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The Impact of Relative Age Effect on Competition Performance in Youth Women's Basketball

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ABSTRACT

The Relative Age Effect (RAE) has been widely examined in various sports, yet its impact on competition performance in youth women's basketball remains underexplored. This study investigates the presence and effects of RAE on the performance of female athletes in the Turkish Women's Basketball Championships across U14, U16, and U18 categories during the 2022, 2023, and 2024 seasons. A retrospective survey model was employed, analysing birth quarter distributions and match statistics of 1,673 players obtained from the Turkish Basketball Federation's official database. Players were categorized into quartiles (Q1-Q4) based on their birth months, and their performance was assessed using the Player Efficiency Rating (PER). Statistical analyses included Pearson's chi-square tests and Kruskal-Wallis H tests to examine RAE's impact on player selection and performance. Results indicated a significant overrepresentation of players born in the first quarter (Q1) across all age categories, confirming the presence of RAE. In the U14 category, players born in Q1 were nearly four times more likely to be selected than those in Q4, with similar trends observed in the U16 and U18 categories. Moreover, Q1 players demonstrated higher efficiency ratings and greater playing time compared to their later-born counterparts. The findings suggest that RAE significantly causes talent selection and performance outcomes in youth women's basketball, potentially leading to long-term player development and progression disparities. Future research should explore interventions to mitigate these biases and promote equitable competition opportunities for all athletes.

INTRODUCTION

In youth sports, athletes are commonly categorized based on their birth year when determining training and competition categories (Cobley et al., 2009; Kearney et al., 2018). This system aspires to engender a more equitable competitive environment by mitigating substantial age disparities (Coelho E Silva et al., 2008). However, it is noteworthy that there may be 12-month disparities in chronological age between athletes born in the same calendar year (Kearney et al., 2018).

During adolescence, a period of rapid anthropometric and physiological change, significant improvements are observed in a range of physical abilities, including height, speed, endurance, agility, strength, and jumping performance (Coelho E Silva et al., 2008; Sickles & Lombardo, 1993). Consequently, athletes born in the initial months of the year may possess certain physical and performance advantages as they transition to puberty earlier compared to those born in the final months. These advantages can result in a disproportionate representation of athlete's months older than their contemporaries born in the same year in the talent selection process (Schorer et al., 2013). Within a given category, this scenario, wherein those born earlier possess an advantage due to their superior physical, cognitive, and emotional development, is termed the 'relative age effect' (RAE) (Delorme & Raspaud, 2009a; Musch & Grondin, 2001).

The Relative Age Effect (RAE) can be explained through maturational and social perspectives. The "maturation-selection" theory (Malina, 1994) suggests that relatively older athletes experience accelerated physical development, granting them preferential access to superior training, coaching, and healthcare, which enhances their likelihood of selection for elite teams (Helsen et al., 2005; Lemez et al., 2014). Conversely, younger athletes face challenges in gaining visibility and reaching top-tier competition (Delorme et al., 2011). In addition, the social agent model (Hancock et al., 2013) emphasizes the role of social actors—parents, coaches, and athletes—in perpetuating RAE. Parents facilitate early participation through the 'Matta effect,' coaches shape talent selection based on the 'Pygmalion effect,' and athletes develop self-efficacy via the 'Galatea effect,' collectively reinforcing a cycle that sustains RAE. The authors suggest focusing on skill development and equitable sport participation rather than choices based on short-term physical advantages (Hancock et al., 2013).

The presence of RAE has been reported in individual sports such as athletics (Brazo-Sayavera et al., 2018; Brustio et al., 2019), judo (Fukuda et al., 2023; Giudicelli et al., 2021) and swimming (Lorenzo-Calvo et al., 2021; Medic et al., 2009), and in team sports such as basketball (Arrieta et al., 2016; Ibáñez et al., 2018; Rubajczyk et al., 2017), soccer (Salinero et al., 2013; Skorski et al., 2016), handball (Costa et al., 2022; Wrang et al., 2018), rugby (Kearney, 2017; Kelly et al., 2021a) and volleyball (Campos et al., 2020; Papadopoulou et al., 2019). It has been documented that the impact of RAE on sporting performance is more evident in sports where performance is directly proportional to strength, power, and body size. However, this relationship is less pronounced in sports that require technical skill (Hancock et al., 2013). This phenomenon has been particularly noted in culturally popular sports and competitive selection processes characterized by intense competition (Wattie et al., 2008). However, it has been reported that its effect diminishes but does not entirely disappear as one moves up to higher categories (Gil et al., 2020).

The extant literature on the impact of the RAE in women's basketball is limited, and research on the relationship between player performance and team success is scarce. A large-scale study conducted in France revealed the existence of RAE in all categories except U17 women players (Delorme & Raspaud, 2009b). A similar finding was reported in a Turkish study, indicating RAE's efficacy in the women's basketball super league (Beşer, 2022). However, studies examining the effect of RAE on performance parameters in basketball are pretty limited.

A pioneering study by Arrieta et al. (2016) revealed a notable finding: players born in the initial months of the year exhibited a higher representation at the U16 and U18 levels. However, this effect waned at the U20 level. The analysis further noted that while the oldest players demonstrated superior performance in the U20 category, this effect did not attain statistical significance for female players. In a similar study, at the U17, U19, and U21 World Basketball Championships, García et al. (2014) found that RAE exhibited a trend that was significant at U17, decreased at U19, and lost its significance at U21. In the male participants, the effect of RAE was more pronounced in positions where physical strength was prominent, while no significant difference was found in the female participants.

A further study undertaken in the Polish Junior Basketball League established that the RAE was evident among male and female players in the U14-U22 age categories (Rubajczyk et al., 2017). The researchers determined that height differences were significant in the U14-U16 men and U14 women groups. However, while it was observed that players born in the first half of the year achieved higher performance parameters in U14 men, no such association was found between birth year and performance in female basketball players. The findings indicate that RAE exerts a significant effect in the male basketball demographic, yet this effect is more constrained in the female basketball demographic.

The existing literature suggests that RAE is prevalent in youth basketball (Arrieta et al., 2016; Rubajczyk et al., 2017), but its effect on performance parameters, playing time, and team success, especially in female athletes, remains largely unexplored. Given the inconsistent findings across studies, our research aims to provide empirical evidence regarding the cause of RAE in Turkish women's basketball at different youth levels (U14, U16, and U18) between 2022 and 2024. This study has two key practical implications. First, it aims to help coaches and sports administrators develop fairer talent identification and development strategies in youth basketball. Research suggests that RAE can lead to selection biases favoring relatively older athletes while overlooking late-developing yet equally skilled players (Schorer et al., 2013; Helsen et al., 2005). This study will identify potential age-based biases in Turkish women's basketball by examining birth quartile distributions and their impact on performance and playing time. Second, the findings could inform policy discussions on improving athlete development pathways. If a strong RAE is found, basketball federations may revise selection and competition structures to promote long-term talent retention and equal opportunities. This aligns with recommendations to shift from physical-based selection to skill-focused development (Hancock et al., 2013).

Addressing these gaps will contribute to a more inclusive and evidence-based approach to youth basketball in Turkey. In this context, this study seeks to address the following research questions:

1. Is there a RAE in the Turkish women's basketball championship competitions in the U14, U16, and U18 categories?

2. What is the distribution of the birth quartiles of female basketball players in U14, U16, and U18 categories, and how does this distribution affect the player's efficiency performances?

3. How does the distribution of birth quartiles of female basketball players in U14, U16, and U18 categories affect their playing time?

The selection of the championships is predicated on two factors. First, they cover all youth levels, starting from the youngest age category. Second, a large pool of players can be analysed by participating from different regions. Furthermore, given the uniform distribution of birth dates throughout the year in Turkey (TSI, 2024) and the maintenance of official records, it is possible to undertake an objective analysis of the relative age effect.

METHODS

Participants

The sample group was selected to represent the study's population, which consists of female youth basketball players in Turkey. The population includes all athletes competing in national-level competitions in the U14, U16, and U18 categories. As a representative sample, this study analyzed the birth quartiles and match statistics of 1,673 female basketball players who participated in the Turkish Championships during the 2022, 2023, and 2024 seasons. These data were obtained from the official records of the Turkish Basketball Federation (Turkish Basketball Federation, 2024).

Prior to the start of this study, approval was provided by the Non-Interventional Clinical Research Ethics Committee of Uşak University (542-542-04/2025), and all procedures were meticulously carried out in accordance with the Declaration of Helsinki.

Procedures

The present study is retrospective, and thus, the archival model is an appropriate methodology. The archival model is a suitable approach for research endeavours that seek to describe a situation in the past or present as it exists (O'donoghue, 2009).

The RAE is based on months; therefore, the birth dates of the participants in each championship were converted into quarters. Initially, players were categorized into four groups based on their birth dates. Thus, players born between 1 January and 31 March were classified in the first quartile (Q1), players born between 1 April and 30 June in the second quartile (Q2), players born between 1 July and 30 September in the third quartile (Q3) and players born between 1 October and 31 December in the fourth quartile (Q4) (Arrieta et al., 2016).

The player efficiency rating (PER) formula was derived by positive and negative player statistics for both players and teams (Hollinger, 2002). The objective of this formula is to evaluate the performance of players or teams by converting all statistical data into a single score. The PER formula comprises 12 variables, each with a unique coefficient, as outlined below: Player Efficiency Rating = Points + 0.4 × Field Goal − 0.7 × Field Goal Attempt − Free Throw Attempt − Free Throw + Offensive Rebound + 0.3 × Defensive Rebound + Steal + 0.7 × Assist + 0.7 × Block − 0.4 × Foul − Turnover.

Data Analysis

In the present study, Pearson chi-square goodness-of-fit tests were conducted to examine the RAE on the game performances of female players in three different categories. The chi-square test was employed, ensuring that the assumption of expected frequencies exceeding five and the assumption of multiple correspondence analysis requiring positive frequencies in the contingency table were both met (Field, 2024). To assess distributional differences between subgroups, odds ratios were calculated using Q4 (fourth quarter) as the reference group in all quarters. A higher odds ratio indicates that group members are more likely to exhibit the trait in question compared to the reference group (Q4).

Tests for normality and homogeneity were conducted before comparing the minutes played and efficiency variables. Normality was assessed using skewness and kurtosis values, while homogeneity of variance was examined using Levene's test. The results indicated that the variables did not follow a normal distribution (Efficiency_{min}= -12, Efficiency_{max}= 44; $\text{Minutes Played}_{min}$= 00:02, $\text{Minutes Played}_{max}$= 41:07), as their skewness and kurtosis values exceeded the ±2 range. Additionally, the homogeneity assumption was not met, as Levene's test yielded significant results ($p < .05$ (Field, 2024). Given the violations of parametric assumptions, the Kruskal-Wallis H test with Dunn's post hoc test for multiple comparisons was used to analyze differences in minutes played and efficiency scores among female basketball players based on their birth quartiles (Q). All statistical analyses were performed using SPSS 25, and statistical significance was set at $p < 0.05$.

RESULTS

The analysis of birth quarter distribution across all age groups revealed a significant deviation from an equal distribution, indicating the presence of a RAE in female basketball players (Table 1). In the U14 category, birth quarter distributions in all years were significantly skewed, with players born in the first quarter (Q1) overrepresented compared to those born in the fourth quarter (Q4). In 2024, the distribution significantly differed from equality ($\chi^2_{(3)}$= 29.57, $p < 0.01$) with a moderate effect size (V§ = 0.24). Players born in Q1 were 5.76 times more likely to be selected than those in Q4 (CI: 3.16–10.50). A similar pattern emerged in 2023 ($\chi^2_{(3)}$= 22.99, $p < 0.01$, V§ = 0.20), with players in Q1 exhibiting an odds ratio of 3.71 relative to Q4 (CI: 2.21–6.22). The effect persisted in 2022 ($\chi^2_{(3)}$= 21.83, $p < 0.01$, V§ = 0.20), where players born in Q1 were 3.24 times more likely to be selected than those born in Q4 (CI: 1.98–5.40). When considering the entire U14 sample (N = 549), birth quarter effects remained pronounced ($\chi^2_{(3)}$=

72.27, $p < 0.01$, V§ = 0.21), with players born in Q1 nearly four times more likely to be selected than those in Q4 (CI: 2.94–5.40).

A comparable trend was observed in the U16 category, where birth quarter distribution significantly deviated from expectations in all years. In 2024, the effect remained statistically significant ($\chi^2_{(3)}$= 20.43, $p < 0.01$, V§ = 0.18), with players born in Q1 displaying a selection advantage of 3.02 times over those in Q4 (CI: 1.89–4.83). In 2023, the birth quarter distribution continued to be skewed ($\chi^2_{(3)}$= 15.59, $p < 0.01$, V§ = 0.17), with an odds ratio of 2.72 for Q1 relative to Q4 (CI: 1.62–4.57). The strongest effect within this age category was observed in 2022 ($\chi^2_{(3)}$ = 27.58, $p < 0.01$, V§ = 0.23), with players born in Q1 being 5.49 times more likely to be selected than those in Q4 (CI: 3.05–9.88). Across the total U16 sample (N = 564), birth quarter significantly caused selection outcomes ($\chi^2_{(3)}$ = 57.89, $p < 0.01$, V§ = 0.19), with Q1 players 3.45 times more likely to be selected compared to Q4 (CI: 2.56–4.64).

The U18 category demonstrated similar disparities, further underscoring the persistence of RAE in female basketball. In 2024, birth quarter distribution significantly deviated from equality ($\chi^2_{(3)}$ = 19.79, $p < 0.01$, V§ = 0.19), with Q1 players being 3.43 times more likely to be selected than Q4 players (CI: 2.06–5.71). In 2023, the magnitude of the effect increased ($\chi^2_{(3)}$ = 31.38, $p < 0.01$, V§ = 0.24), with players born in Q1 exhibiting an odds ratio of 5.44 relative to Q4 (CI: 3.14–9.40). The effect was weaker but still statistically significant in 2022 ($\chi^2_{(3)}$ = 13.91, $p < 0.01$, V§ = 0.16), where players in Q1 were 2.52 times more likely to be selected than those in Q4 (CI: 1.51–4.19). When all U18 players were considered collectively (N = 560), a significant effect persisted ($\chi^2_{(3)}$ = 61.09, $p < 0.01$, V§ = 0.19), with Q1 players exhibiting a 3.59 times higher likelihood of selection than those in Q4 (CI: 2.66–4.85).

When analysing the total sample across all age groups (N = 1673), the results confirmed the systematic advantage for players born earlier in the year. In 2024, birth quarter effects were highly significant ($\chi^2_{(3)}$ = 66.80, $p < .01$, V§ = 0.20), with Q1 players being 3.74 times more likely to be selected than those in Q4 (CI: 3.03–4.62). In 2023, the trend remained consistent ($\chi^2_{(3)}$ = 65.19, $p < 0.01$, V§ = 0.20), with an odds ratio of 3.79 for Q1 compared to Q4 (CI: 3.06–4.70). Similarly, in 2022, a significant bias favouring earlier-born players was observed ($\chi^2_{(3)}$ = 58.84, $p < 0.01$, V§ = 0.19), with Q1 players being 3.46 times more likely to be selected than those in Q4 (CI: 2.80–4.28). Across all years and categories combined, the birth quarter distribution significantly deviated from equality ($\chi^2_{(3)}$ = 190.41, $p < 0.01$, V§ = 0.20), with players born in Q1 exhibiting an odds ratio of 3.66 relative to Q4 (CI: 3.24–4.14).

Table 1.
The RAE in Female Basketball Players Across U14, U16, and U18 Categories (2022-2024)

											Odds ratio (CI 95%)		
		Q1	**Q2**	**Q3**	**Q4**	**TOTAL**	**χ^2**	**df**	**p**	**V§**	**Q1-Q4**	**Q2-Q4**	**Q3-Q4**
U14	2024	64	53	40	16	173	29.57	3	**0.01***	0.24	5.76 (3.16-10.50)	4.33 (2.36-7.96)	2.95 (1.58-5.51)
U14	2023	68	55	38	25	186	22.99	3	**0.01***	0.2	3.71 (2.21-6.22)	2.7 (1.6-4.58)	1.65 (0.95-2.87)
U14	2022	70	55	36	29	190	21.83	3	**0.01***	0.2	3.24 (1.98-5.4)	2.26 (1.37-3.75)	1.3 (0.76-2.22)
U14	TOTAL	202	163	114	70	549	72.27	3	**0.01***	0.21	3.98 (2.94-5.40)	2.89 (2.12-3.94)	1.79 (1.30-2.48)
U16	2024	75	55	40	33	203	20.43	3	**0.01***	0.18	3.02 (1.89-4.83)	1.91 (1.18-3.11)	1.26 (0.76-2.10)
U16	2023	57	60	43	26	186	15.59	3	**0.01***	0.17	2.72 (1.62-4.57)	2.93 (1.75-4.91)	1.85 (1.08-3.16)
U16	2022	65	50	43	17	175	27.58	3	**0.01***	0.23	5.49 (3.05-9.88)	3.72 (2.04-6.76)	3.03 (1.65-5.56)
U16	TOTAL	197	165	126	76	564	57.89	3	**0.01***	0.19	3.45 (2.56-4.64)	2.66 (1.96-3.59)	1.85 (1.35-2.52)
U18	2024	67	56	42	26	191	19.79	3	**0.01***	1.9	3.43 (2.06-5.71)	2.63 (1.57-4.42)	1.79 (1.05-3.06)
U18	2023	74	51	44	20	189	31.38	3	**0.01***	0.24	5.44 (3.14-9.40)	3.12 (1.78-5.49)	2.56 (1.45-4.55)
U18	2022	57	57	38	28	180	13.91	3	**0.01***	0.16	2.52 (1.51-4.19)	2.52 (1.51-4.19)	1.45 (0.85-2.49)
U18	TOTAL	198	164	124	74	560	61.09	3	**0.01***	0.19	3.59 (2.66-4.85)	2.72 (2.01-3.69)	1.87 (1.36-2.56)
TOTAL	2024	206	164	122	75	567	66.80	3	**0.01***	0.2	3.74 (3.03-4.62)	2.67 (2.15-3.31)	1.80 (1.44-2.25)
TOTAL	2023	199	166	125	71	561	65.19	3	**0.01***	0.2	3.79 (3.06-4.70)	2.90 (2.33-3.61)	1.98 (1.58-2.48)
TOTAL	2022	192	162	117	74	545	58.84	3	**0.01***	0.19	3.46 (2.80-4.28)	2.69 (2.17-3.34)	1.74 (1.39-2.18)
TOTAL	TOTAL	597	492	364	220	1673	190.41	3	**0.01***	0.2	3.66 (3.24-4.14)	2.75 (2.43-3.12)	1.84 (1.61-2.09)

*: $p < 0.05$, χ^2: chi square, §V = Cramer´s V

The findings demonstrate a robust and persistent Relative Age Effect, with players born earlier in the competition year being consistently overrepresented across all age categories and years. The effect was particularly pronounced in the U14 and U18 categories, where odds ratios were highest, suggesting that selection biases favouring early born athletes may become more pronounced at entry-level and near-elite stages of development. These findings have implications for talent identification and development strategies in female youth basketball, highlighting the need for interventions to mitigate selection biases and promote equity in athlete development pathways.

The Kruskal-Wallis H test was conducted to determine whether the birth quarter significantly caused the duration of play across different age categories and years (Table 2). The findings revealed no significant differences in playing time based on birth quarter for the U14 ($\chi^2_{(3)}$ = 2.774, p = 0.43) and U18 ($\chi^2_{(3)}$= 2.506, p = 0.47) categories, indicating that the distribution of minutes played was statistically comparable across all birth quarters in these age groups (Field, 2024) (Table 2).

Conversely, a significant effect of birth quarter on playing time was observed in the U16 category ($\chi^2_{(3)}$= 10.304, p = 0.02). Post hoc analysis indicated that players born in the first (Q1) and second (Q2) quarters accumulated significantly more minutes on the court than those born in the third (Q3) and fourth (Q4) quarters. Specifically, Q1 players demonstrated greater playing time than both Q3 and Q4 players (1 > 3, 1 > 4), and a similar trend was observed for Q2 players (2 > 3, 2 > 4), suggesting that athletes born in the latter half of the year were allocated fewer minutes in competitive matches.

When analysing the total sample across all age groups, the results further reinforced the existence of birth quarter disparities in playing time ($\chi^2_{(3)}$ = 12.701, p = 0.01). Post hoc comparisons confirmed that players born in Q1 and Q2 played significantly longer than those born in Q3 (1 > 3, 2 > 3), further supporting the presence of a RAE in game participation.

These findings indicate that birth quarter disparities in playing time are particularly pronounced in the U16 category, where early-born players (Q1 and Q2) receive greater opportunities for in-game participation compared to their later-born counterparts. However, this effect does not appear to persist in the younger (U14) or older (U18) age groups, suggesting that the cause of relative age on playing time may peak during mid-adolescence before diminishing in later developmental stages. These results highlight potential structural biases in coaching and selection decisions, warranting further investigation into developmental policies aimed at ensuring equitable participation opportunities for all athletes.

Table 3 shows the results of the Kruskal-Wallis H test to evaluate the effect of birth quartile on the efficiency scores of female basketball players of different age categories and years. The results revealed no significant differences in efficiency scores for the U14 category ($\chi^2_{(3)}$ = 7.072, p = 0.07) and the U18 category ($\chi^2_{(3)}$ = 3.065, p = 0.382), indicating that players' efficiency was not systematically influenced by birth quarter at these developmental stages.

In contrast, a significant effect of birth quarter on efficiency scores was observed in the U16 category ($\chi^2_{(3)}$ = 14.482, p = 0.002). Post hoc analysis indicated that players born in the first quarter (Q1) exhibited significantly higher efficiency scores than those born in the third quarter (Q3) (1 > 3). This finding suggests that Q1 players may have a competitive advantage over later-born peers, potentially due to accumulated developmental benefits associated with relative age.

When considering the total sample across all age groups, the results demonstrated a statistically significant effect of birth quarter on player efficiency ($\chi^2_{(3)}$ = 16.716, p = 0.001). Post hoc analysis revealed that players born in Q1 and Q2 had significantly higher efficiency scores than those born in Q3 (1 > 3, 2 > 3), reinforcing the notion that early born players tend to perform more efficiently in competitive play.

Table 2.
Kruskal-Wallis analysis of variance for minutes played of players by birth quarters.

Category		n	$\bar{X}$	SD	Means of Rank	df	χ^2	p	Post hoc
U14	Q1	202	18:32	11:29	284.33	3	2.774	0.43	
	Q2	163	18:21	11:55	281.22				
	Q3	114	16:32	11:41	260.16				
	Q4	70	16:39	12:04	257.76				
U16	Q1	197	19:10	11:13	298.63	3	10.304	**0.02***	**1>3, 1>4 2>3, 2>4**
	Q2	165	19:16	11:18	299.23				
	Q3	126	16:08	11:32	255.28				
	Q4	76	15:55	13:07	249.49				
U18	Q1	198	18:21	10:31	282.04	3	2.506	0.47	
	Q2	164	19:08	10:41	292.01				
	Q3	124	17:04	11:28	261.83				
	Q4	74	18:33	11:55	282.15				
TOTAL	Q1	597	18:41	11:04	864.66	3	12.701	**0.01***	**1>3, 2>3**
	Q2	492	18:55	11:18	871.28				
	Q3	364	16:35	11:32	775.11				
	Q4	220	17:02	12:23	787.68				

*: $p < 0.05$, χ^2: chi square

These findings suggest that RAE (Relative Age Effect) may cause player efficiency, particularly in the U16 category, where early-born players appear to outperform their later-born counterparts. The absence of significant effects in the U14 and U18 categories could indicate that RAE-related performance differences emerge during mid-adolescence but may diminish at later stages of development, potentially due to talent filtering and maturation equalization. Given the implications of these results, youth basketball programs should consider mitigating selection biases that favour early born players and implementing developmental strategies that ensure equitable performance opportunities for all athletes, regardless of birth quarter.

Table 3.
The Kruskal-Wallis H test analysis of variance for the efficiency of players by birth quarters.

Category		n	$\bar{X}$	SD	Means of Rank	df	χ^2	p	Post hoc
U14	Q1	202	4.51	6.66	298.03	3	7.072	0.07	
	Q2	163	3.57	5.96	266.8				
	Q3	114	2.81	5.18	256.91				
	Q4	70	2.81	5.60	257.09				
U16	Q1	197	5.66	6.10	309.17	3	14.482	**0.01***	**1>3**
	Q2	165	4.68	5.04	290.33				
	Q3	126	3.61	5.03	242.01				
	Q4	76	4.40	5.54	263.49				
U18	Q1	198	5.37	5.60	282.85	3	3.065	0.38	
	Q2	164	5.68	5.77	290.44				
	Q3	124	4.41	4.64	258.84				
	Q4	74	5.59	5.70	288.49				
TOTAL	Q1	597	5.18	6.15	887.42	3	16.716	**0.01***	**1>3. 2>3**
	Q2	492	4.64	5.66	846.06				
	Q3	364	3.63	4.98	760.34				
	Q4	220	4.30	5.70	806.75				

*: $p < 0.05$, χ^2: chi square

DISCUSSION

This study aimed to achieve three primary objectives. Firstly, it sought to analyze the presence of the RAE in the Turkish Women's Basketball Championship across the U14, U16, and U18 age categories. Secondly, it examined the cause of birth quartiles on the performance efficiency of female basketball players within these categories. Lastly, the study investigated how the distribution of birth quartiles among female athletes in the U14, U16, and U18 divisions impacts their playing time.

The study's initial findings show that a moderate level of RAE exists in the U16 and U18 categories, with the highest level in the U14 category in the 2022-2024 Turkish Women's Basketball Championship. This effect is due to the higher representation of female basketball players born in the first quarter of the year (Q1) compared with those born in the last quarter of the year (Q4), ranging from 2.52% to 5.76%, with variations according to year and category. This situation observed in women's youth basketball may directly or indirectly affect factors such as player selection, talent assessment, development processes, dropout from basketball, and representation at the elite level.

The observed RAE aligns with global research indicating that relatively older athletes within the same age cohort often possess physical and cognitive advantages, leading to higher selection rates. This effect has been observed across various competitive sports, including football and basketball, where athletes born in the first quarter of the year are more likely to be chosen for elite pathways. Research has shown that younger athletes within the same age cohort tend to be underrepresented, particularly in popular sports such as football and basketball. For instance, a study of 9-14-year-olds across competitive sports found a significant underrepresentation of athletes born in the last quarter of the year (de La Rubia Riaza et al., 2020). In basketball, this trend is particularly noticeable; numerous studies have consistently demonstrated the prevalence of RAE (Arrieta et al., 2016; García et al., 2014; Tascioglu et al., 2023), suggesting that earlier-born athletes are more likely to progress through talent pathways due to their physical maturity at younger ages (Kelly et al., 2021a). However, some studies have also suggested that the RAE's impact diminishes as athletes mature, with older age categories showing a more balanced distribution of birth dates (Rubajczyk et al., 2017).

The significance of RAE can be influenced by contextual factors such as the competitive environment, the popularity of a sport, and national or cultural differences in talent identification practices. Research has shown that RAE tends to be more pronounced in countries with strong early talent identification systems, such as those in Europe, especially in widely practiced and highly competitive sports like soccer (Lidor et al., 2021; Helsen et al., 2005). In contrast, less competitive sports with lower participation rates often exhibit a less pronounced RAE, as the emphasis on early selection is reduced (Delorme et al., 2010).

The variability observed between studies underscores an important nuance: the cause of the RAE is not a universal or static phenomenon, but rather depends on specific contexts, including developmental stage, competitive environment, and selection criteria. As athletes progress through age categories, the impact of the RAE may diminish, with other factors such as individual skill development, resilience, and psychological maturity becoming more significant. In the case of the Turkish Women's Basketball Championships, while statistical evidence points to an observable RAE, a critical examination suggests that these effects are not inevitable and do not necessarily determine the long-term success of an athlete. It is essential to interpret these findings not as fixed outcomes, but as indicators that the selection process may need refinement to better accommodate athletes born later in the year. Therefore, while the RAE is a valid concern in youth basketball, its implications should be examined critically and not overgeneralized across all stages of athlete development. Additionally, the success of athletes born in the year's second half requires careful consideration, as they may possess untapped potential if provided with the right developmental conditions.

The findings of this study indicate that the RAE exerts a significant effect on player efficiency and playing time in the U16 category, whereas this effect is not statistically significant in the U14 and U18 categories. Specifically, players born in the first quarter (Q1) of the year exhibited higher efficiency scores compared to those born in the third quarter (Q3). Similarly, an analysis of playing time based on birth quarters revealed significant differences in the U16 category, while such differences were not prominent in the U14 and U18 categories. Players born in Q1 and Q2 received more playing time than those born in Q3 and Q4, suggesting that relatively older players are granted greater opportunities during mid-adolescence (U16). These findings align with previous research indicating that physical, cognitive, and technical maturity confer a competitive advantage to Q1 and Q2 born athletes (Arietta et al., 2016; Delorme et al., 2010; Ibáñez et al., 2018; Kelly et al., 2021).

Despite the presence of RAE in the U14 category, the absence of significant differences in playing time and efficiency scores can be attributed to the ongoing physiological development of athletes and the fact that sport-specific skills are still in the developmental stage (Gryko et al., 2022; Leyhr et al., 2024). At this early stage of adolescence, physical advantages are not yet pronounced. Coaches may prioritize player experience and distribute playing time more equitably (Ibáñez et al., 2018; Kalén et al., 2021). Additionally, policies promoting equal playing time in the U14 category may further contribute to this outcome (Birrento Aguiar et al., 2023).

In contrast, within the U16 category, Q1 and Q2 born athletes were observed to receive more playing time and achieve higher efficiency scores. At this developmental stage, female athletes experience substantial physiological changes, including muscle mass, coordination improvements, and overall athletic development (Ibáñez et al., 2023; Mancha-Triguero et al., 2019). These factors provide early born players with a competitive edge, which may be further reinforced by coaches' unconscious bias favouring physically dominant athletes (Kelly et al., 2021). The pronounced presence of RAE in the U16 category supports findings that mid-adolescence represents a peak period for performance disparities caused by RAE (Lovell et al., 2015). To mitigate these inequalities, the implementation of fair playing time policies, biologically based grouping systems, and increased awareness among coaches are recommended.

In the U18 category, no statistically significant differences were observed in playing time or efficiency scores based on birth quarters. The diminishing effect of RAE at this level may be associated with talent selection processes, where factors such as skill level, tactical awareness, and experience become more critical determinants of player retention than physical advantages (Romann & Fuchslocher, 2011). Moreover, relatively late-born athletes may gradually adapt and compensate for initial physical disadvantages through skill refinement and competitive resilience (Kalén et al., 2021; McCarthy et al., 2016).

Long-term observations indicate that relatively late-born athletes develop enhanced resilience and adaptability over time. Research suggests that athletes who experience physical disadvantages in early years may strengthen their mental toughness and refine their technical skills to sustain their competitive standing (Lupo et al., 2019). Additionally, talent selection criteria evolve, shifting from emphasizing physical dominance to focusing on technical and tactical proficiency (Rogers et al., 2022).

In conclusion, this study demonstrates that the RAE significantly causes player efficiency and playing time in the U16 category but diminishes at the U18 level, possibly due to talent filtering and maturation equalization. Addressing these disparities through inclusive and equitable policies may foster a more balanced and fair sporting environment. These results emphasize the need for equitable playing time policies, particularly in the U16 category, to prevent early born advantages from becoming self-reinforcing. Structured rotation systems, bio-banding (grouping athletes based on biological rather than chronological age), and increased awareness among coaches can help mitigate the effects of RAE and ensure fair developmental opportunities for all players.

Limitations

Despite its contributions, this study has several limitations. First, it is limited to the Turkish Women's Basketball Championship and may not be fully generalized to other leagues or countries with different selection and development structures. Second, the study relies on publicly available match statistics, which may not capture all variables influencing performance, such as psychological resilience or training quality. Lastly, the study does not consider individual biological maturation, which could provide a more nuanced understanding of player development beyond birth quartiles.

CONCLUSION

The findings of this study reinforce the widespread presence of RAE in Turkish women’s basketball, particularly in the U14, U16, and U18 categories. The statistical evidence highlights a significant bias toward selecting and favouring early born players, impacting both playing time and efficiency scores. While this trend aligns with global research on RAE, counterarguments suggest that the initial advantages of early-maturing players may diminish over time, allowing later-maturing athletes to excel if given the right opportunities. Addressing RAE biases in basketball requires a multi-faceted approach, including maturity-adjusted assessments, coach education, and long-term athlete development strategies to ensure fair and equitable talent identification processes.

PRACTICAL IMPLICATIONS

The findings of this study highlight the necessity for a more refined approach to talent identification and development in youth basketball. Coaches, clubs, and federations should consider the implications of the RAE in player selection and development processes to ensure fair and effective talent progression.

First, player selection protocols should move beyond an overreliance on birth quartiles and incorporate a more holistic evaluation of potential. While early physical maturity can contribute to performance advantages, it does not necessarily predict long-term success. Coaches should emphasize a long-term perspective, considering current ability and future developmental potential. Implementing multidimensional assessment criteria, which include technical, tactical, psychological, and cognitive abilities alongside physical attributes, will allow for a more equitable evaluation of players.

Second, clubs and national federations should develop structured programs that mitigate the disadvantages relatively younger players face. This could include implementing adjusted training loads, personalized skill development plans, and additional competitive opportunities to support their growth. Organizing competitions based on maturational levels rather than strict age categories could create a more balanced competitive environment, reducing the exclusion of late-maturing athletes.

Third, player development programs should consider position-specific impacts of birth quartiles. The study indicates that birth date distribution can influence playing profiles, which suggests that training should be tailored to maximize players' strengths within their respective positions. Coaches should design individualized training regimens that address the unique developmental needs of athletes, ensuring they can contribute effectively to team performance regardless of relative age.

Additionally, measures should ensure equitable playing time distribution, preventing systemic biases favoring relatively older players. Creating rotational policies and structured development leagues that integrate less selected, yet talented, younger athletes can help sustain their engagement and development in the sport.

Stakeholders and decision-makers should also revise current competition structures to reduce the impact of RAE. Implementing rules that limit the number of relatively older players per team, adjusting youth competition formats to allow for more fluid player movement between categories, and continuously monitoring the long-term impact of RAE on talent development can contribute to a more inclusive and effective system.

Ultimately, a comprehensive approach incorporating physiological, psychological, and cognitive factors in talent identification and development will ensure that young basketball players have equal opportunities to reach their full potential, regardless of their birth quartile.

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Authors' Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Declaration of Conflict Interest

The author reports there are no competing interests to declare.

Ethics Statement

This research is in accordance with standards set by the Declaration of Helsinki. As a result of the application, approval was given by the Uşak University Clinical Research Ethics Committee with the 542-542-04/2025 decision notification number.

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