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Investigation of Relative Age Effect in Female Soccer: Born to Play?

Kadın Futbolunda Rölatif Yaş Etkisinin İncelenmesi

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ABSTRACT

Early identification and development of "talented" athletes in youth sport is of primary interest to national governing bodies of sport and sport clubs across all sports. Selection bias during recruitment and planning the developmental pathways of athletes is a critical issue to address, and relative age effect (RAE) is one of the concepts to be investigated in this regard. The aim of this study was to examine the prevalence of RAE in U17 and U20 FIFA Women's World Cup, and to investigate the role of age category, playing position and continents with regard to RAE. A total of 2016 female soccer players (U17=1008, U20=1008) participating in the last three consecutive U17 and U20 FIFA Women's World Cups were evaluated based on the birth month distributions. Inter-quartile differences were assessed using the Chi-square (χ^2) goodness-of-fit test, and odds ratios (OR) and 95% confidence intervals were calculated to compare quartiles. RAE was more prevalent in U17 compared to U20 ($\chi2=43.865$, $p<.001$, $V=0.12$; $\chi2=24.071$, $p<.001$, $V=0.09$, respectively). For all positions, the number of female soccer players born in the first quarter of the year was higher than those born in the last quarter. In U17, RAE was statistically significant in all positions, while in U20 only defenders and midfielders' distributions were significantly skewed. In conclusion, RAE is a critical issue to investigate in female soccer context, and age categories, playing position and continents seem such moderators of RAE that coaches and policy makers need to consider.

Keywords: *Talent identification and development, Talent selection, Selection bias, Chronological age, Birth date*

ÖZ

Altyapılarda "yetenekli" sporcuların erken tespiti ve gelişimi, tüm spor dallarındaki kulüplerin ve ulusal spor yönetim organlarının öncelikli ilgi alanlarındandır. Sporcuların seçiminde ve gelişimsel süreçlerinin planlanması sırasındaki seçim yanlılığı, ele alınması gereken kritik bir noktadır ve rölatif yaş etkisi (RYE) bu bağlamda araştırılması gereken olgulardandır. Bu araştırmanın amacı U17 ve U20 FIFA Kadınlar Dünya Kupası'nda RYE prevalansını incelemek ve yaş kategorisi, oyun pozisyonu ve kıtaların rolünü bu bağlamda değerlendirmektir. Düzenlenen son üç U17 ve U20 FIFA Kadınlar Dünya Kupası'na katılmış 2016 kadın futbolcu (U17=1008, U20=1008) doğum ayı dağılımlarına göre değerlendirilmiştir. Çeyrekler arası farklılıklar Ki-Kare (χ^2) uyum iyiliği testi kullanılarak analiz edilmiştir ve çeyrekleri karşılaştırmak için olasılık oranı (OR) ve % 95 güven aralıkları hesaplanmıştır. RYE'nin U17'de U20'ye göre daha yaygın olduğu tespit edilmiştir (sırasıyla, $\chi2=43.865$, $p<.001$, $V=0.12$; $\chi2=24.071$, $p<.001$, $V=0.09$). Tüm pozisyonlar için yılın ilk çeyreğinde doğan kadın futbolcu sayısı son çeyreğinde doğan kadın futbolcu sayısından daha fazladır. U17'de RYE tüm pozisyonlarda anlamlıyken, U20'de sadece defans ve orta saha oyuncularının dağılımlarında önemli ölçüde farklılık tespit edilmiştir. Sonuç olarak, RYE, kadın futbolu bağlamında araştırılması gereken kritik bir konudur ve yaş kategorileri, oyun pozisyonları ve kıtalar RYE bağlamında antrenörlerin ve politika yapıcıların göz önünde bulundurması gereken unsurlardandır.

Anahtar Kelimeler: *Yetenek belirleme ve geliştirme, Yetenek seçimi, Seçim yanlılığı, Kronolojik yaş, Doğum tarihi*

INTRODUCTION

Positive youth development through sport has been an emphasized and suggested phenomenon. Cote et al. (2010) conceptualized this phenomenon from a holistic perspective addressing to youth athletes' developments in four main domains as competence, confidence, connection and character. Yet, particularly the competitive nature of sport calls off the attention from holistic development to success-oriented practices. This competitiveness causes an ongoing pressure to identify and select the most "talented" athletes which has become a focus for national governing bodies of sport, clubs and even individuals themselves across all sports (Collins and MacNamara, 2018). Furthermore, dynamic nature and demands of sport participation and achievement are of primary interests to researchers, policy makers and sport organizations in this regard (Smith et al., 2018). These perspectives lead to talent programs spreading all around the world. Although they help youth players to prepare for the demands of professional sport settings (Faber et al., 2022; Kelly et al., 2021), the effectiveness of such programs has been a central criticism considering the scientific foundations such as the low predictive value and lack of validity (Collins and MacNamara, 2018). Moreover, drop-outs and/or talent loss is also a concern to address related to those programs in practice (Baker et al., 2018; Till and Baker, 2020). Selection bias during recruitment and planning the developmental pathways has been pointed out as another critical issue to address, and relative age effect (RAE) is one such concept to consider (Barnsley et al., 1985; Smith et al., 2018).

RAE refers to the relationship of athletes' birth dates to the age grouping system based on chronological age. Annual age grouping is a commonly used organizational policy in sports settings, in youth categories particularly (Musch and Grondin, 2001). Although it is used to ensure a fair environment to participate, compete and success, several studies has discussed the lack of sensitivity of this system considering the subtle age-related differences (Cobley et al., 2009; Musch and Grondin, 2001; Smith et al., 2018). As such, an athlete born shortly after the cut-off date and another one shortly before it compete in the same age category which is rather better compared to age categories organized as U17 and U20 (e.g., FIFA Women's World Cup). This 12-24-or-36 month age-bands refer almost one- two-or-three years of age difference between two athletes competing in the same age category respectively which may cause (dis)advantages to each athlete accordingly. This system exacerbates the issue of finding diamonds in the rough since athletes' current physical attributes play the significant role in selection rather than their potential to develop in the future (Collins and MacNamara, 2018).

RAE has been an interest from the very early study by Grondin et al. (1984) to today, and it has been discussed in several sports and from different perspectives (Bilgiç and Işın, 2022). Soccer is the most popular sport with 97 research (Bilgiç and Işın, 2022), yet the issue within female context still needs further investigation. Cobley et al.'s (2009) meta-analysis reported that only 2% of participants in RAE studies were females. Furthermore, there are contradictory results on the presence and/or magnitude of RAE in female context with regard to developmental stages, level of expertise, competition level and the demands of sport itself. For instance, Nakata and Sakamoto (2012) reported a skewed distribution of Japanese volleyball players in V-League, which is the top Japanese volleyball league, in favor of players born in the first and second quartile compared to those born in the third and last quartile. Yet, no such distribution bias was noted in male volleyball players in the same study. In soccer, over-representation of players in the first quartile was the case for males, but not for females (Nakata and Sakamoto, 2012). Similarly, Sedano et al. (2015) reported the over-representation of Spanish female soccer players in quartile one with differential characteristics according to competition level and playing position. On the other hand, Vincent and Glamser (2006) reported no such bias in both state and regional female soccer players in The Olympic Development Program organized by the US Youth Soccer Association. Quite differently from the aforementioned results, Ste-Marie et al. (2000) proposed a "flip-flop phenomenon" in gymnastics with over-representation of relatively younger gymnasts, and following research on gymnastics and aesthetic sports like figure skating supported this finding to a certain extent (Hancock et al., 2015; Kalinski et al., 2018; Uğurlu and Bilgiç, 2022).

Recently, Smith et al. (2018) published a systematic review and meta-analysis on RAE in female sport contexts in which significant but rather small RAE was reported, and the underlying mechanisms influencing RAE were discussed such as developmental age. Considering the unique demands of each sport, playing position, developmental age, competition level, popularity of sport and the relatively underestimated research on females with contradictory results discussed above, there appears a need for further research on RAE in female sport contexts (Cobley et al., 2009; Figueiredo et al., 2021; Smith et al., 2018). Thus, this research aims to examine the prevalence of RAE in U17 and U20 FIFA Women's World Cup, and to investigate the role of age category, playing position and continents.

METHOD

Participants: The sample consisted of 2016 female soccer players from countries that participated in 2016, 2018, and 2022 U17 and U20 Women's World Cups. Of 2016 players, 1008 players participated in U17 Women's World Cups (336 players in each tournament), and 1008 players participated in U20 Women's World Cups (336 players in each tournament).

Design and Procedures: This research aiming to evaluate the prevalence of the RAE in youth female soccer context focused on the last three consecutive FIFA U17 and U20 Women's World Cups held in 2016, 2018, and 2022. Countries participating in the tournaments are required to form a squad of no more than 21 players including three goalkeepers, and FIFA's official website (https://www.fifa.com) provides the following information on soccer players in each tournament; height, date of birth, first and last name, country, continent, club and playing position. The information on players' playing position, date of birth and represented countries' continent was used for further analyses in this study. Since the playing positions in squads included goalkeeper (GK), defender (DF), midfielder (MF) and forward (FW), only this categorization based on four main playing positions was evaluated.

The cut-off date used by FIFA for age grouping is January 1st (https://www.fifa.com/about-fifa/official-documents). The birth rate of soccer players was assumed to be equal in all months (8.33% per month), as used in several research (e.g., Helsen et al., 2005; Williams, 2010). Thus, birth dates were grouped into four quarters as Q1 (January-March), Q2 (April-June), Q3 (July-September) and Q4 (October-December).

Ethical approval for this study was obtained from the Clinical Research Ethics Committee of Akdeniz University, and the present study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis: Chi-square ($\chi 2$) goodness of fit test was used to determine differences between observed and theoretically expected distributions of female soccer players' birth dates. To evaluate effect sizes, Cramer's V was calculated and interpreted as follows; small ($V = 0.06 – 0.17$), medium ($V = 0.18 – 0.29$) and large ($V \geq 0.30$), for df3, which is the case in each comparison in this study (Cramér, 1999). Odds ratios (OR) and 95% confidence intervals (CI) were calculated to compare Q1 to Q4, Q1 to Q3 and Q1 to Q2.

RESULTS

Table 1 shows the distribution of births by quarters in the selection year among the soccer players who participated in the last three FIFA U17 and U20 Women's World Cups in 2016, 2018 and 2022.

Table 1

Birth Month Distributions of Female Soccer Players in FIFA U17 and U20 Women's World Cups

		Quarter of birth (number of player)						
		Q1	**Q2**	**Q3**	**Q4**	χ^2	**p**	**V**
U-17	**2016**(n:336)	108	99	64	65	18.595	< .001	0.14
	2018 (n:336)	113	88	74	61	17.690	.001	0.13
	2022 (n:336)	111	74	87	64	14.738	.002	0.12
	Total (n:1008)	332	261	225	190	43.865	< .001	0.12
U-20	**2016**(n:336)	97	89	75	75	4.238	.237	0.06
	2018 (n:336)	106	92	64	74	12.476	.006	0.11
	2022 (n:336)	101	90	62	83	9.643	.022	0.10
	Total (n:1008)	304	271	201	232	24.071	< .001	0.09

Q1: (January-March), **Q2:** (April-June), **Q3:** (July-September), **Q4:** (October-December)
small effect: V = 0.06 - 0.17, **medium effect:** V = 0.18 - 0.29, **large effect:** V ≥ 0.30

As presented in Table 1, RAE was observed in all U17 tournaments ($\chi2$=18.595, p< 0.001, V=0.14; $\chi2$=17.690, p=0.001, V=0.13; $\chi2$=14.738, p=0.002, V=0.12 for 2016, 2018 and 2022 respectively), and in U20 tournaments held in 2018 and 2022 ($\chi2$ =12.476, p=0.006, V=0.11; $\chi2$ =9.643, p=0.022, V=0.10 for 2018 and 2022 respectively), while there is no such statistically significant RAE in U20 tournament held in 2016 ($\chi2$ =4.238, p=0.237, V=0.06).

Table 2

Odds Ratio Comparisons (95% Confidence Interval) Examining Birth Months Distributions Between Quartiles

		Odds ratio comparisons (95% confidence interval)		
		Q1-Q2	**Q1-Q3**	**Q1-Q4**
U-17	**2016**(n:336)	1.09 (0.73-1.64)	1.69 (1.09-2.60)*	1.66 (1.08-2.56)*
	2018 (n:336)	1.28 (0.85-1.94)	1.53 (1.00-2.33)*	1.85 (1.20-2.86)*
	2022 (n:336)	1.50 (0.98-2.29)	1.28 (0.84-1.93)	1.73 (1.13-2.67)*
	Total (n:1008)	1.27 (1.0-1.61)*	1.48 (1.16-1.88)*	1.75 (1.36-2.24)*
U-20	**2016**(n:336)	1.09 (0.72-1.65)	1.29 (0.84-1.98)	1.29 (0.84-1.98)
	2018 (n:336)	1.15 (0.76-1.74)	1.66 (1.07-2.55)*	1.43 (0.94-2.19)
	2022 (n:336)	1.12 (0.74-1.70)	1.63 (1.05-2.52)*	1.22 (0.80-1.85)
	Total (n:1008)	1.12 (0.88-1.43)	1.51 (1.18-1.94)*	1.31 (1.03-1.67)*

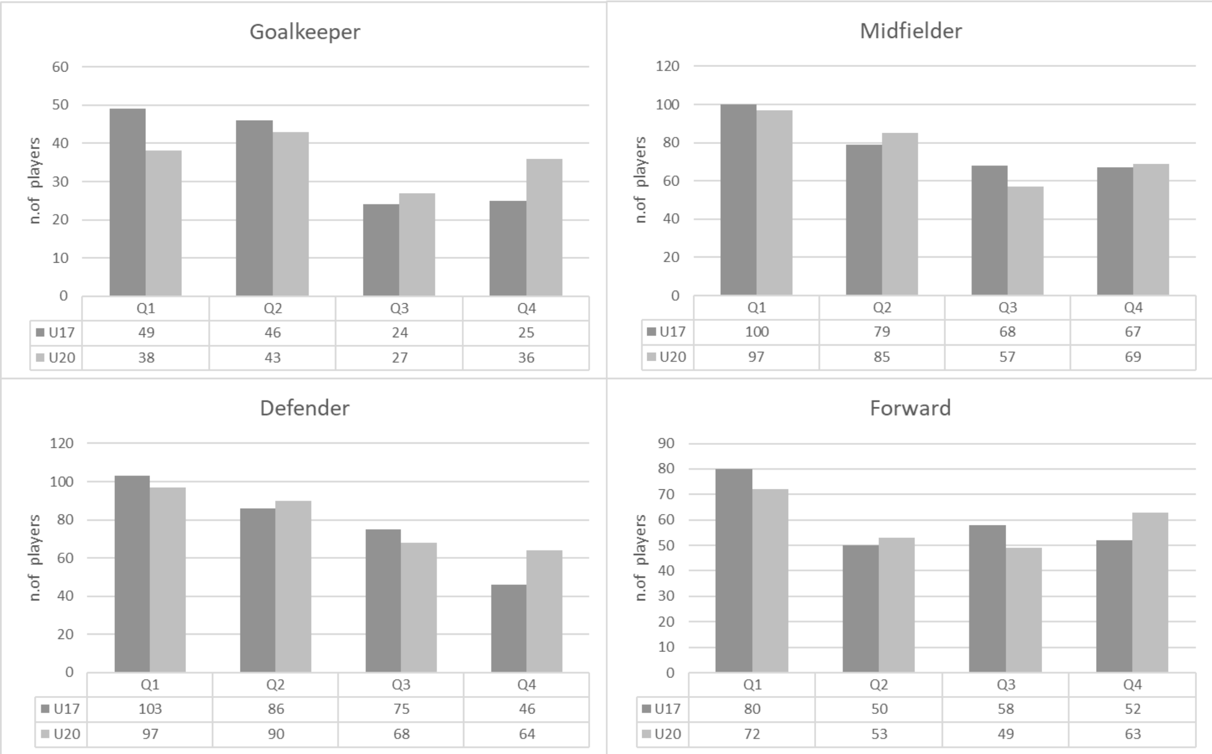
Q1: (January-March), **Q2:** (April-June), **Q3:** (July-September), **Q4:** (October-December)
*Significant of odds ratios

The chances of female soccer players being selected into teams for the U17 and U20 World Cups are shown in Table 2. In U17, players born in the first quarter have almost two-times more chance of being selected compared to those born in the last quarter. In U20, the comparison was significantly differed only when players were evaluated in total (OR: 1.31, 95% CI: 1.03-1.67). Considering all comparisons in each year and total, while there was almost no such difference in Q1 and Q2 comparisons, significance was noted mostly in comparisons between Q1 and Q3-Q4 comparisons.

Figure 1 demonstrates the birth month distributions of female soccer players by playing position. For all positions, the number of players born in the first quarter of the selection year was higher than those born in the fourth quarter. Moreover, RAE was observed at U17 in all playing positions (GK: $\chi2=14.833$, $p=0.02$, $V=0.19$, DF: $\chi2=22.206$, $p<0.001$, $V=0.15$, MF: $\chi2=8.981$, $p=.030$, $V=0.10$, FW: $\chi2 =9.467$, $p=.024$, $V=0.11$). In U20, significantly skewed birth month distributions were determined in the DF ($\chi2 =9.890$, $p=.020$, $V=0.10$) and MF ($\chi2 =12.052$, $p=.007$, $V=0.11$), while there was no such bias in GK ($\chi2 =3.722$, $p=.293$, $V=0.11$) and FW ($\chi2 =3.722$, $p=.144$, $V=0.09$).

Figure 1

Birth Month Distributions of Female Soccer Players in U17 and U20 FIFA Women's World Cups by Playing Position



Goalkeeper	Q1	Q2	Q3	Q4
U17	49	46	24	25
U20	38	43	27	36

Midfielder	Q1	Q2	Q3	Q4
U17	100	79	68	67
U20	97	85	57	69

Defender	Q1	Q2	Q3	Q4
U17	103	86	75	46
U20	97	90	68	64

Forward	Q1	Q2	Q3	Q4
U17	80	50	58	52
U20	72	53	49	63

Birth month distributions of female soccer players by continents are demonstrated in Figure 2. North America in U17 and Europe in U20 were the continents with the highest RAE for female soccer players in all tournaments. Negative RAE was observed in Africa in both U17 and U20 Women's World Cups.

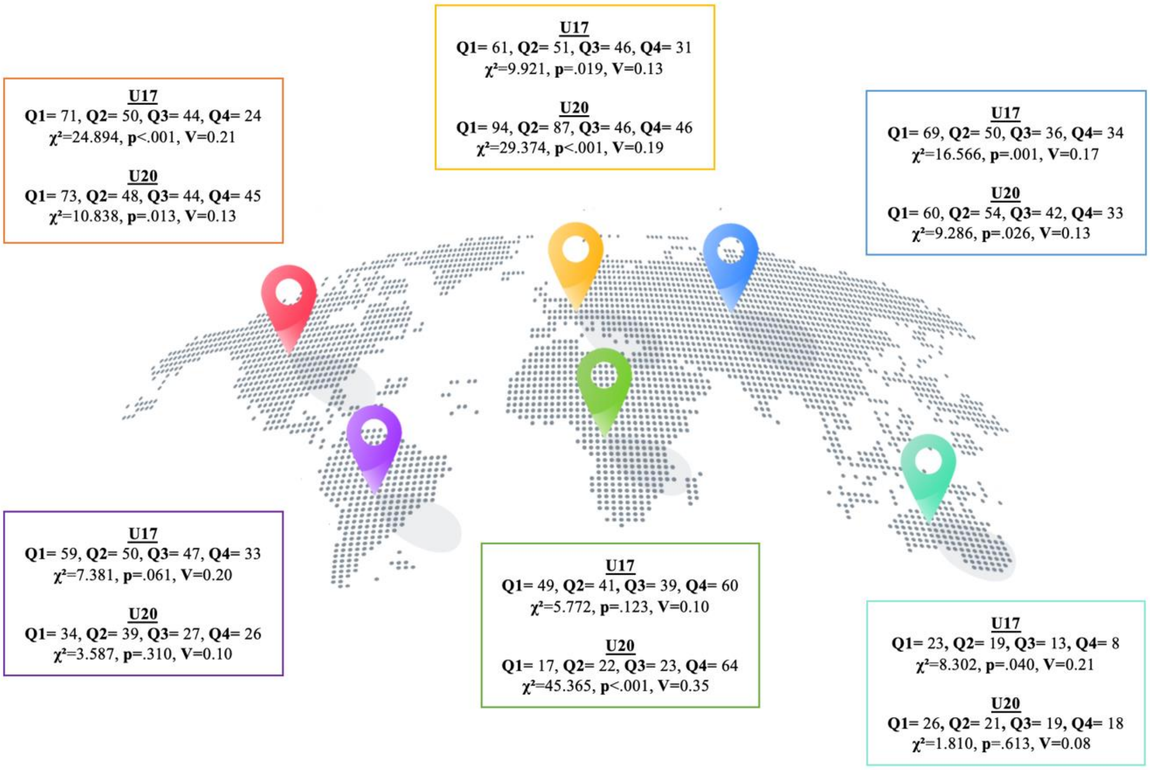
DISCUSSION AND CONCLUSION

This study examined the prevalence of relative age effect in a female sport context, U17 and U20 FIFA Women's World Cup in particular, and investigated the role of age category, playing position and continents. The main findings confirmed the uneven distribution among players at almost all comparisons favoring the players born in the first quartile of the year. Findings revealed that younger ages, defenders and midfielders were more into such distribution biases. Furthermore, a flip-flop phenomenon was noted in Africa in both U17 and U20, and no such bias in S. America in U17. Yet, there appeared a trend pointing to the advantage of relatively older players.

To gain a thorough understanding and explain the RAE, several models have been proposed (e.g., Hancock et al., 2013; Wattie et al., 2015). Recently, Wattie et al. (2015) suggested a developmental systems model which utilized Newell's (1986) constraints-based approach to explain interactions. Regarding the presence of RAE, interactions among individual, task and environmental constraints were stated as the underlying mechanism. In particular, individual constraints refer to athlete's birthdate, maturation, handedness and gender. Task constraints include type and physicality of sport, competition level and playing position. Environmental constraints refer to age grouping policies, popularity of sport, social norms, family and coach influence. Change over time is suggested as a critical factor affecting these bi-directional interactions in this model (Wattie et al., 2015).

Figure 2

Birth Month Distributions of Female Soccer Players in U17 and U20 FIFA Women's World Cups by Continents



In accordance with this model, RAE in male team sports has been reported as a persistent worldwide problem (e.g., Figueiredo et al., 2021; Işın, 2021; Kelly et al., 2021; Li et al., 2020; Romann and Fuchslocher, 2013; Vincent and Glamser, 2006), while the findings in female sport context are still unclear and contradictory (Figueiredo et al., 2021; Nakata and Sakamoto, 2012; Smith et al., 2018). Gender seems a quite important individual constraint considering these results in the relevant literature. Some studies reported no significant RAE in female soccer context (e.g., Delorme et al., 2009; Nakata and Sakamoto, 2012; Romann and Fuchslocher, 2011), while Smith et al. (2018) reported a significant but rather small RAE in female overall sport contexts in a recent systematic review and meta-analysis. In both male and female contexts, several concerns have been discussed as moderators of this effect such as developmental age, age categories, popularity of the sport and playing positions which are directly related to the aforementioned constraints in the proposed developmental systems model by Wattie et al. (2015).

Youth categories are suggested as more prone to RAE compared to adults (Arrieta et al., 2016; Bruner et al., 2011; Helsen et al., 2005). This proposition may fit in the findings of this study considering that U17 and U20 age categories have been investigated, and U20 is the last youth category prior to adults. Stronger RAE was noted in U17 compared to U20 which leads to an interpretation/prediction that this decreasing effect might eventually disappear in the system. Williams (2010) investigated RAE in males in the last six FIFA U17 World Cup, spanning 10 years, and reported similar trends to this study.

Müller et al. (2016) suggested another approach to RAE which reconsiders the characteristics of sport specifically. Strength and endurance-related sports have been stated as more prone to RAE compared to aesthetic sports (e.g., figure skating) due to the maturation-related developmental lead. Considering soccer as a more strength and endurance-related sport, the findings of this study is consistent with the literature that maturational advantage of relatively older athletes might give rise to the biased distribution favoring relatively older players. As such, Malina et al. (2005) discussed players' maturity level as a moderator with regard to shooting accuracy. Similarly, Musch and Grondin (2001) discussed the physical, physiological and psychological differences caused by varied maturational time changes of each athlete as the determinant of RAE. Thus, characteristics and demands of a sport can be suggested as strong moderators of RAE.

The age categories (i.e. U17 and U20) investigated in this study may seem not affected by such maturational differences, yet "accumulative advantage" is a highly discussed concept referring to the continuation of (dis)advantages throughout athletes' careers from different aspects such as talent selection, re-selection to the squad, opportunities to attain quality coaching, training and equipments which possibly give rise to physical, technical and tactical (dis)advantages in the future (Gladwell, 2008; Musch and Grondin, 2001). Thus, both maturation-related developmental lead perspective and "accumulative advantage" perspective require further research to get a deeper understanding.

In this study, playing position was considered as another variable, and significant distribution biases were determined in all positions in U17, but not in U20. Only in defenders and midfielders in U20, there noted significant biases. In the relevant literature, similar research outcomes were reported to a certain extent. Işın (2021) examined male soccer players representing their countries and reached the podium in FIFA U17 and U20 World Cups between 2009 and 2019, and reported that there were distribution biases in all positions in U17 except for goalkeepers, while in U20 only midfielders and forwards' distributions differed significantly. Similarly, Romann and Fuchslocher (2013) noted significant differences between defenders, goalkeepers, midfielders and strikers in the elite U15 to U21 teams compared to the registered male soccer players in Switzerland. In female context, Romann and Fuchslocher (2011) reported significant under-representation of defenders and strikers in the last quartile compared to the registered female soccer players in Switzerland in the national elite U17 to A teams. On the other hand, Sedano et al. (2015) noted skewed distribution favoring players born in the first half of the year in goalkeepers and defenders in regional teams and second division groups, while there was no such bias in other positions and competition levels. These similar and different results might be related to the topics discussed above in terms of maturation-related developmental lead perspective, "accumulative advantage" and the coaches' selection practices in each unique context.

Lastly, there appeared similar and consistent findings in the investigations of RAE based on geographical differences (i.e. continents) in the relevant literature. Strongest RAEs were noted in N. America and Europe favoring players born in the first quarter in U17 and U20, respectively. However, there is a flip-flop phenomenon in Africa referring to the reverse RAE as over-representation of relatively younger players. Williams (2010) reported similar results for male soccer players in FIFA U17 World Cups indicating the trend for players born in the last months of the calendar year rather compared to early-born players. Specifically, Williams (2010) questioned the correctness of reporting procedures of date of births in Africa and discussed a study by Ndong et al. (1994) pointing to the lack of birth certificate confirmation in Cameroon. In addition, Williams (2010) argued that only about half of the births for children under 1-year-old were registered. Our study includes players from Morocco, Cameroon, Ghana, Nigeria, South Africa and Tanzania, while in Williams' (2010) study only players from the western region of Africa were investigated. Considering both Williams' (2010) and our studies, the findings related to different regions of Africa showed that this overrepresentation of relatively younger players might not be coincidence. On the other hand, Işın and Melekoğlu (2020) reported no such distribution bias among male soccer players in Africa in FIFA U17 World Cup in 2017. Thus, there appeared an unmet need for further research on RAE in African sporting contexts investigating both males and females.

In conclusion, players birth-months distributions in both U17 and U20 FIFA Women's World Cups differed significantly at almost all comparisons favoring the ones born in the first quartile of the year. Stronger RAEs were determined in U17 compared to U20 considering the age categories in FIFA Women's World Cups. Regarding playing positions, defenders and midfielders were noted more into such distribution biases. Furthermore, there appeared over-representation of relatively older players regarding continents except for the reverse effects in Africa in both U17 and U20. Several models have been suggested to get a thorough understanding of the underlying mechanisms affecting RAE such as developmental systems model by Wattie et al. (2015). In practice, coaches and policy makers' awareness should be raised regarding the role of RAE in talent identification and selection processes. They are better to take talent-related issues as a process instead of a point in the continuum. Players' developmental processes should be considered over this continuum, and possible maturational differences are better to be kept in mind while deciding on talent.

Authors' Contribution:

1. **Ali IŞIN:** Conceptualization, Research Design, Data Interpretation, Manuscript Preparation, Literature Search, Critical Reviewing and Editing
2. **Mert BİLGİÇ:** Conceptualization, Research Design, Data Collection, Statistical Analysis, Data Interpretation, Critical Reviewing and Editing

Information Regarding Ethics Committee Permission

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