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Relative Age Effects in Competitive Wrestling: Variations by Age Group and Gender

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Relative Age Effects in Competitive Wrestling: Variations by Age Group and Gender

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Abstract

This study examined the presence of the relative age effect (RAE) in wrestling and its association with competitive success across age groups, styles, and gender. Data were drawn from 6,631 wrestlers (5,678 males and 953 females) competing in freestyle, Greco-Roman, and women's categories at the 2025 Turkish Wrestling Championships, spanning ages 10–14 and the senior level. Birthdates were grouped into quartiles, and competitive outcomes were classified as medalists, quarterfinalists, others. Chi-square goodness-of-fit tests and chi-square tests of independence were conducted to examine the distribution of birth quarters and their association with tournament success outcomes. Analyses showed that there were no differences between birth quartiles in male freestyle and Greco-Roman wrestlers aged 10–13, as well as in all age categories among female wrestlers ($p>0.05$); however, athletes born in the early months of the year were statistically significantly

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overrepresented in the male 14 years and senior categories ($p<0.05$). In both styles, for males and in all categories for females, athletes born earlier in the year were found to have a higher likelihood of achieving higher tournament rankings across all youth categories ($p<0.05$), whereas this relationship was not observed at the senior level ($p>0.05$). Overall, the findings suggest that relative age advantages are most pronounced during developmental stages and diminish at the elite adult level, highlighting the potential value of considering relative-age-related performance differences when designing youth talent identification and development systems.

Keywords: Wrestler; relative age effect; birth quartile; athlete development; talent identification

1. Introduction

The age-grouping system was a common practice in youth sports aimed at minimizing developmental differences (Yu & Yang, 2025). Although this approach targeted equal competitive conditions, even within single-year groups, differences in birth dates of up to 12 months could occur (Musch & Grondin, 2001). For instance, considering January 1 as the cut-off date, a child born on that day would be placed in the same age group as a child born on December 31 (Delorme et al., 2011). Age differences among individuals participating in performance-based activities, depending on their birth month, were defined as “Relative Age (RA),” whereas the birth date imbalance in which athletes born in the earlier months of the year dominated compared to those born in later months was defined as the “Relative Age Effect (RAE)” (Barnsley et al., 1985; Barnsley & Thompson, 1988). However, the literature frequently showed that these two terms were often used interchangeably.

Relatively older children were advantaged in terms of growth, biological maturity, and cognitive development (Cumming et al., 2017; Hill et al., 2020). This advantage could explain why they were often preferred during talent selection in many sports (Furley & Memmert, 2016; Sarmento et al., 2018), as physically more mature children were generally perceived as more skilled (Schorer et al., 2009). Although the physical advantage of being born in the early months of the year was limited, it could also confer other benefits that might lead to performance differences, such as increased coach attention, parental support, and self-confidence (Helsen et al., 2005; Lames et al., 2008). Success in sport was often accompanied by positive feedback from parents

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and coaches, which could encourage the athlete to exert more effort and ultimately achieve better performance (Brustio et al., 2022; Hancock et al., 2013). Moreover, measures such as extra training with elite coaches for selected athletes could provide a substantial performance advantage (Augste & Lames, 2011). These sequential processes could lead to a consistent improvement in performance and being born just a few months earlier than competitors could provide athletes with greater opportunities and advantages (Augste & Lames, 2011; Wattie et al., 2015). Conversely, athletes born in the later months of the year may be exposed to various disadvantages, including lower levels of physical maturity (e.g., reduced strength, size, and coordination), increased selection bias during talent identification processes, reduced playing time, and potential psychological disadvantages such as lower perceived competence and decreased self-confidence (Bilgiç & Işın, 2023; Hill ve ark., 2020). This situation could negatively affect the future sports careers of athletes who were unable to perform sufficiently and were assessed as unsuccessful in tournaments, potentially leading them to drop out of sport at an early age (Hancock, Adler, & Côté, 2013). Preventing individuals from dropping out or losing talent in sport represented a significant practical challenge (Baker, Schorer, & Wattie, 2018; Till & Baker, 2020), particularly because coaches might prioritize athletes with physical advantages, thereby overlooking less physically mature but potentially talented individuals (Furley & Memmert, 2016).

A previous study had demonstrated that the RAE existed in almost all competition-based sports (Musch & Grondin, 2001). The effect was particularly pronounced in physically contact-based sports (Baxter-Jones, 1995) and tended to decrease as athletes aged (Lames et al., 2008). In combat sports such as boxing, wrestling, judo, and taekwondo, classification according to weight categories to balance athletes' physical differences was suggested as a partial solution to mitigate the effects of the RAE (Musch & Grondin, 2001; Cobley et al., 2009). However, studies specifically examining this issue in combat sports indicated that the RAE persisted among wrestlers (Albuquerque et al., 2014; Latyshev et al., 2022; Yıldırım & Deniz, 2023), judokas (Albuquerque et al., 2013), boxers (Delorme, 2014), and taekwondo athletes (Albuquerque et al., 2012). On the other hand, athletes being in the same weight category implied that their body weights were similar; however, this did not necessarily indicate that their levels of physical, mental, and psychological maturity

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were equivalent. Wrestling, as a sport involving high levels of physical contact (Tomczak et al., 2013), made the examination of RAE among wrestlers particularly important.

The aim of the present study was to investigate the prevalence of RAE among athletes participating in the men's freestyle, men's Greco-Roman, and women's categories at the Turkish Wrestling Championships across different age groups, and to evaluate the relationship between RA and tournament success. The hypotheses proposed in the study were as follows: (1) In the younger age groups (10, 11, 12, 13, and 14 years), athletes born in the early months of the year will achieve higher tournament success, whereas no such association is expected at the senior level. (2) The distribution of birth months across participants in the younger age groups (10, 11, 12, 13, and 14 years) will not differ significantly from a uniform distribution, whereas in the senior category, a significant deviation from a uniform distribution will be observed, indicating a more pronounced RAE.

2. Materials and Methods

2.1. Participants

The sample consisted of 6,631 wrestlers (953 women, 5,678 men) who participated in the 2025 Turkish Wrestling Championships in the men's freestyle, men's Greco-Roman, and women's categories across different age groups. Participation was distributed across the 10–14 youth categories and the senior category (18–35 years). The official age-group cutoff date used in the 2025 Turkish Wrestling Championships is set from 1 January to 31 December.

In the youth divisions, the number of athletes by age was as follows: 787 wrestlers aged 10 years (401 male freestyle, 292 male Greco-Roman, and 94 female), 1,146 aged 11 years (557 male freestyle, 397 male Greco-Roman, and 192 female), 1,352 aged 12 years (663 male freestyle, 473 male Greco-Roman, and 216 female), 1,310 aged 13 years (651 male freestyle, 507 male Greco-Roman, and 152 female), and 1,106 aged 14 years (567 male freestyle, 403 male Greco-Roman, and 136 female).

The senior category included a total of 930 wrestlers, comprising 444 male freestyle, 323 male Greco-Roman, and 163 female athletes.

2.2. Data Collection and Procedures

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The 2025 tournament results for the participants were obtained from the publicly available official results book on the Turkish Wrestling Federation's website (https://tgf.tr/musabaka-sonuclari). Participants' birth date information (day/month/year) was obtained from the team lists submitted to the Turkish Wrestling Federation on the day of the tournament. Official permission to use the data was granted by the Turkish Wrestling Federation, and this permission was submitted along with an application to the XXXXXX University Social and Human Sciences Research and Publication Ethics Committee. The ethics committee determined that formal ethical approval was not required for this type of study (28 November 2025; numbered 2025–10/3).

Athletes' birth dates were classified according to birth quarters, created by dividing the months of the year into three-month periods: Q1 (January, February, March), Q2 (April, May, June), Q3 (July, August, September), and Q4 (October, November, December). Based on tournament results, athletes were categorized into three groups: medalists, quarter-finalists, and others. In the 10, 11, 12, 13, and 14-year-old tournaments, all participants were of the same age, whereas in the senior category, participants' ages ranged from 18 to 35 years.

2.3. Statistical Analysis

The data were analyzed using SPSS version 28.0 (IBM Corp., Armonk, NY, USA). For each age group, the distribution of all participants across birth quarters was evaluated using chi-square goodness-of-fit tests, and Cohen's w was calculated as the measure of effect size. Cohen (1992) suggested that values of 0.1, 0.3, and 0.5 represented small, medium, and large effects, respectively. It was assumed that the expected distribution across the four quarters of the year would be equal at 25% each, as in similar studies in the literature (Yıldırım & Deniz, 2023; Kim et al., 2024). To assess the relationship between birth quarters and tournament outcomes, separate chi-square tests of independence were conducted for each age group, with Cramer's V used as the effect size measure ($V \leq 0.06$: negligible effect; $0.06 < V \leq 0.17$: small effect; $0.17 < V < 0.29$: medium effect; $V \geq 0.29$: large effect) (Cramer, 1999). For all chi-square analyses, expected cell counts were examined to ensure that the assumptions of the test were met, and no violations were observed. When statistically significant differences were detected, standardized residuals (SR) were examined to

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determine which variable levels contributed to the significance. Cells with absolute SR values greater than 1.96 indicated a significant deviation from expected counts. Statistical significance was set at $p<0.05$ for all analyses.

3. Results

The RA quarter distribution ratios of male freestyle wrestlers by age group can be seen in Figure 1. In the men's freestyle tournaments, the observed RA quarter distributions for wrestlers in the 10, 11, 12, and 13-year-old groups did not differ significantly from the expected distributions (or from an equal distribution across RA quarters), respectively ($\chi^2=1.62$, df=3, $p=0.654$, $w=0.06$; $\chi^2=1.36$, df=3, $p=0.716$, $w=0.05$; $\chi^2=1.96$, df=3, $p=0.586$, $w=0.05$; $\chi^2=1.91$, df=3, $p=0.591$, $w=0.05$). In the 14-year-old group, the observed distributions differed significantly from the expected distributions ($\chi^2=111.47$, df=3, $p<.001$, $w=0.44$), with observed frequencies in Q1 (30.34%) and Q2 (37.39%) being significantly higher than expected. In the senior age group, the observed distributions also differed significantly from expected distributions ($\chi^2=131.23$, df=3, $p<.001$, $w=0.54$), with Q1 (38.96%) and Q2 (36.94%) showing substantially higher observed frequencies than expected.

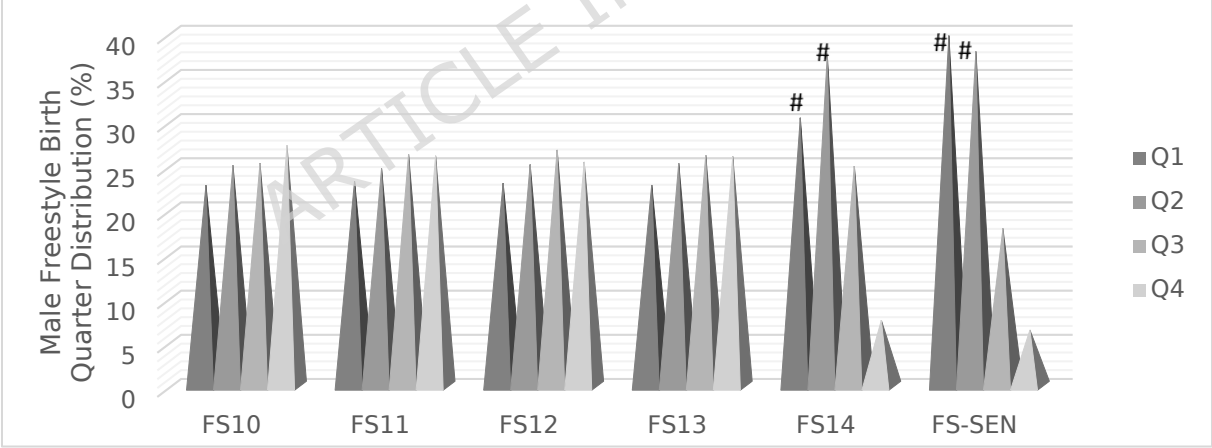


Figure 1. Relative age quarter (Q1, Q2, Q3, Q4) distribution of male freestyle wrestlers across different age groups, expressed as percentages. #: The observed value is significantly higher than the expected value.

The RA quarter distribution ratios of male Greco-Roman wrestlers by age group are presented in Figure 2. In the men's Greco-Roman tournaments, the observed RA quarter distributions for wrestlers in the 10, 11, 12, and 13-year-old groups did not differ significantly from the expected distributions, respectively ($\chi^2=2.27$, df=3,

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p=0.518, w=0.09; χ^2=5.13, df=3, p=0.163, w=0.11; χ^2=2.15, df=3, p=0.541, w=0.07; χ^2=1.93, df=3, p=0.587, w=0.06). In the 14-year-old group, the observed distributions differed significantly from the expected distributions (χ^2=71.65, df=3, p<.001, w=0.42), with Q1 (29.28%) and Q2 (34.74%) showing observed frequencies significantly higher than expected. In the senior age group, the observed distributions also differed significantly from expected distributions (χ^2=163.25, df=3, p<.001, w=0.71), with Q1 (51.39%) and Q2 (30.96%) having substantially higher observed frequencies than expected.

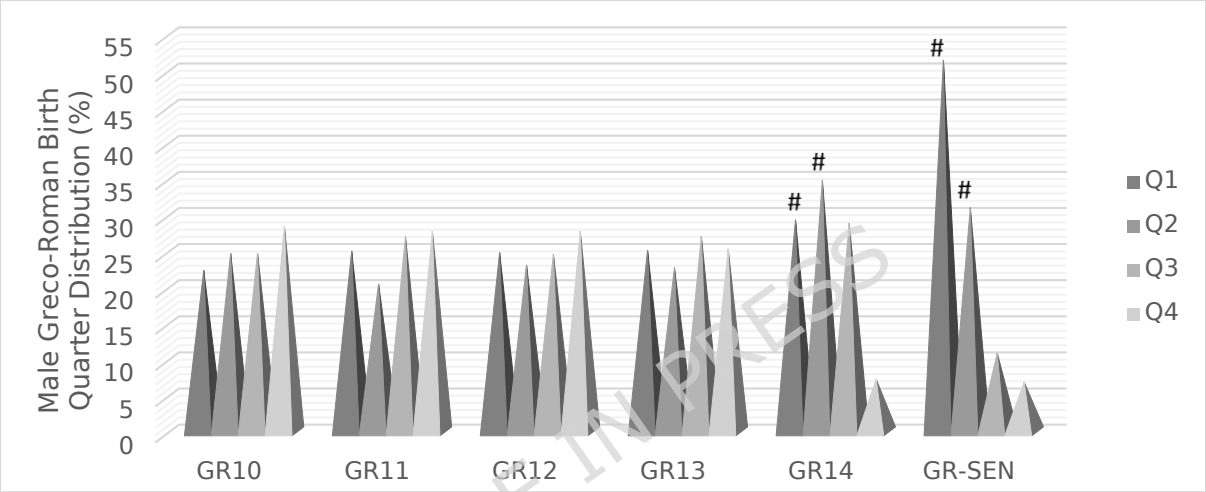


Figure 2. Relative age quarter (Q1, Q2, Q3, Q4) distribution of male greco-roman wrestlers across different age groups, expressed as percentages. #: The observed value is significantly higher than the expected value.

The RA quarter distribution ratios of female wrestlers by age group are presented in Figure 3. In the women's tournaments, the observed RA quarter distributions for wrestlers in the 10, 11, 12, 13, 14-year-old, and senior age groups did not differ significantly from the expected distributions, respectively (χ^2=0.55, df=3, p=0.907, w=0.08; χ^2=1.54, df=3, p=0.673, w=0.09; χ^2=1.67, df=3, p=0.644, w=0.09; χ^2=1.47, df=3, p=0.688, w=0.10; χ^2=0.59, df=3, p=0.996, w=0.07; χ^2=0.95, df=3, p=0.813, w=0.08).

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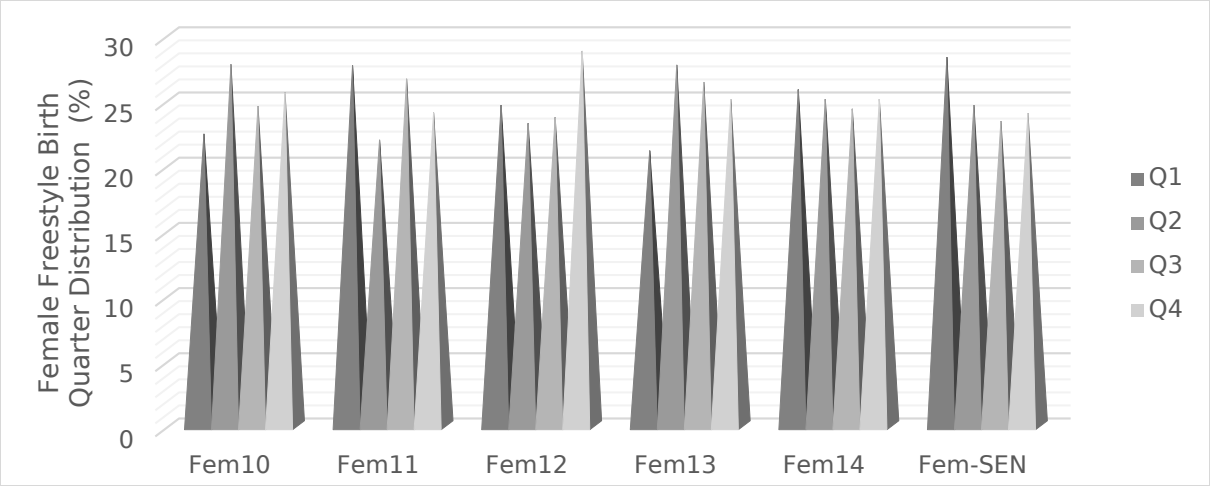


Figure 3. Relative age quarter (Q1, Q2, Q3, Q4) distribution of female wrestlers across different age groups, expressed as percentages.

The chi-square tests of independence examining the relationship between birth quarter and tournament outcomes for male freestyle wrestlers (analyzed separately for each age group) are presented in Table 1. When a significant relationship was observed, standardized residual (SR) values were provided to indicate which variable levels contributed to the significance.

In the FS10 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=48.14, df=6, p<.001, V=0.25). Among medalists, athletes born in Q1 (SR=4.2) were overrepresented, whereas those born in Q3 (SR=-3.0) and Q4 (SR=-2.1) were underrepresented. In the quarter-finalist category, athletes born in Q2 (SR=3.0) were overrepresented, while those born in Q4 (SR=-3.2) were underrepresented. In the “others” category, athletes born in Q1 (SR=-4.6) and Q2 (SR=-3.1) were underrepresented, whereas those born in Q3 (SR=3.4) and Q4 (SR=4.0) were overrepresented.

In the FS11 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=72.93, df=6, p<.001, V=0.26). Among medalists, athletes born in Q1 (SR=4.6) were overrepresented, whereas those born in Q3 (SR=-3.6) and Q4 (SR=-2.2) were underrepresented. In the quarter-finalist category, athletes born in Q1 (SR=4.3) and Q2 (SR=2.5) were overrepresented, while those born in Q3 (SR=-3.6) and Q4 (SR=-2.9) were underrepresented. In the “others” category, athletes born in Q1 (SR=-6.6) and Q2 (SR=-3.0) were underrepresented, whereas those born in Q3 (SR=5.4) and Q4 (SR=3.8) were overrepresented.

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In the FS12 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=65.20, df=6, p<.001, V=0.22). Among medalists, athletes born in Q1 (SR=5.5) were overrepresented, whereas those born in Q3 (SR=-2.9) and Q4 (SR=-2.1) were underrepresented. In the quarter-finalist category, athletes born in Q1 (SR=4.2) were overrepresented, while those born in Q3 (SR=-2.6) and Q4 (SR=-3.0) were underrepresented. In the “others” category, athletes born in Q1 (SR=-7.2) were underrepresented, whereas those born in Q3 (SR=4.0) and Q4 (SR=3.8) were overrepresented.

In the FS13 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=82.11, df=6, p<.001, V=0.25). Among medalists, athletes born in Q1 (SR=6.6) were overrepresented, whereas those born in Q3 (SR=-3.8) were underrepresented. In the quarter-finalist category, athletes born in Q1 (SR=3.9) and Q2 (SR=2.3) were overrepresented, while those born in Q3 (SR=-2.5) and Q4 (SR=-3.5) were underrepresented. In the “others” category, athletes born in Q1 (SR=-7.7) were underrepresented, whereas those born in Q3 (SR=4.7) and Q4 (SR=3.9) were overrepresented.

In the FS14 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=29.28, df=6, p<.001, V=0.16). Among medalists, athletes born in Q1 (SR=2.8) were overrepresented. In the quarter-finalist category, athletes born in Q1 (SR=2.1) and Q4 (SR=3.1) were overrepresented, while those born in Q2 (SR=-2.5) were underrepresented. In the “others” category, athletes born in Q2 (SR=3.2) and Q3 (SR=2.0) were overrepresented, whereas those born in Q1 (SR=-3.6) and Q4 (SR=-2.9) were underrepresented.

In the FS-SEN group, no significant relationship was observed between birth quarter and tournament outcomes (χ^2=7.77, df=6, p=0.256, V=0.09).

Table 1. Chi-square test of independence results showing the relationship between the birth quarter of male freestyle wrestlers and their tournament outcomes.

Category			Ranking			χ^2	df	p	V
			Medalist N/SR	Quarterfinalist N/SR	Other N/SR				
FS10	Birth Quarter	Q1	21 / 4.2#	15 / 1.9	55 / -4.6#	48.14*	6	<.001	0.25tt
		Q2	14 / 1.1	19 / 3.0#	67 / -3.1#				

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		Q3	3 / -3.0#	7 / -1.5	91 / 3.4#				
		Q4	6 /-2.1#	3 / -3.2#	100 / 4.0#				
		Total	44	44	313				
FS11	Birth Quarter	Q1	24 / 4.6#	23 / 4.3#	82 / -6.6#	72.93*	6	<.001	0.26tt
		Q2	16 / 1.5	19 / 2.5#	102 /-3.0#				
		Q3	2 / -3.6#	2 / -3.6#	142 / 5.4#				
		Q4	6 / -2.2#	4 / -2.9#	135 / 3.8#				
		Total	48	48	461				
FS12	Birth Quarter	Q1	28 / 5.5#	24 / 4.2#	100 / -7.2#	65.20*	6	<.001	0.22tt
		Q2	12 / -0.3	18 / 1.7	136 / -1.0				
		Q3	5 / -2.9#	6 / -2.6#	166 / 4.0#				
		Q4	7 / -2.1#	4 / -3.0#	157 / 3.8#				
		Total	52	52	559				
FS13	Birth Quarter	Q1	31 / 6.6#	23 / 3.9#	94 / -7.7#	82.11*	6	<.001	0.25tt
		Q2	11 / -0.7	20 / 2.3#	133 / -1.2				
		Q3	2 / -3.8#	6 / -2.5#	162 / 4.7#				
		Q4	8 / -1.8	3 / -3.5#	158 / 3.9#				
		Total	52	52	559				
FS14	Birth Quarter	Q1	23 / 2.8#	21 / 2.1#	128 / -3.6#	29.28*	6	<.001	0.16t
		Q2	12 / -1.9	10 / -2.5#	190 / 3.2#				
		Q3	8 / -1.4	8 / -1.4	125 / 2.0#				
		Q4	5 / 0.8	9 / 3.1#	28 / -2.9#				
		Total	48	48	471				
FS-SEN	Birth Quarter	Q1	19 / 1.2	14 / -0.5	140 / -0.5	7.77	6	0.256	0.09t
		Q2	8 / -2.3#	17 / 0.8	139 / 1.2				
		Q3	9 / 0.8	5 / -0.9	65 / 0.1				

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Q4	4 / 1.0	4 / 1.0	20 / -1.5
Total	40	40	364

χ^2: chi-square analysis, df: degrees of freedom, V: magnitude of the effect size the Cramer's V, SR: standardized residual, FS10-14: freestyle 10-14 age group, FS-SEN: freestyle seniors, Q1-4: birth quarter 1-4, *: $p<0.05$, ^{t}: small effect, ^{tt}: intermediate effect, ^{ttt}: large effect, #: 1.96<SR or -1.96>SR.

The chi-square tests of independence examining the relationship between birth quarter and tournament outcomes for male Greco-Roman wrestlers (analyzed separately for each age group) are presented in Table 2. When a significant relationship was observed, standardized residual (SR) values were provided to indicate which variable levels contributed to the significance.

In the GR10 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=61.49, df=6, p<.001, V=0.32). Among medalists, athletes born in Q1 (SR=5.6) were overrepresented, whereas those born in Q3 (SR=-3.0) and Q4 (SR=-3.4) were underrepresented. In the quarter-finalist category, athletes born in Q2 (SR=2.7) were overrepresented, while those born in Q4 (SR=-2.7) were underrepresented. In the "others" category, athletes born in Q1 (SR=-5.3) and Q2 (SR=-3.0) were underrepresented, whereas those born in Q3 (SR=3.2) and Q4 (SR=4.8) were overrepresented.

In the GR11 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=60.98, df=6, p<.001, V=0.28). Among medalists, athletes born in Q1 (SR=5.7) were overrepresented, whereas those born in Q3 (SR=-3.4) and Q4 (SR=-3.5) were underrepresented. In the quarter-finalist category, athletes born in Q2 (SR=2.0) were overrepresented, while those born in Q4 (SR=-2.2) were underrepresented. In the "others" category, athletes born in Q1 (SR=-5.7) and Q2 (SR=-2.7) were underrepresented, whereas those born in Q3 (SR=3.7) and Q4 (SR=4.3) were overrepresented.

In the GR12 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=83.06, df=6, p<.001, V=0.30). Among medalists, athletes born in Q1 (SR=6.4) were overrepresented, whereas those born in Q3 (SR=-3.1) and Q4 (SR=-3.5) were underrepresented. In the quarter-finalist category, athletes born in Q1 (SR=3.6) and Q2 (SR=2.5) were overrepresented, while those born in Q3 (SR=-

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2.4) and Q4 (SR=-3.5) were underrepresented. In the “others” category, athletes born in Q1 (SR=-7.5) and Q2 (SR=-2.1) were underrepresented, whereas those born in Q3 (SR=4.1) and Q4 (SR=5.3) were overrepresented.

In the GR13 group, a significant relationship was observed between birth quarter and tournament outcomes (χ^2=113.59, df=6, p<.001, V=0.34). Among medalists, athletes born in Q1 (SR=8.1) were overrepresented, whereas those born in Q3 (SR=-4.0) and Q4 (SR=-3.1) were underrepresented. In the quarter-finalist category, athletes born in Q1 (SR=3.7) and Q2 (SR=3.2) were overrepresented, while those born in Q3 (SR=-3.3) and Q4 (SR=-3.4) were underrepresented. In the “others” category, athletes born in Q1 (SR=-8.9) were underrepresented, whereas those born in Q3 (SR=5.5) and Q4 (SR=4.9) were overrepresented.

The analysis revealed a significant relationship between birth quarter and tournament outcomes in GR14 (χ^2=68.76, df=6, p<.001, V=0.29). Among medalists, those born in Q1 (SR=5.3) were overrepresented, whereas those born in Q3 (SR=-3.4) were underrepresented. In the quarterfinalists, wrestlers born in Q1 (SR=5.0) were overrepresented, while those born in Q3 (SR=-3.8) were underrepresented. In the “others” category, wrestlers born in Q1 (SR=-7.7) were underrepresented, whereas those born in Q2 (SR=2.4) and Q3 (SR=5.4) were overrepresented.

No significant relationship was observed between birth quarter and tournament outcomes in GR-SEN (χ^2=2.06, df=6, p=0.914, V=0.06).

Table 2. Chi-square test of independence results showing the relationship between the birth quarter of male greco-roman wrestlers and their tournament outcomes.

Category			Ranking			χ^2	df	p	V
			Medalist N/SR	Quarterfinalist N/SR	Other N/SR				
GR10	Birth Quarter	Q1	24 / 5.6#	13 / 1.3	28 / -5.3#	61.49*	6	<.001	0.32tt
		Q2	14 / 1.2	18 / 2.7#	40 / -3.0#				
		Q3	3 / -3.0#	8 / -1.1	61 / 3.2#				
		Q4	3 / -3.4#	5 / -2.7#	75 / 4.8#				
		Total	44	44	204				

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GR11	Birth Quarter	Q1	28 / 5.7#	17 / 1.8	54 / -5.7#	60.98*	6	<.001	0.28tt
		Q2	14 / 1.6	15 / 2.0#	52 / -2.7#				
		Q3	3 / -3.4#	9 / -1.4	95 / 3.7#				
		Q4	3 / -3.5#	7 / -2.2#	100 / 4.3#				
		Total	48	48	301				
GR12	Birth Quarter	Q1	30 / 6.4#	22 / 3.6#	65 / -7.5#	83.06*	6	<.001	0.30tt
		Q2	12 / 0.3	18 / 2.5#	79 / -2.1#				
		Q3	3 / -3.1#	5 / -2.4#	108 / 4.1#				
		Q4	3 / -3.5#	3 / -3.5#	125 / 5.3#				
		Total	48	48	377				
GR13	Birth Quarter	Q1	37 / 8.1#	24 / 3.7#	66 / -8.9#	113.59*	6	<.001	0.34tt
		Q2	9 / -1.0	21 / 3.2#	85 / -1.7				
		Q3	2 / -4.0#	4 / -3.3#	131 / 5.5#				
		Q4	4 / -3.1#	3 / -3.4#	121 / 4.9#				
		Total	52	52	403				
GR14	Birth Quarter	Q1	28 / 5.3#	27 / 5.0#	63 / -7.7#	68.76*	6	<.001	0.29tt
		Q2	11 / -1.4	10 / -1.8	119 / 2.4#				
		Q3	3 / -3.4#	2 / -3.8#	111 / 5.4#				
		Q4	2 / -0.7	5 / 1.1	22 / -0.3				
		Total	44	44	315				

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GR-SEN	Birth Quarter	Q1	19 / -0.5	18 / -0.9	129 / 1.1	2.06	6	0.914	0.06
		Q2	13 / 0.2	14 / 0.6	73 / -0.6				
		Q3	6 / 0.9	5 / 0.4	24 / -1.0				
		Q4	2 / -0.5	3 / 0.2	17 / 0.2				
		Total	40	40	243				

χ^2: chi-square analysis, df: degrees of freedom, V: magnitude of the effect size the Cramer's V, SR: standardized residual, GR10-14: greco-roman style 10-14 age group, GR-SEN: greco-roman style seniors, Q1-4: birth quarter 1-4, *: $p<0.05$, ^{t}: small effect, ^{tt}: intermediate effect, ^{ttt}: large effect, #: 1.96<SR or -1.96>SR.

The results of the chi-square independence tests, which examined the relationship between birth quarter and tournament outcomes across different age groups of female wrestlers, are presented in Table 3. When a significant relationship was observed, SR values were reported to indicate which levels of the variables contributed to the significance.

In Fem10, a significant relationship between birth quarter and tournament outcomes was observed ($\chi^2=26.85$, df=6, $p<.001$, V=0.38). Among medalists, those born in Q1 (SR=3.8) were overrepresented, whereas those born in Q4 (SR=-2.2) were underrepresented. In the other category, wrestlers born in Q1 (SR=-4.1) were underrepresented, whereas those born in Q4 (SR=3.4) were overrepresented.

In Fem11, a significant relationship between birth quarter and tournament outcomes was also observed ($\chi^2=35.12$, df=6, $p<.001$, V=0.30). Among medalists, wrestlers born in Q1 (SR=2.2) and Q2 (SR=3.5) were overrepresented, whereas those born in Q3 (SR=-3.0) and Q4 (SR=-2.6) were underrepresented. In the other category, those born in Q2 (SR=-4.5) were underrepresented, while wrestlers born in Q3 (SR=2.4) and Q4 (SR=3.1) were overrepresented.

In Fem12, a significant relationship between birth quarter and tournament outcomes was observed ($\chi^2=67.39$, df=6, $p<.001$, V=0.40). Among medalists, wrestlers born in Q1 (SR=4.4) and Q2 (SR=2.7) were overrepresented, whereas those born in Q3 (SR=-2.9) and Q4 (SR=-4.0) were underrepresented. In the quarterfinalists, wrestlers born in Q2 (SR=3.9) were overrepresented, while those born in Q4 (SR=-2.8) were underrepresented. In the other category, wrestlers born in Q1 (SR=-2.7) and Q2 (SR=-

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5.5) were underrepresented, whereas those born in Q3 (SR=2.2) and Q4 (SR=5.6) were overrepresented.

In Fem13, a significant relationship between birth quarter and tournament outcomes was observed (χ^2=36.08, df=6, p<.001, V=0.35). Among medalists, wrestlers born in Q1 (SR=4.5) were overrepresented, whereas those born in Q3 (SR=-2.9) and Q4 (SR=-2.3) were underrepresented. In the other category, wrestlers born in Q1 (SR=-3.4) and Q2 (SR=-2.3) were underrepresented, while those born in Q3 (SR=2.2) and Q4 (SR=3.4) were overrepresented.

In Fem14, a significant relationship between birth quarter and tournament outcomes was observed (χ^2=57.33, df=6, p<.001, V=0.46). Among medalists, wrestlers born in Q1 (SR=4.5) were overrepresented, whereas those born in Q3 (SR=-2.7) and Q4 (SR=-2.8) were underrepresented. In the quarterfinalists, wrestlers born in Q1 (SR=2.7) were overrepresented, while those born in Q4 (SR=-3.3) were underrepresented. In the other category, wrestlers born in Q1 (SR=-6.1) were underrepresented, whereas those born in Q3 (SR=2.6) and Q4 (SR=5.2) were overrepresented.

No significant relationship between birth quarter and tournament outcomes was observed in Fem-SEN (χ^2=4.26, df=6, p=0.642, V=0.11).

Table 3. Chi-square test of independence results showing the relationship between the birth quarter of female wrestlers and their tournament outcomes.

Category			Ranking			χ^2	df	p	V
			Medalist N/SR	Quarterfinalist N/SR	Other N/SR				
Fem10	Birth Quarter	Q1	12 / 3.8#	7 / 0.9	2 / -4.1#	26.85*	6	<.001	0.38ttt
		Q2	7 / 0.2	8 / 0.7	11 / -0.8				
		Q3	3 / -1.6	6 / 0.1	14 / 1.3				
		Q4	2 / -2.2#	3 / -1.7	19 / 3.4#				
		Total	24	24	46				
Fem11	Birth Quarter	Q1	18 / 2.2#	10 / -0.8	25 / -1.2	35.12*	6	<.001	0.30ttt
		Q2	18 / 3.5#	14 / 1.8	10 / -4.5#				
		Q3	4 / -3.0#	12 / 0.1	35 / 2.4#				

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		Q4	4 / -2.6#	8 / -1.0	34 / 3.1#				
		Total	44	44	104				
Fem12	Birth Quarter	Q1	22 / 4.4#	8 / -1.1	23 / -2.7#	67.39*	6	<.001	0.40tt
		Q2	17 / 2.7#	20 / 3.9#	13 / -5.5#				
		Q3	3 / -2.9#	11 / 0.2	37 / 2.2#				
		Q4	2 / -4.0#	5 / -2.8#	55 / 5.6#				
		Total	44	44	128				
Fem13	Birth Quarter	Q1	16 / 4.5#	6 / -0.4	10 / -3.4#	36.08*	6	<.001	0.35tt
		Q2	11 / 1.0	13 / 1.8	18 / -2.3#				
		Q3	2 / -2.9#	9 / 0.3	29 / 2.2#				
		Q4	3 / -2.3#	4 / -1.8	31 / 3.4#				
		Total	32	32	88				
Fem14	Birth Quarter	Q1	18 / 4.5#	14 / 2.7#	3 / -6.1#	57.33*	6	<.001	0.46tt
		Q2	10 / 0.9	10 / 0.9	14 / -1.6				
		Q3	2 / -2.7#	7 / -0.4	24 / 2.6#				
		Q4	2 / -2.8#	1 / -3.3#	31 / 5.2#				
		Total	32	32	72				
Fem-SEN	Birth Quarter	Q1	9 / -0.9	11 / -0.1	26 / 0.9	4.26	6	0.642	0.11t
		Q2	13 / 1.3	12 / 0.9	15 / -2.0#				
		Q3	9 / -0.1	9 / -0.1	20 / 0.2				
		Q4	9 / -0.2	8 / -0.7	22 / 0.8				
		Total	40	40	83				

χ^2: chi-square analysis, df: degrees of freedom, V: magnitude of the effect size the Cramer's V, SR: standardized residual, Fem10-14: female 10-14 age group, Fem-SEN: female seniors, Q1-4: birth quarter 1-4, *: $p<0.05$, t: small effect, tt: intermediate effect, ttt: large effect, #: 1.96<SR or -1.96>SR.

4. Discussion

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The aims of the present study were to investigate the presence (prevalence) of RAE across different age groups in the men's freestyle, men's Greco-Roman, and women's categories at the Turkish Wrestling Championships. Additionally, the study aimed to examine the relationship between relative age (RA) and tournament success. Initially, it was hypothesized that RAE would be prevalent in the senior categories, whereas it would be absent in the younger age groups (10, 11, 12, 13, and 14 years). The analyses largely supported this hypothesis. In men's freestyle and Greco-Roman, the 10, 11, 12, and 13-year-old groups exhibited a homogeneous distribution of all participants across birth quarters, indicating the absence of RAE. In contrast, in the 14-year-old and senior groups, the majority of participants were concentrated in the first two quarters of the year. It should also be acknowledged that the senior category covers a wide age range (18–35 years), and thus any observed birth-quarter distribution in this group is more likely to reflect long-term selection, retention, dropout, and cohort effects rather than immediate maturational differences. This wide age range represents an important limitation, as it combines athletes with substantially different developmental, experiential, and career-stage characteristics. Taken together, these findings may suggest that the clustering within quartiles (RAE) emerges in the later age groups. Previous studies have reported that, in younger age groups, athletes born in the later months of the year may experience lower performance due to relative age disadvantage, which can lead to early termination of their sports careers (Bilgiç & Işın, 2023; Hollings et al., 2014; Delorme et al., 2009). Additionally, athletes who perform better tend to be more resistant to dropping out, whereas those who are less successful may leave the sport at a young age (Hancock, Adler, & Côté, 2013). One possible explanation is that athletes born earlier in the year may be more likely to remain in the sport over time, whereas relatively younger athletes may be more vulnerable to attrition. However, because the present study did not track athletes longitudinally, this interpretation should be considered speculative. This may suggest that early relative age advantages are not merely transient but may accumulate over time, thereby suggesting their potential role in shaping long-term talent selection and retention in wrestling.

A previous study reported the presence of RAE among male wrestlers who participated in the U21 World Championships between 2006 and 2014 (Fukuda et al., 2017). Another study found RAE in the overall distribution of Olympic male Greco-

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Roman wrestlers (Mülazımoğlu & Boyacı, 2023). The present study is consistent with these earlier investigations conducted on adult wrestlers; however, no studies were found that specifically examined the prevalence of RAE in younger age-group wrestlers. Recent studies have documented the presence of RAE in combat sports. One study reported a pronounced RAE in young amateur boxing groups (Kim et al., 2024). In a study involving football players of different age groups, those born in the first quarter of the year were overrepresented in U21, U19, and U17 male teams (Morgans et al., 2024). Another study indicated a widespread RAE in karate kumite and fencing disciplines (de Almeida-Neto et al., 2023). Conversely, one study reported that RAE was not consistently observed among Olympic combat sports athletes (Campideli et al., 2018). A study conducted on athletes worldwide found that RAE was present across all age groups (U18, U20, Seniors) and both sexes in high jump and long jump events (Xia & Zhang, 2025). Taken together, these mixed findings highlight that selection policies and competition structures may play a critical role in whether relative age advantages translate into performance outcomes.

Additionally, in this study, it was observed that the prevalence of the RAE, particularly reflected through interquartile differences, increased markedly at the age of 14 in both men's freestyle and men's Greco-Roman wrestling styles. In Turkey, the high school entrance exam, which represents a significant milestone in academic life, is administered at this age. Consequently, the period from 13 to 14 years is characterized by increased academic pressure, during which some adolescents may reduce or temporarily discontinue sport participation to focus on exam preparation (Aydın et al., 2024). In addition to these environmental and educational factors, biological maturation may also contribute to the observed patterns. Relative age differences are often confounded by variations in biological maturity, with early-maturing athletes typically exhibiting temporary advantages in strength, size, and coordination compared to their later-maturing peers within the same chronological age group (Malina et al., 2015). Athletes born in the last quarter of the year, who consequently may be less likely to achieve competitive success—particularly before the age of 14—may also be more likely to withdraw from sport and redirect their efforts toward academic pursuits. Although the present study does not provide direct data on this issue; it can be inferred that the majority of athletes who continue participating in sports are those born in the first quarter of the year, and that the

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general population in the 14-year-old and senior groups is also predominantly composed of these athletes. This interaction between educational pressures and sport participation suggests that observed RAE at age 14 may partly reflect structural dropout rather than only biological or performance-based selection. On the other hand, the factor driving relatively younger athletes out of the system may not be limited to voluntary sport dropout; the systematic selection process itself, which becomes increasingly competitive over time, may also contribute to their exclusion.

In male freestyle and Greco-Roman wrestlers, the RAE was observed in the 14 years and senior categories, whereas in female wrestlers, birth quartile distributions were found to be similar across all age groups. This pattern is consistent with Cobley (2009) and supports the view, in line with the theory proposed by Kelly (2015), that RAE is more pronounced in more popular sports. This finding is practically important, as it suggests that talent identification and competition structures in women's wrestling may currently be less influenced by birthdate-related bias, potentially allowing for a more equitable selection environment. The higher prevalence of RAE in males compared to females may be attributable to several additional factors, including earlier maturation in females and a more variable maturation pattern in males (Vincent & Glamser, 2006). Previous research reported RAE in male freestyle and Greco-Roman wrestlers at the Olympic level, whereas it was not observed in female wrestlers (Albuquerque et al., 2014). Conversely, Delorme (2014) found no evidence of RAE among young French male and female boxers. Similarly, RAE was not observed in male or female Olympic taekwondo athletes (Albuquerque et al., 2012). Moreover, meta-analyses conducted by Musch and Grondin (2001), Cobley et al. (2009), and Albuquerque et al. (2016) indicated that RAE is significantly higher in male categories compared to female categories. In contrast, Fukuda (2015) reported the presence of RAE in both elite young male and female judo athletes. These conflicting findings in combat sports may stem from differences in skill sets and physiological demands between "close-contact/grappling" sports such as wrestling and judo, and "striking/contact" sports such as taekwondo and boxing (Fukuda, 2015).

In the present study, the relationship between birth quarter (RA) and tournament outcomes was also examined. It was initially hypothesized that RA would be associated with tournament results in the 10–14 age categories, whereas this relationship would diminish in the senior category. The analyses largely supported

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this hypothesis. A significant relationship between birth quarter and tournament success was observed in all categories (men's freestyle, men's Greco-Roman, and women) among the 10, 11, 12, 13, and 14-year-old groups. In all of these age groups, the majority of medalists and quarterfinalists were born in the first two quarters of the year, whereas the majority of participants in the other category were born in the last two quarters of the year. Notably, although overall birth-quarter distributions were relatively balanced in several younger categories, athletes born earlier in the year were still disproportionately represented among successful competitors. This suggests that the absence of a population-level RAE does not necessarily imply the absence of relative-age-related performance advantages. Such findings may reflect how being born earlier in the selection year can provide immediate competitive advantages in younger age groups (Irid et al., 2025). In contrast, no significant relationship between birth quarter and tournament outcomes was observed among senior men (freestyle and Greco-Roman) and senior women. These results suggest that birth quarter influences tournament success in younger age groups but that this effect diminishes in the senior category. In the early stages of development, athletes who are chronologically older tend to be biologically more mature, providing physical and cognitive advantages (Bezuglov et al., 2022). Furthermore, as chronological age increases, the proportion of late-maturing children declines significantly (Figueiredo et al., 2009), which is thought to explain the reduced impact of birth month differences on performance at the senior level. However, the absence of a statistically significant relationship between relative age and tournament success in the senior category may be partly attributed to the heterogeneous nature of this group (aged 18–35). Differences in age, experience, and career stage may attenuate or obscure relative age-related patterns. Previous research reported that in freestyle and Greco-Roman wrestling tournaments, the majority of medalists and top-8 wrestlers were born in the first half of the year (although not statistically significant), and that the influence of birth month on performance was more pronounced in younger age groups and diminished with age (Lathsyev et al., 2022). Another study examining 11-year-old wrestlers found that athletes born in the early months of the year performed better in both freestyle and Greco-Roman categories (Yıldırım & Deniz, 2023). Additionally, Fukuda et al. (2017) reported the presence of RAE among medal-winning wrestlers. These findings indicate that the results of the present study are consistent with previous research in the literature. Moreover, the overall RAE results among

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male freestyle and Greco-Roman wrestlers were similar, aligning with prior literature (Fukuda et al., 2017; Yıldırım & Deniz, 2023).

Studies examining the relationship between RA and tournament success among wrestlers are limited in the literature. However, research investigating the association between RA and performance in combat sports is available. A previous study reported the presence of RAE among medal-winning male judokas at the Olympic level (Albuquerque et al., 2015). In another study, male boxers who won medals in all major tournaments (World Championships and Olympic Games) across three Olympic cycles between 2000 and 2012 were examined, and it was found that the majority of medalists were born in the first half of the year (Edginton et al., 2014). In a study with taekwondo athletes (n = 259), analyses revealed no significant difference between expected and observed frequencies based on birth month across all athletes; however, a significant difference between observed and expected frequencies according to birth year was reported for medal winners (Babić et al., 2021). Another study with young triathletes reported that the majority of medalists were born in the first quarter of the year (Ferriz-Valero et al., 2020). These studies collectively indicate a relationship between RA and tournament success. However, such investigations were generally conducted at the adult athlete level. In the present study, birth quarter influenced tournament success in younger age groups, whereas no relationship between RA and tournament outcomes was observed among senior wrestlers. Based on the underlying rationale of this study, it would be more appropriate to include all participants within a single age group to determine the relationship between birth month and tournament success. In practice, however, competitions in many sports are typically organized with athletes from multiple age groups, such as 11–13, 13–15, and 15–17 years. In Turkey, for the first time in 2025, wrestling competitions were held separately across five distinct age groups (10, 11, 12, 13, and 14 years) (Turkish Wrestling Federation, 2025). The approach applied in the present study similarly allows the minimization of confounding effects caused by age heterogeneity in RAE research. Although the present findings do not directly evaluate intervention strategies, the observed association between birth quarter and competitive success in youth categories suggests that approaches such as bio-banding or alternative age-grouping models may warrant further investigation as potential methods for addressing potential selection bias.

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5. Limitations and Future Directions

Although the findings of this study provide important insights into the manifestation of RA in wrestling, several limitations should be considered. First, the study included only athletes participating in the Turkish Wrestling Championships. This may limit the generalizability of the results to wrestling systems in other countries or to international tournaments.

Second, the study considered only the chronological age and birth quarter of the athletes; variables such as biological maturation, anthropometric characteristics, and physical performance indicators were not included in the analysis. The absence of biological maturation indicators such as Peak Height Velocity or skeletal age may preclude drawing definitive conclusions regarding the specific roles of biological maturation and chronological age. Future studies incorporating skeletal age, pubertal development markers, or physical fitness assessments could provide a more detailed understanding of the relationship between RA and performance.

Another limitation is that, although the absence of RA in female wrestlers is an important finding, the underlying reasons for this result could not be examined in detail within the scope of the present study. Future research investigating structural factors such as competitive intensity, the size of the athlete pool, and selection pressure for female athletes would contribute to a better understanding of sex-related differences.

In addition, in the present study, annual birth rate data for the country could not be obtained. Therefore, the expected values for birth quarters were assumed to be equal (25%). It is recommended that future studies determine the expected values based on the country’s birth rate distribution.

Another limitation of the present study is that weight categories were not considered in the analyses. Future studies are recommended to examine the RAE with respect to weight categories as well.

It is also recommended that future studies adopt a comparative approach across wrestling systems in different countries, examine the potential role of alternative age-grouping models (e.g., classification based on biological age) in mitigating RA, and be supported by qualitative data regarding coaches’ selection criteria. Such

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approaches would help frame RA not merely as a statistical phenomenon but also as an issue of sports policy and talent development.

Another limitation of the present study is the potential inflation of Type I error due to multiple chi-square tests conducted across several categorical variables. Since the analyses were exploratory in nature, no correction for multiple comparisons was applied. Therefore, findings, particularly those based on standardized residuals, should be interpreted with caution.

6. Conclusion

This study revealed that RAE among male freestyle, male Greco-Roman, and female wrestlers participating in the Turkish Wrestling Championships varied according to age group and sex. The findings indicated that RAE (birth quartile distribution differences) was not observed in the 10, 11, 12, and 13-year-old groups, but became pronounced among 14-year-old and senior male wrestlers. This suggests that RAE becomes apparent in later stages of athlete selection, retention, and dropout processes rather than in early ages. In female wrestlers, the balanced distribution across birth quartiles in all age groups indicated that there were no differences between birth quartiles. The observed difference between male and female wrestlers may be explained by sex-dependent variability in competitive intensity and biological maturation processes.

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Furthermore, across all styles and genders, a significant relationship between birth quartile and tournament performance was observed in younger age groups (ages 10, 11, 12, 13, and 14), whereas this relationship was found to disappear in the senior categories. These findings suggest that RA provides a temporary performance advantage in early developmental stages, but its effect diminishes at the elite level. In conclusion, the results of this study emphasize the importance of RA-sensitive approaches in talent selection and athlete development processes in wrestling and demonstrate that organizing competitions separately by age group provides a methodological advantage for RAE research.

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