken, yalnızca %19,4'ü Q4'te doğmuştur. Bu durum UEFA CL ve UEFA EL'de tutarlılık göstermiş ve ligler arasında anlamlı bir farklılık olmadığını ortaya koymuştur. Doğum çeyreklerine göre dağılım, oyuncuların pozisyonlarına (kaleci, defans, orta saha, forvet) göre anlamlı bir farklılık göstermemiştir. **Sonuç:** Bulgular, elit Avrupa futbolunda BYE'nin kalıcı bir etkisinin olduğunu ve yılın erken aylarında doğan oyuncuların avantajlı konumda bulunduğunu göstermektedir. Bu yanlılık, farklı ligler ve pozisyonlar arasında tutarlıdır ve yetenek belirleme süreçlerinin daha kapsayıcı hale getirilmesi gerektiğine işaret etmektedir. BYE'nin ele alınması, yetenek seçiminde kapsayıcılığı ve çeşitliliği artırarak profesyonel futbolun genel kalitesini yükseltebilir.

Anahtar Kelimeler: Futbol; bağıl yaş etkisi; Avrupa Futbol Federasyonları Birliği Şampiyonlar Ligi; Avrupa Futbol Federasyonları Birliği Avrupa Ligi

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Sport organizations typically organize children and teenagers into chronological age cohorts, typically consisting of one or 2 years, to establish age bands and competitive divisions. This is particularly crucial when it comes to team sports.[1] The various classifications that come from these groups show how the people who make them up have changed over time. The difference in age of up to 12 months is called relative age, and the effects of it are called the Relative Age Effect (RAE).[1-3] RAE is a well-documented phenomenon in sports, reflecting the impact of an athlete's birth date relative to a cutoff date used for age-group classifications. This effect benefits those born closer to the cutoff, often leading to an overrepresentation of relatively older individuals in youth and professional sports teams. In European elite soccer, including the Union of European Football Associations Champions League (UEFA CL) and UEFA the European League (EL), the RAE has significant implications for talent identification, player development, and team selection.[4]

For example, in a group of players who were all born in the same year, those who were born in January are almost a whole year older than those who were born in December. This age disparity may result in variations in height, strength, and skill levels, thus granting the older children a competitive advantage.[5] Over time, the early benefits experienced by older individuals might result in increased possibilities for training, coaching, and selection for higher-level teams. This creates a self-reinforcing cycle of success.

RAE has been studied in a wide range of sports. These sports include soccer, ice hockey, basketball, and volleyball.[6-12] The results show that the relative age impact is present in both team and individual sports. In particular, the RAE phenomenon affects soccer players all over the world. It has been the premise of most RAE studies that a soccer player's maturity level and the month they were born could be deciding factors in their success.[1] These soccer-specific studies consistently describe and present evidence of a strong RAE at various league levels across various countries (e.g., Türkiye, Germany, Spain, England, Belgium, and the United States of America). This phenomenon is a likely reason for the undervaluation of young players. Padrón-Cabo et al. found that, with the exception of the English Premier League, the majority of professional leagues across the globe exhibit a significant RAE.[13] This highlights the pervasive influence of relative age on soccer players' success and selection worldwide.

Currently, soccer stands as the most widely favored sport among all others. Over time, several studies have been carried out focusing on how RAE affects the UEFA CL, including.[14,15] However, we have observed that no study has examined the relative age effect in both the UEFA CL and UEFA EL, along with the players' position and league level. This research is important because it has the potential to inform more equitable talent identification and player development strategies, ultimately improving the fairness and inclusivity of player selection processes in elite competitions. The aim of our study was to investigate the presence and magnitude of the RAE among professional soccer players who participated in the UEFA CL and UEFA EL during the 2023/24 season.

MATERIAL AND METHODS

PARTICIPANT

The sample consists of all players (n=2,168) from the squads of 64 soccer teams that participated in the group stages of the UEFA CL and UEFA EL during the 2023/24 season, as reported by the clubs to UEFA. The characteristics of the sample are presented in Table 1. The study was conducted in accordance with the tenets of the Declaration of

TABLE 1: Sample distribution according to the variables analysed.

Variables	Variables	f	%
Competition	UEFA CL	1121	51.71%
	UEFA EL	1047	48.29%
Game position	Goalkeeper	286	13.19%
	Defender	706	32.56%
	Midfield	688	31.73%
	Forward	488	22.51%

f: Frequency; %: Percentage. UEFA CL: The Union of European Football Associations Champions League; UEFA EL: The Union of European Football Associations European League.

Helsinki and approved by the Ethics Committee of Nevşehir Hacı Bektaş University Non-Interventional Clinical Research Publication (date: March 8, 2024; no: 2400021646).

MEASURES

The data were manually collected, following a similar procedure to several previous studies such as Arslan et al., Yagüe et al. and Yagüe et al. from 2 publicly accessible soccer statistics websites, www.transfermarkt.com and https://www.uefa.com/.[1,7,16] The year was divided into 4 quartiles because the cut-off date was set to January 1. The classification and definition of the variables in this study can be found in Table 1 and Table 2.

DATA ANALYSIS

Frequency analysis, showing both the frequency and the percentage of the variables in this study, was carried out using continuity tables. An analysis of the observed frequencies and months of birth was carried out using the chi-squared test (χ^2) to investigate the relationship between age quartiles (Q1: January to March; Q2: April to June; Q3: July to September; and Q4: October to December) and the other variables (position and league) via chi-square test.

Most studies assume that the birthdates of the players are evenly distributed across the four quarters, with each quarter containing about 25% of the players.[1] Therefore, we tested all quarters equal to each other via one sample chi-square test. The level of significance was set at $p<0.05$. The IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA) was used to analyze and interpret the data.

RESULT

Table 3 presents the analysis results regarding the impact of league level on the relative age variable. According to these results, the quartile with the highest proportion of players, in terms of the relative age variable, is the 1st quartile (Q1: January-March) with 32.0% (n=694), while the quartile with the lowest proportion is the 4th quartile (Q4: October-December) with 19.4% (n=420). The chi-square analysis results indicate that the league variable (UEFA CL and UEFA EL) is not a significant factor (χ^2: 0.362[a]; df: 3; $p>0.05$). This means that, in terms of the relative age variable (Q1, Q2, Q3, Q4), there is no difference based on the league level. The proportions of players born in each quartile are similar across both leagues: Q1 (UEFA CL: 31.6%; UEFA EL: 32.5%), Q2 (UEFA CL: 25.6%; UEFA EL: 25.7%), Q3 (UEFA CL: 23.0%; UEFA EL: 22.9%), and Q4 (UEFA CL: 19.8%; UEFA EL: 18.9%).

Table 4 presents the analysis results regarding the impact of players' field positions on the relative age variable. According to the chi-square analysis results, the position variable (goalkeeper, defender, midfielders, and forward) is not a significant factor affecting the relative age variable (χ^2: 13.528[a]; df: 9; $p>0.05$). This means that the relative age variable (Q1, Q2, Q3, Q4) does not differ based on field position. The proportions of players born in each quartile are similar across all positions: Q1 (goalkeeper: 30.4%; defender: 33.0%; midfielders: 32.8%; forward: 30.3%), Q2 (goalkeeper: 31.5%; defender: 23.2%; midfielders: 25.9%; forward: 25.4%), Q3 (goalkeeper: 21.7%; defender: 22.0%; midfielders: 24.3%; forward: 23.4%), and Q4 (goalkeeper: 16.4%; defender: 21.8%; midfielders: 17.0%; forward: 20.9%).

Table 5 presents the results of the analysis of the differences in the relative age variable of players based on the league level (UEFA CL and UEFA EL). According to these results, there is a statistically significant difference in the distribution of players across the quartiles Q1, Q2, Q3, and Q4 in both the

TABLE 2: Definition of study variables.

Variable	Definition
Birth quartile	Players' date of birth has been classified into 4 quartiles (Helsen et al.)[18]: Q1 (January 1-March 31), Q2 (April 1-June 30), Q3 (July 1-September 30) and Q4 (October 1-December 31)
Playing position	The players were classified according to the different roles that occur in football such as goalkeepers, defenders, midfielders and forwards.

Q: Quartile.

TABLE 3: Cross-tabulation of relative age and league groups.

		Quarter of Birth							
		Q1	Q2	Q3	Q4	Total	χ^2	df	p value
CL	f	354	287	258	222	1121			
	% within League	31.6%	25.6%	23.0%	19.8%	100.0%			
EL	f	340	269	240	198	1047	0.362	3	0.948
	% within League	32.5%	25.7%	22.9%	18.9%	100.0%			
Total	f	694	556	498	420	2168			
	% within League	32.0%	25.6%	23.0%	19.4%	100.0%			

Q1: First quartile percentage; Q2: Second quartile percentage; Q3: Third quartile percentage; Q4: Fourth quartile percentage. X^2: Chi-square value cells (0.0%) have expected count less than 5. The minimum expected count is 202.83. χ^2: Pearson chi-square test statistic. p-values are obtained from Pearson chi-square test; f: frequency; CL: Champions League; EL: European League.

TABLE 4: Cross-tabulation of relative age and position.

		Quarter of Birth							
		Q1	Q2	Q3	Q4	Total	χ^2	df	p value
Goalkeeper	f	87	90	62	47	286			
	% within Position	30.4%	31.5%	21.7%	16.4%	100.0%			
Defense	f	233	164	155	154	706			
	% within Position	33.0%	23.2%	22.0%	21.8%	100.0%	13.528	9	0.140
Midfield	f	226	178	167	117	688			
	% within Position	32.8%	25.9%	24.3%	17.0%	100.0%			
Forwards	f	148	124	114	102	488			
	% within Position	30.3%	25.4%	23.4%	20.9%	100.0%			
Total	f	694	556	498	420	2168			
	% within Position	32.0%	25.6%	23.0%	19.4%	100.0%			

Q1: First quartile percentage; Q2: Second quartile percentage; Q3: Third quartile percentage; Q4: Fourth quartile percentage; f: Frequency; χ^2: Pearson chi-square test statistic; df: Degrees of freedom; p-values are obtained from Pearson chi-square test.

TABLE 5: Distibution of the birth quartile according to the analysed Union of European Football Associations Champions League and European League.

		Quarter of Birth							
	n	Q1	Q2	Q3	Q4	Total	X^2	df	p value
UEFA CL	f	354	287	258	222	1121	33.444	3	0.000
	% within League	31.6%	25.6%	23.0%	19.8%	(100%)			
UEFA EL	f	340	269	240	198	1047	40.927	3	0.000
	% within League	25.7%	25.7%	22.9%	18.9%	100%			
Total	f	694	556	498	420	2168	74.022	3	0.000
	% within league	32.01%	25.65%	22.97%	19.37%	100%			

n: Sample size; χ^2: Chi-square; Q: Quartile; f: Frequency; Numbers in parentheses below the first value in a line represent the observed percentage of each Q, and the number in parentheses below that represents the expected value for each Q. p value: Probability value indicating the statistical significance of the test results; df: Degrees of freedom, representing the number of independent categories minus one. p-values are obtained from the one-sample chi-square test. UEFA CL: The Union of European Football Associations Champions League; UEFA EL: The Union of European Football Associations European League.

UEFA CL (χ^2: 33.444; df: 3; $p<0.01$) and the UEFA EL (χ^2: 40.927; df: 3; $p<0.01$). In the UEFA CL, the proportion of players born in Q1 (31.6%; n=354) is significantly different from those born in Q2 (25.6%), Q3 (23.0%), and Q4 (19.8%). Similarly, in the UEFA EL, the proportion of players born in Q1 (25.7%; n=340) differs significantly from those born in Q2 (25.7%), Q3 (22.9%), and Q4 (18.8%).

TABLE 6: Distribution of the birth quartile according to the game position.

		Quarter of Birth							
	n	Q1	Q2	Q3	Q4	Total	χ^2	df	p value
Goalkeeper	f	87	90	62	47	286	17.804	3	0.000
	% within position	30.4%	31.5%	21.7%	16.4%	100.0%			
Defender	f	233	164	155	154	706	24.459	3	0.000
	% within position	33.0%	23.2%	22.0%	21.8%	100.0%			
Midfield	f	226	178	167	117	688	34.895	3	0.000
	% within position	32.8%	25.9%	24.3%	17.0%	100.0%			
Forward	f	148	124	114	102	488	9.377	3	0.025
	% within position	30.3%	25.4%	23.4%	20.9%	100.0%			
Total	f	694	556	498	420	2168	74.022	3	0.000
	% within position	32.0%	25.6%	23.0%	19.4%	100.0%			

n: Sample size; χ^2: Chi-square; Q: Quartile; f: Frequency; p value: Probability value indicating the statistical significance of the test results; df: Degrees of freedom, representing the number of independent categories minus one. Numbers in parentheses below the first value in a line represent the observed percentage of each Q, and the number in parentheses below that represents the expected value for each Q. p-values are obtained from the one-sample chi-square test.

Table 6 presents the analysis results regarding the differences in the relative age variable among players based on their playing positions (goalkeeper, defender, midfielder, forward). According to these results, there are statistically significant differences in the distribution of players across the quartiles Q1, Q2, Q3, and Q4 among goalkeepers (χ^2: 17.804; df: 3; $p<0.01$), defenders (χ^2: 24.459; df: 3; $p<0.01$), midfielders (χ^2: 24.459; df: 3; $p<0.01$), and forwards (χ^2: 9.377; df: 3; $p<0.01$). Specifically, among goalkeepers, 30.4% were born in the 1st quartile, 31.5% in the 2nd quartile, 21.7% in the 3rd quartile, and 16.4% in the 4th quartile. Among defenders, 33.0% were born in the 1st quartile, 23.2% in the 2nd quartile, 22.0% in the 3nd quartile, and 21.8% in the 4th quartile. Among midfielders, 32.8% were born in the 1st quartile, 25.9% in the 2nd quartile, 24.3% in the 3rd quartile, and 17.0% in the 4th quartile. Among forwards, 30.3% were born in the 1st quartile, 25.4% in the 2nd quartile, 23.4% in the 3rd quartile, and 20.9% in the 4th quartile.

DISCUSSION

The aim of this study was to investigate the presence and extent of RAE in professional soccer players participating in the UEFA CL and UEFA EL in the 2023/24 seasons. Specifically, the study sought to analyze the impact of players' birth quartiles on their representation in these leagues and determine if differences exist based on playing positions (goalkeeper, defender, midfielders, forward). There was a high proportion of players born in quarter 1 (Q1: January to March) with 32.0%, and a low proportion of players born in quarter 4 (Q4: October to December) with 19.4%. This pattern was consistent across both the UEFA CL and UEFA EL, indicating that league level does not significantly affect the distribution of players' birth quartiles (χ^2: 0.362; df: 3; $p>0.05$). Moreover, the relative age distribution did not vary significantly by playing position (goalkeepers, defenders, midfielders, forwards) (χ^2: 13.528; df: 9; $p>0.05$). In both the UEFA CL (31.6%) and the UEFA EL (25.7%), the proportion of Q1 players was significantly higher than in the rest of the leagues (χ^2: 33.444; df: 3; $p<0.01$ and χ^2: 40.927; df: 3; $p<0.01$, respectively).

The prevalence of Q1 players in this study is in line with the results of multiple other studies. Jiménez and Pain indicate that players born in the early months of the year are overrepresented in the U17 (Under-17 age)-U21 (Under-21 age) national teams, while this effect decreases at the professional level.[17] This implies that selection favors players born earlier, who are physically more mature, but this advantage erodes over time, potentially excluding talented late-born players from the game. Consequently, the RAE is significant in younger age groups in Spanish football but decreases at the professional level. Helsen et al. analyzed data from the 2010-11 season

across multiple leagues and found significant RAE in all but the Primeira Liga (Portugal).[18] Padrón-Cabo et al. observed the RAE during the 2014-15 season in various leagues, except in the Premier League (England), Primeira Liga (Portugal), and K-League Classic (South Korea).[13] González-Víllora et al. conducted a study on RAE in teams participating in the European Football Championship across different age categories (professional, U21, U19, U17).[15] The results highlighted that while the relative age effect was not significant at the professional level, it had a considerable impact in the younger age groups. All categories showed a higher prevalence of athletes born in Q1, with the U17 age group showing a particularly high prevalence compared to the professional, U21, and U19 groups. The study concluded that as the age category decreases, the relative age effect increases. Yagüe et al. found significant differences in RAE in the 2016-17 season across UEFA and CONMEBOL leagues, with the exception of the Premier League (England).[16] Similarly, Úbeda-Pastor et al. reported significant RAE in the 5 major European Leagues (Spain, Italy, Germany, France, and England) during the 2016-17 season, except for the Premier League.[19] These findings indicate that the RAE is a widespread phenomenon in professional soccer, though some leagues, particularly the Premier League and Primeira Liga, exhibit different patterns. Selection processes that favor players with greater physical maturity and associated advantages in strength, speed, and endurance are responsible for the overrepresentation of Q1 players. Previous research highlights that anthropometric, physical, and physiological variables closely related to the RAE likely drive this trend.[20,21] Bezuglov et al. conducted a study on the RAE involving 18.429 soccer players from 54 different leagues.[14] The results indicated that RAE is widespread among soccer players, with a higher number of players born in the Q1 compared to other quarters. The findings also revealed that RAE is more pronounced in the most competitive leagues and top teams, where the proportion of players born in Q1 was found to be 30%. Additionally, another significant finding was that as the level of competition decreased, the proportion of players born in Q1 also decreased.

The study demonstrates the pervasive presence of the RAE across various competitive levels in European professional soccer, particularly favoring players born in the Q1. This phenomenon is consistently observed in both the UEFA CL and UEFA EL, with Q1 players being significantly overrepresented. Despite some variations in specific leagues, such as the Premier League and Primeira Liga where RAE is less pronounced, the overall trend underscores the bias in player selection favoring those with early physical maturity. This selection bias persists across different playing positions and age categories, although its impact diminishes slightly at the professional level. The findings highlight the need for revised selection processes that mitigate the disadvantages faced by late-born players, ensuring a more equitable assessment of talent based on potential rather than physical maturity alone. Addressing the RAE could lead to a more inclusive and diverse pool of talent, ultimately enhancing the overall quality and competitiveness of professional soccer.

LIMITATION

This study restricts its data to the players on the rosters of 64 soccer teams that competed in the group stages of the UEFA CL and UEFA EL in the 2023/24 season. As a result, the study only includes data from players in these specific leagues and seasons.

CONCLUSION

The findings of this study, along with comparisons to other research, highlight the significant impact of the RAE on player selection and performance in professional soccer. Understanding and addressing the RAE is essential for creating fairer and more equitable talent identification and development processes. Interventions to mitigate the effects of RAE and to promote equal opportunities for all players, regardless of their date of birth, should be further explored in future research.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct con-

nection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mücahit Işık, Erhan Işıkdemir;* ***Design:*** *Mücahit Işık, Erhan Işıkdemir;* ***Control/Supervision:*** *Mücahit Işık, Erhan Işıkdemir, Özlem Köklü, Osman Dağ;* ***Data Collection and/or Processing:*** *Mücahit Işık, Erhan Işıkdemir;* ***Analysis and/or Interpretation:*** *Osman Dağ, Erhan Işıkdemir;* ***Literature Review:*** *Erhan Işıkdemir, Mücahit Işık;* ***Writing the Article:*** *Erhan Işıkdemir, Mücahit Işık;* ***Critical Review:*** *Mücahit Işık, Özlem Köklü;* ***References and Fundings:*** *Erhan Işıkdemir, Mücahit Işık.*

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