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Relative age effect reversal on the junior-to-senior transition in world-class athletics

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Abstract

It is unclear how the birthdate impacts the junior-to-senior transition in international track and field. This study aimed to quantify the magnitude of the Relative Age Effect (RAE) at the youth and senior levels and test the underdog hypothesis on the junior-to-senior transition rate. The birthdate and performances of 5,794 sprinters (female:50.9%) and 6,079 jumpers (female:45.1%). Elite athletes (operationally defined as the World's all-time top 200, 100, and 50 athletes) were identified according to Under 18 and Senior categories (i.e.,>20 years old). RAE was investigated, and the successful junior-to-senior transition was calculated according to the birth quartile. Skewed quartile distributions in the Under 18 (effect size ranged=0.15-0.10) were observed but not for the Senior category. RAE magnitude increased according to performance level (i.e., from Top 200 to Top 50) and was higher in males than females. Different trends in the transition rate were observed according to the birth quartile. Relatively younger athletes showed significantly higher transition rates than relatively older athletes. Relatively younger top-level athletes had a higher chance of maintaining top-level in the senior category. Data corroborates the underdog hypothesis that relatively younger athletes are disadvantaged in the junior category but advantaged in the transition from junior-to-senior categories.

Keywords: RAE, underdog hypothesis, track and field, talent development; athlete development.

Introduction

During youth, athletes are grouped based on (bi)annual age-group cohorts to reduce inter-individual developmental differences (Cobley, Baker, Wattie, & McKenna, 2009; Smith, Weir, Till, Romann, & Cobley, 2018). This policy invariably produces chronological age differences of up to 12-24 months between individuals within the same age cohort and brings about the phenomenon known as relative age effects (RAEs). Both in teams and individual sports (Cobley et al., 2009; Smith et al., 2018), RAEs are characterized by a birthdate asymmetry, where athletes born later in an age-grouped cohort are significantly under-represented (Till & Baker, 2020) and have a lesser probability of being selected in high-level programs, talent development academies, and representative teams (Cobley et al., 2009; Smith et al., 2018). RAE magnitudes are larger during childhood, adolescence, and the beginning of senior sports career. During this period, more significant differences in anthropometric (e.g., body height and weight) and physiological characteristics (e.g., muscular strength and power) exist between older and younger athletes (i.e., maturation-selection hypothesis) (Cobley et al., 2009). As a result, athletes born early in an age-grouped cohort hold a physical advantage due to normative growth (Cobley et al., 2009) and outperform relatively older athletes (Brustio et al., 2022). In this regard, we quantified the performance differences between athletes born at the beginning and the end of the selection date (Brustio et al., 2022). In the 12-year category, early born long jumpers may have an advantage of up to 47% compared to late-born jumpers. This difference decreased to 5% in the 17-year category. Additionally, at the social level, the favourable judgment of social agents (i.e., coaches, parents, and athletes) for relatively older athletes may affect the early stages of experiences and sport participation, consequently exacerbating the phenomenon (Hancock, Adler, & Côté, 2013).

In the track and field context, different national (Brazo-Sayavera, Martinez-Valencia, Muller, Andronikos, & Martindale, 2017; Brustio et al., 2022; Gundersen et al., 2022; Kearney, Hayes, & Nevill, 2018; Kirkeberg, Roaas, Gundersen, & Dalen, 2022) and international investigations (Boccia, Cardinale, & Brustio, 2021a; Brustio & Boccia, 2021; Hollings, Hume, & Hopkins, 2014) identified an over-representation of the relatively older athletes, modulated by age (Brustio et al., 2019; Hollings et al., 2014; Kearney et al., 2018), gender (Brustio et al., 2019; Hollings et al., 2014) and level of competition (Brustio & Boccia, 2021; Brustio et al., 2022). RAE effect sizes were more prominent in pre-18 age groups than in post-18 age groups or adult competition (Kearney et al., 2018). At the international level, the RAE magnitude was large in the Under 18 and Under 20 categories, so early-born athletes are three times more likely to be included in the top 100 world rankings (Brustio et al., 2019). Conversely, at the senior level, the RAE disappeared or subsided (Brustio et al., 2019).

Although RAE affects the selection of potential future athletes, some studies identified a possible advantage reversal in favour of relatively younger athletes, especially at the senior level (Gibbs, Jarvis, & Dufur, 2012; McCarthy, Collins, & Court, 2016; Smith & Weir, 2020). This scenario, known as the underdog hypothesis, suggests that while relatively older athletes are more likely to be selected by academy systems, the relatively younger ones may have a greater opportunity to successfully transition from junior-to-senior competition and reach senior elite status (McCarthy et al., 2016). For example, Kelly et al. (2020) found that the probability of achieving a professional contract for soccer and rugby players was about four times higher for athletes born in the last quartile compared to athletes born in the first quartile of the year. The underdog hypothesis has been proposed in various nations and sports, including professional rugby (Jones, Lawrence, & Hardy, 2018; Kelly, Till, et al., 2021; McCarthy et al., 2016), soccer (Fumarco, Gibbs, Jarvis, & Rossi, 2017; Kelly et al., 2020; Morganti et al., 2022), ice hockey (Fumarco et al., 2017; Gibbs et al., 2012), basketball (Kelly, Jiménez Sáiz, et al., 2021), and cricket (Jones et al., 2018; McCarthy et al., 2016). The underlying mechanisms for the underdog were not completely understood. Nevertheless, being a relatively younger athlete may confer a significant potential for success at the adult level, including the enhancement of skill proficiency (e.g., superior technical and tactical skill) and superior psychological and social skills necessary to overcome the odds of the RAE (Gibbs et al., 2012; Kelly et al., 2020; McCarthy et al., 2016; Smith & Weir, 2020). Despite sparse evidence about the underdog hypothesis in team sports, little is known about individual sports. In this regard, the study of Bjerke et al. (2017) found that late-born alpine skiers were, on average, able to accumulate more World Cup points than early-born skiers. Related to track and field, we previously demonstrated a large turnover in international athletes transitioning from the junior-to-senior top-ranking levels (Boccia et al., 2021a; Boccia, Cardinale, & Brustio, 2021b). Accordingly, we underlined a birth asymmetry favouring relatively older athletes in the top rank of the junior category (i.e., Q1 ~ 40 % vs Q4 ~ 10 % in jumpers and throwers), while no RAEs were observed in the top rank of the senior one (i.e., Q1~ 20% vs Q4 ~ 20% and Q1~ 30% vs Q4 ~ 20 % in jumpers and throwers) (Boccia et al., 2021a). Nevertheless, there is limited knowledge in track and field about the relationship between birthdates and the likelihood of successful transit from the junior-to-senior levels in elite athletes. For this reason, this study aimed to comprehensively quantify the prevalence and magnitude of RAE in top-level sprinters and jumpers (*Part I*) and explore if the successful and unsuccessful transition from junior-to-senior level was affected by the underdog hypothesis (*Part II*).

Methods

This study further analyzed previous studies' data (Boccia et al., 2021a, 2021b) gathered from publicly available online sources supplied by the World Athletics (https://worldathletics.org). The datasets contained the birthdates and annual best performance of world-class sprinters (i.e., 100m, 200m, and 400m), jumpers (long, triple, and high jump and pole vaults) ranked in the top 100 official lists of the World Athletics at least one year from 2000 to 2018 and/or who participated in the U18, and U20 World Championships (from 1998 to 2015). Athletes younger than 20 years old in 2018 (i.e., not yet concluded transition from youth to senior career) and athletes disqualified for doping offences (n = 155; 43.9% female) were excluded from the analysis. Due to the data being collected from open-access sites, no informed consent was obtained. This study was conducted according to the declaration of Helsinki. A total of 5,794 sprinters (female: 50.9%) and 6,079 jumpers (female: 45.1%) entered the final database.

Statistical Analysis

Part I: According to World Athletics cut-off date criteria for age-grouping,(Brustio et al., 2019) players' birth dates were categorized into four quarters (i.e., Q1, Q2, Q3, and Q4) following World Athletics cut-off dates: January–March = Quartile 1 (Q1); April-June = Quartile 2 (Q2); July-September = Quartile 3 (Q3); October-December = Quartile 4 (Q4). Chi-Square Goodness of Fit tests (χ^2) and Cramer's V effect size were calculated to investigate differences between observed and expected uniform quartile distributions (i.e., 25% for each quartile). Threshold values for Cramer's V: $V \leq 0.06$: trivial effect; $0.06 < V \leq 0.17$: small effect; $0.17 < V < 0.29$ medium effect; $V \geq 0.29$ large effect). Odds ratios (ORs) and 95% confidence intervals [95% CIs] were calculated to investigate discrepancies between Q1 vs Q4 and for S1 vs S2 (i.e., half-year distribution comparisons). To assess whether effect sizes changed, RAEs were computed according to Under 18 and Senior categories (i.e., >20 years old) and attainment of different performance levels (i.e., all-time Top 200, Top 100, and Top 50 performers, respectively).

Part II: successful junior-to-senior transition rates among the different birth quartiles was defined calculating how many junior athletes ranked in the Top 200, Top 100, and Top 50 of the Under 18 remained at the exact top level in the Senior category (>20 years old). The transition rates were calculated for each quartile using a binomial proportion confidence interval (90% CI).

To give a broad view of the RAE (i.e., *Part I*) and successful junior-to-senior transition rates (i.e., *Part II*) in World class track and field athletes, we merged data from different disciplines. Separate analyses were performed to investigate the phenomenon and assess gender differences. All data were analyzed with custom-written software in MATLAB R2020b (MathWorks, Natick, Massachusetts), and the graphs were prepared with GraphPad Prism 8 (San Diego, CA, USA).

Results

Part I: Table 1 summarizes the relative age distribution, including Chi-square statistics and ORs (i.e., Q1 vs. Q4 and Q1 & Q2 vs. Q3 & Q4) considering the Under 18 and the Senior age-group category.

At Under 18 category there was a significant RAE with small effect sizes (Crammer's V ranged = from 0.10 to 0.15). The comparison between effect sizes showed a higher effect in males than females. Quartile comparison ORs underlined a disproportionate number of athletes born in the first-half of the year compared to the second half. RAE magnitude increased when the performance level increased (i.e., from Top 200 to Top 50). For example, while the likelihood of finding an athlete born in the Q1 was 1.92 or 1.53 (in males or females respectively) higher than in Q4 for the Top 200 category, the same probability increased in the Top 50 category (i.e., 2.07 and 2.02 in males and females respectively).

When analyzing senior-level birth distributions, we identified a removal or reduction of RAEs. For males, RAEs predominantly dissipated in the Top 100 and 50 performers. The only exception was when considering the Top 200 performers where RAE is presented but with a trivial effect size (Crammer's V=0.05). According to the above findings, no differences in the number of athletes born in the first-half compared to the second half of the year were observed (see ORs in Table 1). For females, evenly distributed quartile distributions were observed in all performance levels (all $p > 0.05$). No significant ORs were apparent for quartile comparisons (OR range = 0.57–1.02), suggesting consistent RAE removal.

Part II: Figure 1 shows the junior-to-senior transition rates according to birth quartile separately for the Top 200 (a), Top 100 (b), and Top 50 (c) performers, respectively. In general, the transition rate was relatively low (on average ~30% and 32% in males and females); however, it was higher for females. In addition, the transition rate decreased according to the increase in performance level: the greater the performance level, the lower the transition rate (see Figure 1). For example, the transition rate was ~24% and ~29% for males and females when focusing on the Top 50 category.

We found different trends in the transition rate when considering the birth quartile. Relatively younger athletes (Q4) showed significantly higher conversion rates than relatively older athletes (Q1, Q2, and Q3). Indeed, Q4 had the highest proportion of young athletes able to maintain the top level and successfully transitioned out of the Under 18 to compete at the top level in the Senior category. This trend was evident both in male (transition rate Q1 = 17% [11.3, 23.3] vs transition rate Q4 = 29% [19.6, 40.7]) and female athletes (transition rate Q1 = 19% [13.6, 25.6] vs transition rate Q4 = 34% [24.1, 44.7]).

Discussion

This study aimed to investigate the prevalence and magnitude of RAE in top-level sprinters and jumpers (*Part I*) and explore if the underdog hypothesis affected the successful transition from junior-to-senior level (*Part II*). For this purpose, we identified top-level athletes (operationally defined as the World all-time top 200, 100, and 50 athletes) in Under 18 and Senior categories (i.e., >20 years old). We investigated transition rate from junior-to-senior top-level ranking according to the birth quartile. In *part I* we found skewed birthdate distributions evident the Under 18 (effect size ranged=0.15-0.10) but not in the Senior category. As previously suggested, RAE was modulated by gender and competition level. In *Part II* we found significantly higher transition rates of U18 athletes born in Q1 vs Q4 corroborating the RAE reversal of the underdog hypothesis.

Skewed quartile distributions within Under 18 categories were observed with small effect sizes in both sexes (see Table 1). Independently of the level of competition, the proportion of relatively older athletes (i.e., Q1) in this study was, on average 1.9 (male) and 1.7 times (female) higher than relatively younger athletes (i.e., Q4). On the contrary, symmetric birth distributions were observed in the Senior category (except for the top 200 male performers). Together these findings confirm previous studies that extensively highlighted as RAE affect talent identification and selection during youth career (Brazo-Sayavera et al., 2017; Brustio & Boccia, 2021; Brustio et al., 2022; Brustio et al., 2019; Hollings et al., 2014; Kearney et al., 2018; Kirkeberg et al., 2022; Romann & Cobley, 2015). According to previous studies in track and field, relatively older athletes outperformed relatively younger ones.(Brustio & Boccia, 2021; Brustio et al., 2022; Gundersen et al., 2022) It is possible to suggest that the difference in physical maturation at youth age (i.e., maturation hypothesis)

(Cobley et al., 2009) may explain a higher prevalence of relatively older players at the top level observed in this study. Again, this effect may be amplified by the different agents that may affect the youth career pathway (Hancock et al., 2013). As previously reported, RAE was generally more prominent in males compared to female athletes underlining that RAE has a smaller influence on female sports (Brazo-Sayavera et al., 2017; Kearney et al., 2018; Kirkeberg et al., 2022; Smith et al., 2018). Furthermore, RAE was more pronounced at increased performance levels (i.e., World all-time top 200, 150, and 50 athletes) RAE sizes increased (Brustio et al., 2022). Finally, as RAE disappeared in Senior category (Brustio & Boccia, 2021; Brustio et al., 2019) we hypothesized different transition rates based on birthdate quartile known as RAE reversal.

In *Part II*, found that the transition rate from youth to senior level was in general quite low and modulated by gender and level of performance. On average, 31% of athletes managed to maintain the top level in junior and senior career. This is in line with previous studies (Boccia et al., 2021a; Boccia, Cardinale, & Brustio, 2021c), confirming that outperforming during the youth career is not a guarantee of being at the top during a senior career. In the comparison between sex, data showed a lower transition rate in male athletes than their female counterparts (on average ~30% and 32% in males and females). Again, the greater the performance level, the lower the transition rate.

The key finding of the present study was that the transition rate from youth to senior level was affected by a reversal of RAE advantage, confirming the underdog hypothesis. Indeed, athletes born in Q4 had a greater chance of maintaining the top performance level than those born in Q1 (29% vs 17%). Thus, relatively younger athletes overcame the initial birth date disadvantages (Kelly, Jiménez Sáiz, et al., 2021) and had a greater chance of a successful transition from junior-to-senior career. Different speculations may explain this potential underdog benefits for later birth quartiles. As suggested previously (Smith & Weir, 2020), it is possible that later birth athletes may develop higher skill proficiency during youth they competed against relatively older athletes. Again, also injury may affect these results. Indeed, the higher rate of injury of relatively older athletes may exacerbate the dropout rate and consequently advantage relatively younger athletes to reach success (Kelly, Jiménez

Sáiz, et al., 2021; Kelly, Till, et al., 2021; Kelly et al., 2020). Additionally, from a psychological point of view, to compete at a higher level during youth, relatively younger athletes may have developed a higher level of degree of psychological resilience and toughness.(Jones et al., 2018) Overall, it is possible to suggest that the later success of relatively younger athletes may be developed through the rocky road (Jones et al., 2018) that these athletes should run across during their junior career.

Talent identification based on youth performance is unsuitable for selecting athletes with the best chance of becoming successful senior athletes. Here we show that this is even more true for relatively older athletes, i.e., those born in the first quartile of the year. Indeed, while those athletes are more frequently ranked in the top ranking of the junior category, they rarely transit to the senior category with the same level of performance. Therefore, sports organizations should not consider their youth performances as an indicator of future success.

In conclusion, the present study reveals that top-level young athletes born in the latter part of the year (i.e., in the last quartile) had a higher chance of maintaining the top level in the senior category. This corroborates the underdog hypothesis that relatively younger athletes are disadvantaged in the junior category but advantaged in the junior-to-senior transition.

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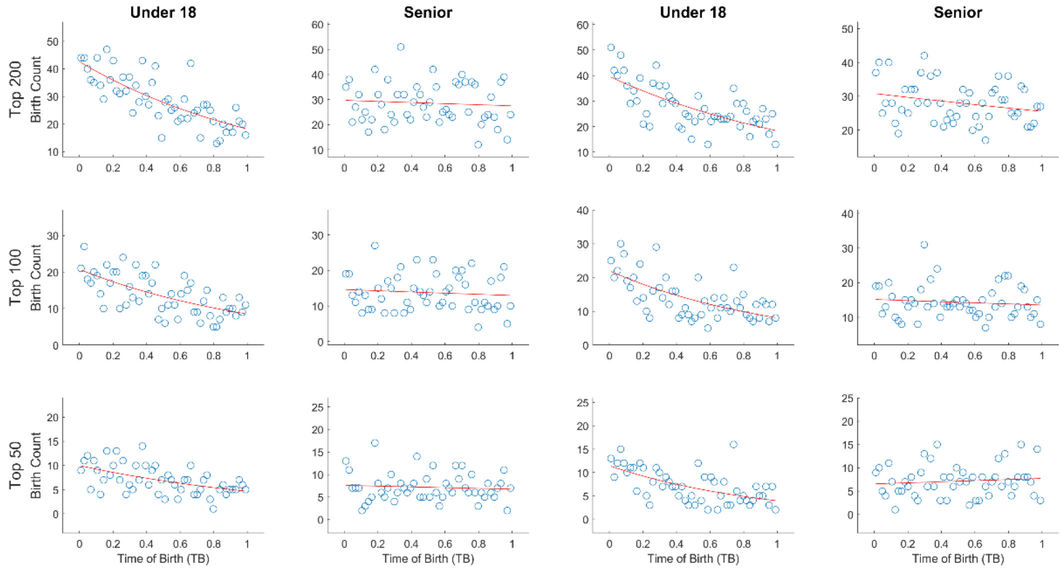
Figures caption

Figure 1. Scatter-plots of relative birth frequency by week considering male and female athletes in the Top 200, Top 100 and Top 50 in Under 18 and Senior age-groups. The red line represents the best fit of the Poisson regression modeling.

Figure 2. Junior-to-senior transition rates calculated in relation to quartile birth. Data are presented for Top 200 (Figure 1 a), Top 100 (Figure 1 b) and Top 50 athletes (Figure 1 c). Data are presented merging data from different disciplines.

Figure 1



Under 18
Senior
Under 18
Senior
Top 200
Birth Count
Top 100
Birth Count
Top 50
Birth Count
Time of Birth (TB)
Time of Birth (TB)
Time of Birth (TB)
Time of Birth (TB)

Figure 2

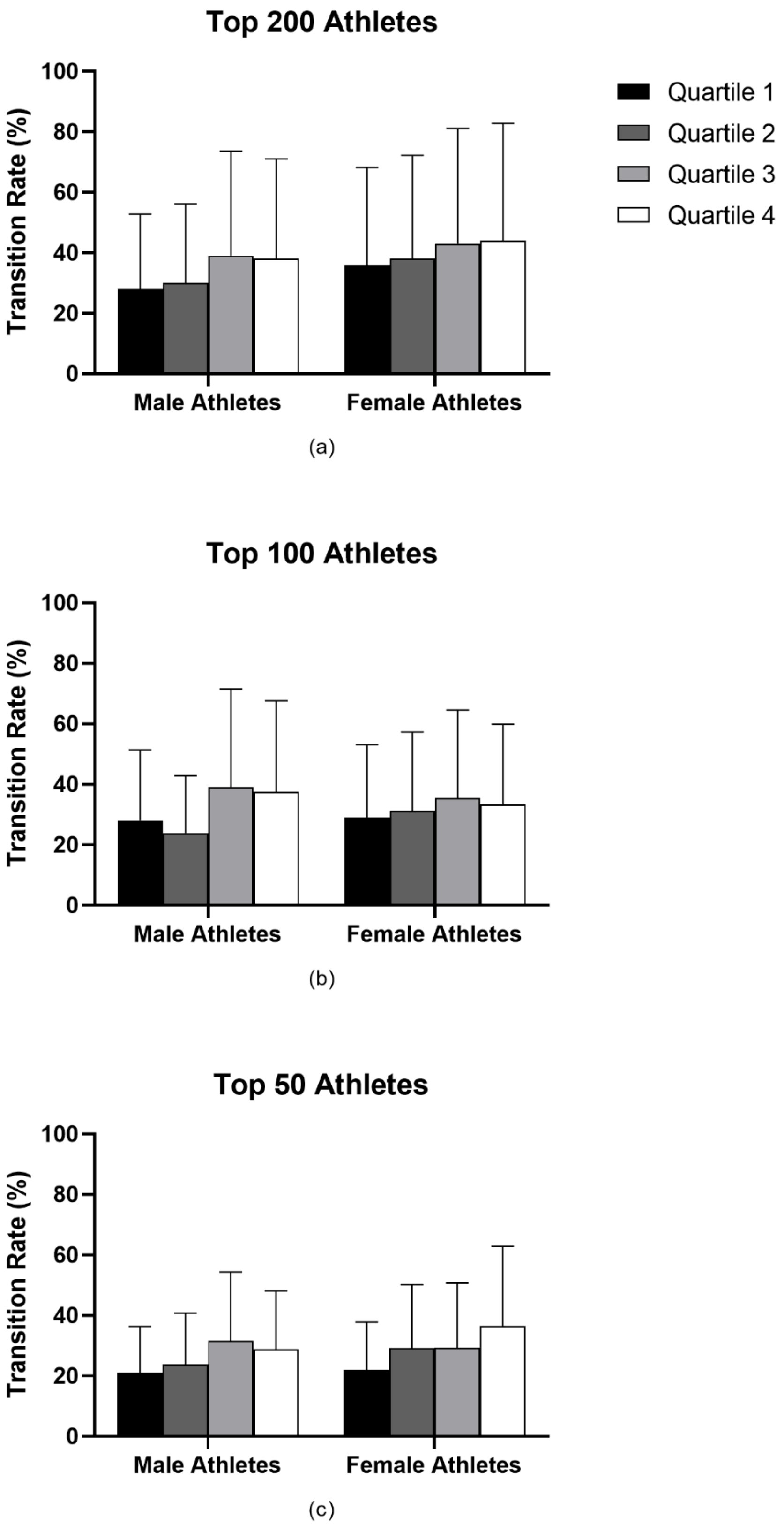

Top 200 Athletes
Transition Rate (%)
0
20
40
60
80
100
Male Athletes
Female Athletes
Quartile 1
Quartile 2
Quartile 3
Quartile 4
(a)
Top 100 Athletes
Transition Rate (%)
0
20
40
60
80
100
Male Athletes
Female Athletes
(b)
Top 50 Athletes
Transition Rate (%)
0
20
40
60
80
100
Male Athletes
Female Athletes
(c)

Table 1. The relative age distribution, chi-square, odds ratio analyses and Poisson regression coefficients of male and female athletes. Data were examined according to age group (i.e., Under 18 and Senior) and performance levels (i.e., Top 200, Top 100, and Top 50 performers).

Male Athletes

Performance level	Age-group	Total N	Q1 %	Q2 %	Q3 %	Q4 %	χ^2	P	*V*	*ES cat.*	OR Q1 VS Q4	OR Q1&2 VS Q3&4	β
Top 200	Under 18	1492	33.2	27.3	22.3	17.1	85.464	<0.001	0.14	Small	1.95 [1.58, 2.40]	1.54 [1.33, 1.78]	-0.86^{***}
	Senior	1487	24.3	26.2	27.0	22.5	7.347	0.062	0.04	Trivial	1.08 [0.88, 1.33]	1.02 [0.88, 1.18]	-0.08
Top 100	Under 18	714	33.3	28.7	21.1	16.8	47.05	<0.001	0.15	Small	1.98 [1.47, 2.68]	1.63 [1.32, 2.02]	-0.88^{***}
	Senior	716	24.9	25.7	27.9	21.5	6.101	0.107	0.05	Trivial	1.16 [0.86, 1.56]	1.02 [0.83, 1.26]	-0.13
Top 50	Under 18	358	34.1	28.2	21.2	16.5	25.578	<0.001	0.15	Small	2.07 [1.35, 3.17]	1.65 [1.23, 2.22]	-0.77^{***}
	Senior	373	25.5	25.7	26.5	22.3	1.602	0.659	0.04	Trivial	1.14 [0.76, 1.73]	1.05 [0.79, 1.40]	-0.12

Female Athletes

Performance level	Age-group	Total N	Q1 %	Q2 %	Q3 %	Q4 %	χ^2	*P*	*V*	*ES cat.*	OR Q1 VS Q4	OR Q1&2 VS Q3&4	β
Top 200	Under 18	1440	31.7	26.0	22.1	20.2	44.35	<0.001	0.10	Small	1.57 [1.27, 1.93]	1.36 [1.18, 1.58]	-0.72^{***}
	Senior	1462	26.3	25.8	24.0	23.9	2.721	0.437	0.02	Trivial	1.10 [0.90, 1.35]	1.09 [0.94, 1.26]	-0.19^{*}
Top 100	Under 18	725	34.5	25.1	21.8	18.6	40.923	<0.001	0.14	Small	1.85 [1.38, 2.48]	1.47 [1.20, 1.82]	-0.91^{***}
	Senior	746	24.0	28.2	22.4	25.5	5.358	0.147	0.05	Trivial	0.94 [0.71, 1.26]	1.09 [0.89, 1.33]	-0.11
Top 50	Under 18	367	35.4	24.3	23.2	17.2	25.467	<0.001	0.15	Small	2.06 [1.36, 3.13]	1.48 [1.11, 1.98]	-0.99^{***}
	Senior	371	22.1	27.2	22.9	27.8	3.753	0.289	0.06	Trivial	0.80 [0.53, 1.20]	0.97 [0.73, 1.30]	0.16

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Table 2. Logistical regression outcomes

	Top 200		Top 100		Top 50	
	B (SE)	OR [95% CI]	B (SE)	OR [95% CI]	B (SE)	OR [95% CI]
Q1 Vs Q2	0.09 (0.11)	1.09 [0.89, 1.35]	-0.06 (0.16)	0.94 [0.62, 1.12)	0.20 (0.24)	1.22 [0.77, 1.95]
Q1 Vs Q3	0.33 (0.11)**	1.40 [1.13, 1.73]	0.34 (0.16)*	1.41 [1.03, 1.93)	0.40 (0.24)$^{¥}$	1.50 [0.93, 2.39]
Q1 Vs Q4	0.40 (0.12)***	1.49 [1.18, 1.86]	0.31 (0.17)$^{¥}$	1.37 [0.96, 1.92)	0.56 (0.26)*	1.75 [1.05, 2.90]
Females Vs Males	-0.16 (0.08)*	0.85 [0.73, 1.00]	0.10 (0.12)	1.10 [0.87, 1.40)	-0.01 (0.18)	0.99 [0.70, 1.40]
Jumpers Vs Sprinters	-0.43 (0.09)***	0.65 [0.55, 0.78]	-0.37 (0.14)**	0.69 [0.52, 0.91)	-0.58 (0.22)**	0.56 [0.36, 0.87]
1980s Vs 1990s	-1.02 (0.08)***	0.36 [0.31, 0.42]	-0.94 (0.12)***	0.39 [0.31, 0.50)	-0.89 (0.18)***	0.41 [0.29, 0.58]
Europe Vs Africa	-0.86 (0.22)***	0.42 [0.27, 0.64]	-1.77 (0.41)***	0.17 [0.07, 0.36)	-1.87 (0.76)*	0.15 [0.02, 0.55]
Europe Vs America	0.22 (0.10)*	1.25 [1.03, 1.51]	0.25 (0.15)	1.29 [0.96, 1.73)	0.23 (0.24)	1.26 [0.80, 2.01]
Europe Vs Asia	-0.47 (0.13)***	0.62 [0.49, 0.80]	-0.72 (0.19)***	0.49 [0.33, 0.70)	-0.79 (0.28)**	0.46 [0.26, 0.78]
Europe Vs Oceania	-0.17 (0.23)	0.85 [0.53, 1.33]	-0.33 (0.35)	0.72 [0.35, 1.40)	-0.11 (0.47)	0.90 [0.33, 2.18]

Notes: Q1, first quartile; Q2, second quartile; Q3, third quartile; Q4, fourth quartile; B, estimated beta score: SE, Standardized Error; OR, odds ratio and 95% confidence intervals [95% CI]; ***, p<0.001; **, p<0.01; *, p<0.05; $^{¥}$, near p=0.05.

Supplementary Material 1

Males									
Discipline	**Sample Size N**	**N. performances M ± SD**	**Birth Decades N (%)**		**Continental Birth Place N (%)**				
			1980s	1990s	Africa	Asia	America	Europe	Ocenia
Sprinters	2,823	7.3 ± 3.2	1,293 (45.8)	1,530 (54.2)	312 (11.1)	1,380 (48.9)	328 (11.5)	691 (24.5)	112 (4.0)
Jumpers	3,170	7.3 ± 3.5	1,135 (35.8)	2,035 (64.2)	141 (4.4)	916 (28.9)	576 (18.2)	1,443 (45.5)	94 (3.0)
100 m	975	7.7 ± 3.4	490 (50.3)	485 (49.7)	110 (11.3)	468 (48.0)	123 (12.6)	233 (23.9)	41 (4.2)
200 m	817	7.4 ± 3.1	409 (50.1)	408 (49.9)	86 (10.5)	431 (52.8)	80 (9.8)	194 (23.7)	26 (3.2)
400 m	1,031	6.9 ± 3.0	394 (38.2)	637 (61.8)	116 (11.3)	481 (46.7)	125 (12.1)	264 (25.6)	45 (4.4)
Hight Jump	829	7.3 ± 3.6	308 (37.2)	521 (62.8)	28 (3.4)	232 (28.0)	151 (18.2)	380 (45.8)	38 (4.6)
Long Jump	892	7.1 ± 3.2	311 (34.9)	581 (65.1)	53 (5.9)	257 (28.8)	172 (19.3)	380 (42.6)	30 (3.4)
Triple Jump	766	7.2 ± 3.5	266 (34.7)	500 (65.3)	9 (1.3)	222 (32.5)	81 (11.9)	358 (52.4)	13 (1.9)
Pole Vualt	683	7.8 ± 3.5	250 (36.6)	433 (63.4)	51 (6.7)	205 (26.8)	172 (22.5)	325 (42.4)	13 (1.7)
Females									
Discipline	**Sample Size N**	**N. performances M ± SD**	**Birth Decades N (%)**		**Continental Birth Place N (%)**				
Sprinters	2,943	7.2 ± 3.1	1,043 (35.4)	1,900 (64.6)	220 (7.5)	1,466 (49.8)	222 (7.5)	929 (31.6)	106 (3.6)
Jumpers	2,693	7.6 ± 3.4	940 (34.8)	1,758 (65.2)	82 (3.0)	760 (28.3)	319 (11.8)	1,425 (52.9)	108 (4.0)
100 m	1,011	7.4 ± 3.2	376 (37.2)	635 (62.8)	68 (6.7)	513 (50.7)	80 (7.9)	309 (30.6)	41 (4.1)
200 m	1,013	7.1 ± 3.1	349 (34.5)	664 (65.5)	75 (7.4)	550 (54.3)	67 (6.6)	293 (28.9)	28 (2.8)
400 m	919	7.1 ± 3.1	318 (34.6)	601 (65.4)	77 (8.4)	403 (43.9)	75 (8.2)	327 (35.6)	37 (4.0)
Hight Jump	617	7.9 ± 3.4	217 (35.2)	400 (64.8)	13 (2.1)	139 (22.5)	63 (10.2)	367 (59.5)	35 (5.7)
Long Jump	689	7.6 ± 3.3	257 (37.3)	432 (62.7)	33 (4.8)	203 (29.5)	85 (12.3)	343 (49.8)	25 (3.6)
Triple Jump	694	7.1 ± 3.4	234 (33.7)	462 (66.7)	31 (4.5)	158 (22.8)	122 (17.6)	362 (52.2)	21 (3.0)
Pole Vualt	693	7.8 ± 3.5	231 (33.3)	460 (66.3)	5 (0.7)	260 (37.5)	49 (7.1)	352 (50.8)	27 (3.9)