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Hill on a mountaintop: A longitudinal and cross-sectional analysis of the relative age effect in competitive youth football

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Abstract
The aim of this study was to examine the origin and persistence of the relative age effect (RAE) in competitive youth football. To examine its origin, birthdates of 121 category one Premier League academy players recruited over six years were compared with 691 Under 8 (U8) players in one of the regional grassroots leagues from which academy players are selected. To examine persistence of the RAE we conducted a longitudinal comparison of retention rates in early-birth and late-birth academy players from U9 to U15, and made a cross-sectional comparison of birthdate distributions from U7 to U18 in 10,857 regional league players. The results revealed birthdate asymmetry in both the academy and grassroots players but a much larger RAE in the academy. Longitudinal analysis revealed that the cumulative probability of retention at the academy was higher for early-birth than late-birth players. A small to medium RAE persisted across grassroots football age groups though it declined somewhat from U15 to U18. The implication of these results for academy player recruitment is discussed.

Keywords: relative age; soccer; birthdate

Introduction

The relative age effect (RAE) refers to the phenomenon of chronological age asymmetry within a competitive age group in a specific context or domain (Cobley, Baker, Wattie, & McKenna, 2009). In competitive sport the RAE is often characterised by over-representation of performers who are relatively old for their year of selection (see Cobley, et al., 2009; Smith, Weir, Till, Romann, & Cobley, 2018, for reviews); which, in many instances, has been attributed to physical advantages associated with age conferring a performance and selection advantage (Wattie, Cobley, & Baker, 2008). In regard to age, 'early birth' players are likely to be taller and have greater mass relative to their younger or 'late birth' counterparts, creating selection pressure for positive attributes in younger players. For example, the confidence interval for the height of 'late birth' players recruited to football academy development programmes was between the 75th and 91st percentile of UK growth charts whereas that of 'early birth' players was around the 50th percentile (Lovell, Towlson, Parkin, Portas, Vaeyens, & Cobley, 2015). In support of differences in physical stature driving an ongoing selection advantage, the distribution of elite academy football players was more strongly influenced by skeletal maturation status than relative age in the U12 to U17 age groups (Johnson, Farooq, & Whiteley, 2017).

The RAE is particularly pronounced in junior-elite football, in which studies have shown a clear difference between the birthdate distributions of academy level players and the general population (Helsen, Starkes, & van Winckel, 1998; Lovell, et al., 2015). Researchers have established the magnitude of the effect; however, they have not unequivocally identified its origin, which is assumed to be at selection to an academy. Grassroots teams in the UK compete in regional youth leagues from six years of age (U7) so it is possible that the RAE in academy U9 teams simply reflects pre-existing birthdate asymmetry in the pool of players selected to compete at grassroots level. Alternatively, researchers have highlighted the importance of selection pressure in exacerbating the RAE, be it the popularity of a sport relative to the number of teams and places available or specific selection 'pinch points' to higher levels of competition (Wattie, et al., 2008). By this reasoning, one would expect the RAE to be present in players selected to compete in grassroots football and to be more pronounced in the small proportion of these players who are selected for a football academy.

In the most relevant study to date, Helsen, et al. (1998) compared birthdate distributions of 223 players aged 6 to 10 years who were competing in 'regular youth leagues' in Belgium with 158 players in the same age category who had been selected for a first division youth team. They found substantial birthdate asymmetry in the players who were selected for first division teams but not in the regular youth league players. Because the two groups were drawn from a relatively small pool of players it is possible that the large age bias in players selected for professional youth teams reduced or eliminated any age bias in the pool of grassroots players. For example, an analysis of the RAE in female youth football players across all levels revealed that the effect was already present in the U8 group (Delorme, Boiché, & Raspaud, 2010). Likewise, early birth players were over-represented in a sample of U11 to U14 regional youth league players (Mujika, Vaeyens, Matthys, Santisteban, Goiriena, & Philippaerts, 2009). Accordingly, the first aim of the present study was to compare the magnitude of the RAE at entry to an English Premier League football academy with the size of the effect in U8 players competing in one of the regional leagues from which the academy selects its players. In line with the difference in selection pressure, we hypothesise there will be a larger RAE in the U9 academy players than in the U8 players competing at grassroots level.

In contrast to the under-representation of relatively young players in junior-elite football (Helsen, van Winckel, & Williams, 2005), the RAE is attenuated and sometimes reversed in professional sports. For example, cross-sectional comparisons showed that the effect was more pronounced in football academies than in senior professional teams (Barnsley, Thompson, & Legault, 1992; Dudink, 1994; Fleming & Fleming, 2012; Helsen, et al., 1998; Rada, Padulo, Jelaska, Ardigo, & Fumarco, 2018) but nonetheless persisted at the professional level (Doyle & Bottomley, 2018). By inference, one might expect the attrition rate to be higher for early-birth than late-birth players who are selected for an academy. Evidence for RAE reversal was found in a 'feeder' football academy for professional clubs in which players were selected at the U14 age group (Carling, le Gall, Reilly, & Williams, 2009). Players were grouped according to whether they were born in the first (Q1), second (Q2), third (Q3) or fourth quartile (Q4), and analysis of outcomes showed that a higher proportion of Q4 players than Q1 and Q2 players successfully secured a professional contract when they graduated from the academy. In other sports, researchers found that a higher proportion of late-birth than early-birth players achieved senior professional status in rugby union (McCarthy & Collins, 2014), and progressed from elite academy status to international status in cricket (McCarthy, Collins, & Court, 2016). In each of these studies, initial intake was characterised by over-representation and under-representation of Q1 and Q4 players, respectively, so, while there was evidence of reversal in the form of higher conversion rates for late-birth players, the absolute numbers remained strongly skewed in favour of early-birth players. For example, almost five times as many Q1 players (N = 34) as Q4 players (N = 7) secured professional football contracts in the Carling et al. study. It is also important to consider the number of places or contracts available when interpreting these data – it might have been highly unlikely or impossible for 70% of the more numerous Q1 and Q2 players to have secured professional contracts.

While birthdate distributions in professional teams suggest a weakening of the RAE, there remains a lack of evidence for RAE reversal in youth football. In a study of lower league football academies, the ratios between players born in the first half (H1) and second half (H2) of the selection year and those born in Q1 and Q4 were consistent across the U9 to U16 age categories then declined somewhat in the U17 and U18 age groups (Lovell, et al., 2015). Similarly, the combined RAE in an English Premier League football academy and Middle East Sports academy was consistent across the U9 to U16 age groups (Johnson, et al., 2017). Moreover, a strong RAE persisted in junior national football teams across the U15 to U18 age groups and was even stronger in national team selections than in club youth U12 and U14 teams (Helsen, van Winckel, & Williams, 2005). These data suggest that, in junior-elite football, the effect persists and that attenuation or reversal likely occurs late on the road to professional status. Understanding of the pattern of the RAE in academy football is currently limited to cross-sectional comparisons so the second aim of the present study was to conduct a longitudinal comparison of retention rates in early-birth and late-birth players at a professional football club academy.

The final aim of the present study was to examine evidence for RAE reversal in grassroots football. Researchers have suggested that the additional challenges and adversity faced by younger players lead to the development of a range of psychological characteristics that collectively constitute greater resilience (McCarthy, et al., 2016). Regardless of whether these positive psychological characteristics are selected or developed, to the extent they relate to chronological age and benefit performers at all competitive levels (Sarkar & Fletcher, 2014) one would also expect to find evidence of RAE reversal in grassroots football. Set against this, a recent study of 11 to 16-year olds in English professional football academies showed that adaptive self-regulation was unrelated to relative age but negatively associated with biological maturity, which suggests that any influence of psychological factors might be independent of chronological age (Cumming, Searle, Hemsley, Haswell, Edwards, Scott, et al., 2018). The only study to compare the RAE across different age groups in grassroots football revealed over-representation of early-birth players in the 12-16 year age group but not in the 6-10 year age group (Helsen et al., 1998). This suggests the RAE became more rather than less pronounced over time; however, the small sample size only allowed for a coarse comparison across two broad age groups. In the present study, we therefore sought to conduct a more comprehensive cross-sectional comparison of the RAE in grassroots football that encompassed almost 11,000 players across twelve age groups from U7 to U18.

The overall purpose of the present study was to examine the origin and persistence of the RAE in competitive youth football. We sought to identify the origin of the RAE by comparing its magnitude in a category one academy to one of the regional leagues from which it recruits the large majority of its academy players. We sought evidence for the persistence and potential reversal of the RAE by conducting the first longitudinal comparison of retention rates in early-birth and late-birth academy players, and by comparing the magnitude of the RAE across twelve age groups competing in the regional league.

Method

Participants

A category one English Premier League club football academy agreed to participate in the study. Category one is the highest academy status and, in line with the Premier League's elite player performance plan, is awarded based on an independent assessment of a number of criteria, including the quality of coaching, facilities, education and welfare provision. In line with institutional ethical guidelines on the use of secondary data for research purposes, the academy provided complete sets of anonymous birthdate data in seven age groups from U9 to U15 over nine consecutive seasons (2007-2015). From these data, we were able to longitudinally track the birthdates of 121 academy players, made up of six groups of U9 players recruited between 2007 and 2012. Of the six groups, progression data were available for two cohorts to U15, three cohorts to U14, four cohorts to U13, five cohorts to U12, and all six cohorts to U11. To facilitate comparison between the RAE at the academy and a representative pool of players from which it selects, the academy additionally provided a list of 10,857 anonymous regional league player birthdates divided into twelve competitive age categories (U7 to U18) from a single season. Accordingly, the anonymity of players was protected and data analysis referred only to selection year half or quartile.

Procedure

To compare birthdate distributions at entry to the academy with those in the regional league players, birthdates for academy U9 and regional league U8 players were classified by year quarter (Q) according to the selection cut-off date for the regional youth League (31 August). Q1 comprised birthdates from September to November, Q2 from December to February, Q3 from March to May, and Q4 from June to August. Chi-square analysis was used to compare birthdate distributions in each data set with the population distribution for England and Wales (Office for National Statistics, 2015). We then compared the distribution of academy birthdates with that of the regional league U8 players. In all analyses, Cramer's *V* was used to measure effect size, with values of 0.06, 0.17, and 0.29 corresponding to a small, medium and large effect size in tests with three degrees of freedom (Cohen, 1988). Small, medium, and large effect sizes for tests of half-year comparisons (one degree of freedom) are 0.1, 0.3, and 0.5, respectively.

To examine the effect of birthdate on progression through the academy, we classified player birthdates by year half (H), so that H1 comprised birthdates from September to February and H2 from March to August. We compared the rates of attrition in H1 and H2 players by plotting Kaplan-Meier survival curves showing the cumulative probability of being retained by the academy from U9 to U15. Because expected frequencies for H2 players were low, we used Fisher exact probability tests to compare the retention frequencies of H1 and H2 players across the age groups.

Results

There were 691 players enrolled for regional league U8 teams. Of these, a higher number were born in Q1 (n = 209; 30.3%) and Q2 (n = 175; 25.3%) than in Q3 (n = 157; 22.7%) and Q4 (n = 150; 21.7%), which yielded a Q1:Q4 odds ratio of 1.4. Chi-square analysis revealed this to be a small but statistically non-significant effect, $X^2 = 6.11$, $p = .11$, $V = .09$, reflecting a small difference from the census birth-date distribution. Of the 121 U9 players recruited by the academy, many more were born in Q1 (n = 69; 57.0%) and Q2 (n = 35; 28.9%) than in Q3 (n = 9; 7.4%) and Q4 (n = 8; 6.6%), yielding a Q1:Q4 odds ratio of 8.6 (CI = 4.0, 18.7). Chi-square analysis revealed a very large and statistically significant difference from the census birth-date distribution, $X^2 = 39.87$, $p < .001$, $V = .41$. Direct comparison of the birthdate distributions in the academy U9 and regional league U8 players revealed a medium to large effect, $X^2 = 45.91$, $p < .001$, $V = .24$. This was characterised by over-representation of Q1 players and under-representation of Q3 and Q4 players selected for the academy relative to the regional league U8 players (see Figure 1).

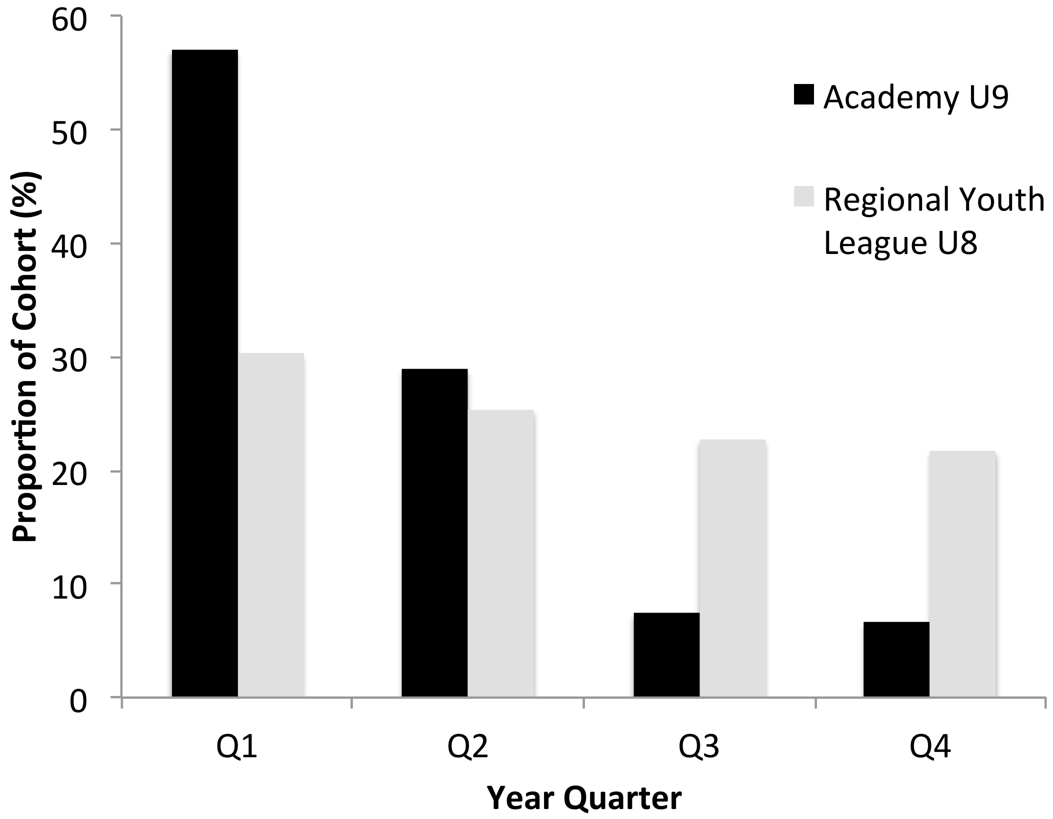

Figure 1. The distribution of birthdates in the academy U9 (N = 121) and regional youth league U8 (N = 691) player cohorts.

To examine differences in the regional youth league birthdate distributions from U7 to U18 age groups we compared birthdate quartiles in each age category with expected values from the national birth rate data. As can be seen in Figure 2, the number of players competing in each age group increased from U7 to U14 then decreased markedly from U14 to U18. Birthdate asymmetry was relatively consistent across the age groups, with Q1 birthdates most numerous in every age group, and Q4 birthdates least frequent in all age groups except U18 (Figure 2). Overall, the chi-square analysis revealed a small to medium effect of birth quarter caused by over-representation of Q1 and Q2 births and under-representation of Q3 and Q4 births compared to national birth rate data, $X^2 = 161.04$, $p < .001$, $V = .12$. Analysis of birthdate distributions in each age group revealed a medium effect size in the U7 ($X^2 = 18.05$, $p < .001$, $V = .20$) and U15 ($X^2 = 38.65$, $p < .001$, $V = .19$) age groups. For all other age categories, effect sizes were small (.06 to .16), and were non-significant for the U13 ($V = .07$, $p = .09$), U17 ($V = .09$, $p = .19$), and U18 ($V = .07$, $p = .54$) cohorts (see Figure 3).

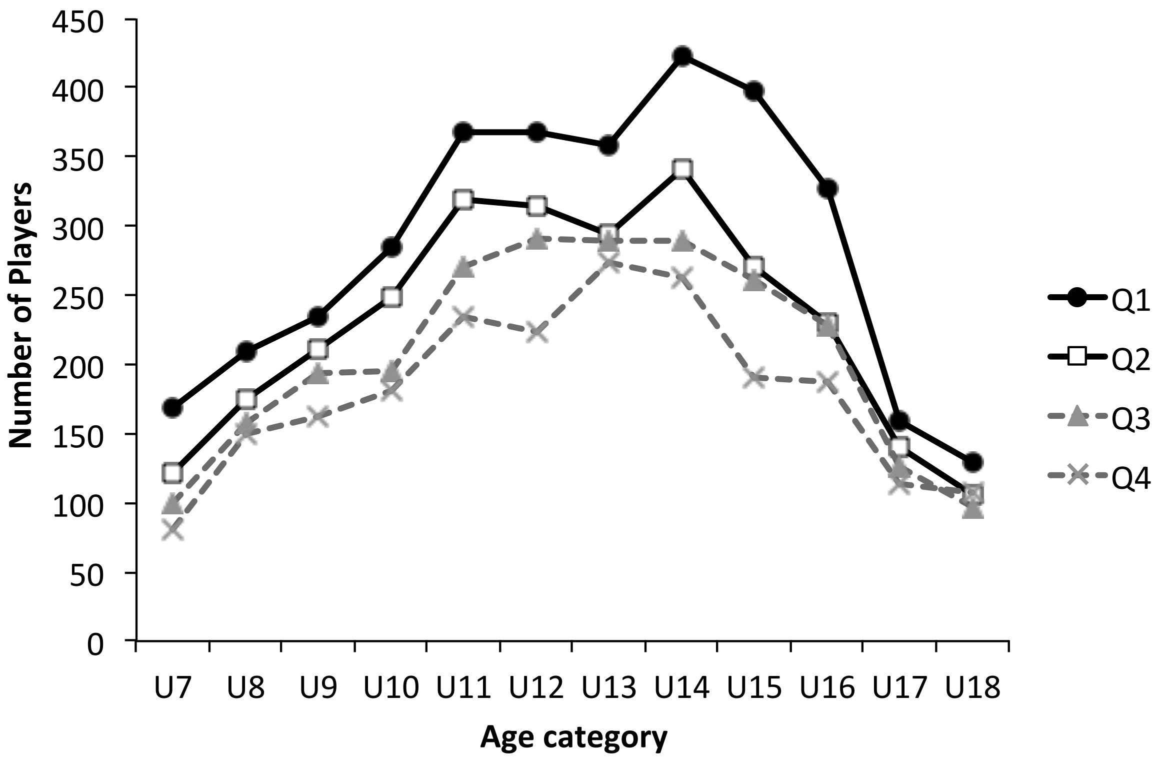

Figure 2. The number of players born in Quarter 1 (Q1), Quarter 2 (Q2), Quarter 3 (Q3), and Quarter 4 (Q4) of the selection year for each regional youth league age category.

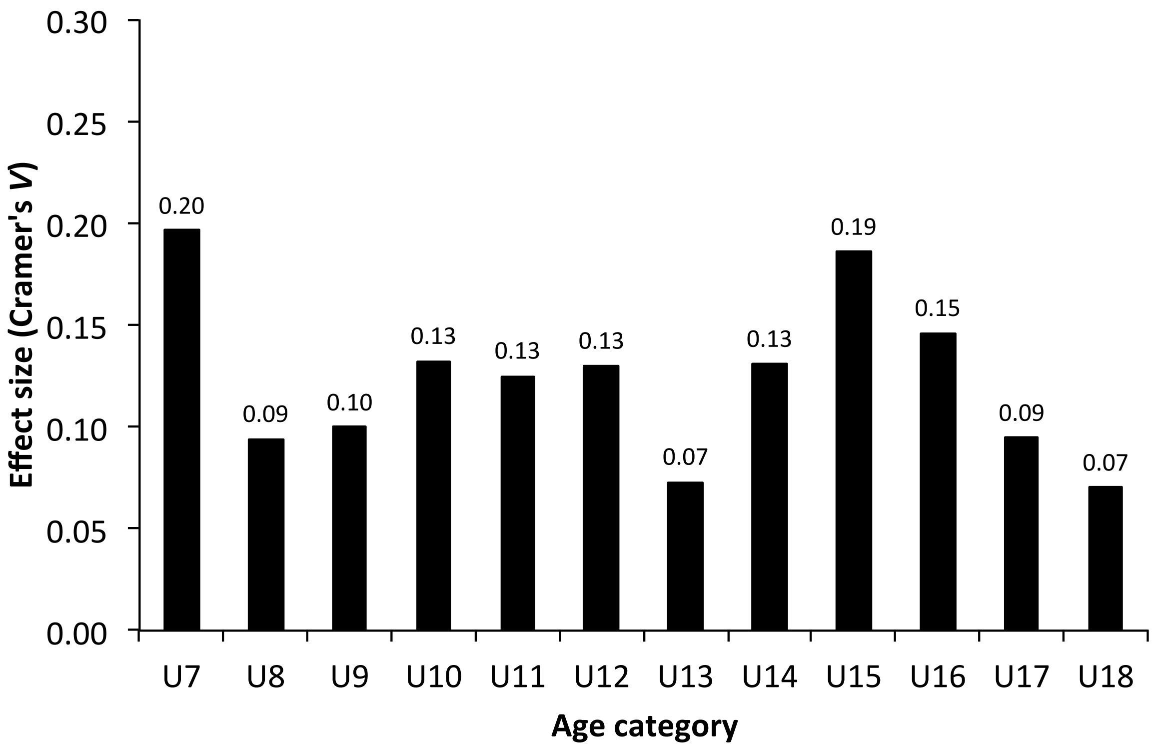

Figure 3. Relative age effect size for each regional youth league age category. Values of 0.06, 0.17, and 0.29 correspond to small, medium, and large effects, respectively.

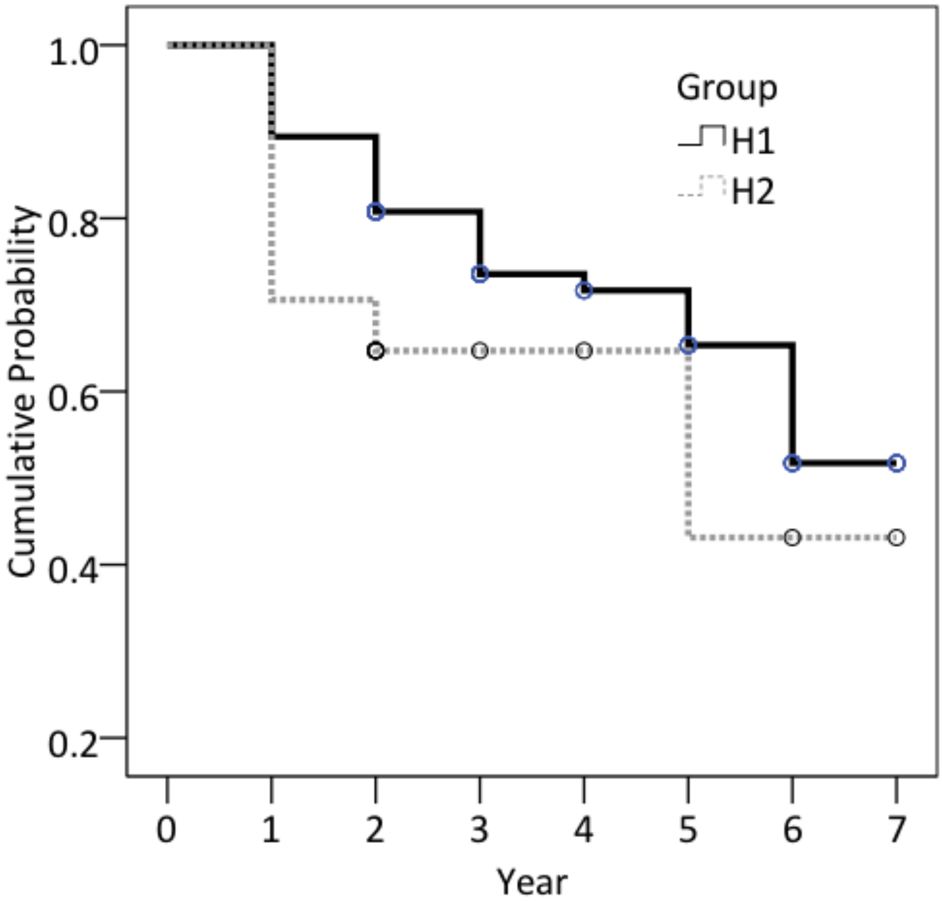

Figure 4. Kaplan-Meier survival curves for academy players born in Half 1 (H1) and Half 2 (H2) of the selection year, following entry to the academy (Year 0).

In regard to attrition rates there was no evidence of RAE reversal after recruitment to the academy. Indeed, the Kaplan-Meier survival curves show that the cumulative probability of being retained was lower for H2 than H1 players, particularly in progression over the first two years to U10 (H1 p_{cum}(retained) = .89; H2 p_{cum}(retained) = .71) and U11 (H1 p_{cum}(retained) = .81; H2 p_{cum}(retained) = .65, see Figure 4). Fisher exact probability tests revealed a statistically significant small to medium association between birth half and likelihood of progression to U10, V = .19, p = .049. Similar effect sizes were observed for progression to U11, V = .21, p = .07; U12, V = .20, p = .15; U13, V = .30, p = .049; U14, V = .32, p = .05; and U15, V = .23, p = .34.

Figure 4 about here

Discussion

The purpose of the study was to compare the magnitude of the RAE at entry to a football academy with one of the grassroots football regional youth leagues from which the large majority of players are selected, and to examine how these effects persisted across age groups. We found a clear and substantial difference between the size of the RAE in grassroots U8 players and the U9 academy players who were recruited over a period of eight years. In both groups birthdate distributions differed from the general population; however, the RAE was far larger in the U9 academy players than in the U8 grassroots players (for which the effect was statistically non-significant). Indeed, of the 121 players recruited to the academy just eight were born in the months of June, July, and August (Q4), whereas 69 were born in September, October or November (Q1). It is striking that the Q1:Q4 odds ratio of 8.6 is even larger than that reported in lower league player development programmes (Lovell et al., 2015) and is of a similar magnitude to that reported more than 20 years ago in a sample of British junior-elite football players (Baxter-Jones, 1995) and youth elite club players aged 6 to 8 years (OR = 6.7; Helsen, et al., 1998). Such a disparity in the effect size for grassroots and junior-elite football supports the view that selection pressure is a key driver of the magnitude of the RAE (Wattie, et al., 2008). By way of illustration, the Premier League academy in this study recruits only 15 to 20 players each year from the thousands of grassroots players who compete in regional leagues across the country.

Consistent with previous cross-sectional comparisons, we found no evidence of RAE reversal in the seven years after players joined the academy. One must be cautious when interpreting these data because so few late-birth players were initially recruited; however, the cumulative retention rate was higher for early-birth than late-birth players in all but the fifth year after recruitment. By virtue of their selection, late-birth players must have displayed a combination of qualities that were deemed equivalent to their early-birth counterparts so were arguably better players relative to their chronological age. If academy coaching staff became aware of birthdates after players joined the academy it is reasonable to expect they would have retained a higher proportion of late-birth than early-birth players; however, we found evidence to the contrary. Indeed, having successfully scaled the mountain to selection, late-birth players faced another hill on the road to retention. This suggests coaches either remained unaware of individual player birthdates or judged their players by a range of technical, tactical, and psychological criteria that were largely independent of relative age (Larkin & O'Connor, 2017). We speculate this would be more likely if selection to the academy favoured physical characteristics that decreased intra-group variability relative to the general population (Figueiredo, Coelho-e-Silva, Cumming, & Malina, 2019). For example, researchers showed that skeletal maturation status strongly influenced retention decisions for academy football players but did not affect the magnitude of the RAE, which remained the same from U9 to U16 (Johnson, et al., 2017). Another possibility is that coaches had knowledge of birthdates but were not aware of them when evaluating players. The practical importance of the distinction between knowledge and awareness was neatly illustrated in a study of football, which showed that the age selection bias was eliminated when scouts were informed that shirt numbers corresponded to the players' relative age (Mann & van Ginneken, 2017). Crucially, mere knowledge of birthdates was insufficient to eliminate the age bias – when scouts were informed of player birthdates the effect persisted. This highlights the need for clear identifiers that increase moment-to-moment awareness of relative age, require minimal processing, and do not create structural interference with coaching activities.

Cross-sectional analysis of birthdate distributions across age groups in the regional youth league provided weak evidence for a RAE reversal. Indeed, the overall effect was small but remarkably consistent across the U7 to U18 age categories (see Figure 3). The RAE was large at the age of initial selection (U7) and became progressively smaller from U15 to U18. These latter age groups were characterised by a sharp fall in the total number of players who competed in the League, and both the absolute and relative decline across these age groups was steeper for Q1 players (N = -268, -68%) than Q4 players (N = -83 = -44%). These are cross-sectional data and we did not measure psychological or physical characteristics so can only speculate about why the RAE was smaller in these age groups. It may be a result of differences in the possession or development of psychological attributes, such as resilience or self-regulation, or of sport-specific 'software' advantages linked to anticipation, decision making, problem solving and creativity (Andronikos, Elumaro, Westbury, & Martindale, 2016). Equally, greater dropout rates might simply reflect that older players are first to prioritise other things in their lives. More broadly, it is notable that the data differ somewhat from the findings of Helsen, et al. (1998) in that a RAE was present in the U7 to U10 year age groups, and was not larger in the U11 to U16 age groups. This difference might be explained by differences in sample size – the present study used a much larger sample size that included age groups prior to selection for the academy – but might also reflect a difference in selection pressure for places in regional league football in the UK and Belgium.

Implications

The present data show that the RAE was much more pronounced at selection to the academy than in grassroots football. This clearly demonstrates that the birthdate distribution of academy players does not simply reflect an existing age bias in grassroots football, which has important implications for the process used to identify and recruit players. The data support the view that scouting staff conflate talent with attributes associated with chronological age (Baxter-Jones & Helms, 1994; Carling et al., 2009; Furley & Memmert, 2016; Helsen, Hodges, van Winckel, & Starkes, 2000). On the one hand, this shows that talent scouts are very good at identifying the attributes on which they make their selection; if they were not then there would be no RAE. On the other hand they appear to make no adjustment for age, possibly because they do not know the birthdates of grassroots players they observe. Many football academies now engage in practices to address this challenge, such as using 'in-house' talent identification and development programmes in which coaching staff can be made aware of player birthdates. As others have suggested, awareness can be increased through the use of salient identifiers (e.g., arm bands, shirt numbers) that identify each player's birth month or birth quartile relative to the selection period (Mann & van Ginneken, 2017). In addition, mean age competitions, in which teams must be made up of players with a mid-category mean age (e.g., 8.5 years for U9), would help ensure that players from across the age category are more equally represented. Academies might also hold talent identification events for specific birth quartiles, with a particular emphasis on identifying the best players in under-represented quartiles. By scheduling these every three months, starting with Q1 players followed by Q2, Q3 and Q4 players, coaching staff would further benefit from seeing players of approximately the same chronological age and stage of development. Grassroots competition presents a greater challenge for scouting staff; however, subject to the rules of each league, it might be possible to give players the opportunity to wear identifiers that indicate birth month or quartile. Academies should also consider the efficacy of making age-related adjustments to data that are influenced by chronological age in order to make more informed selection and retention decisions.

Limitations

The sample size was large for the grassroots players as a whole and for the U8 cohort; however, it was comparatively small for the academy players and only a small number of these were born in the second half of the selection year. It is therefore important to be cautious when interpreting the longitudinal retention data and to appreciate that these data are from a single category one Premier League academy, which might not be representative of all academies. For example, one English Premier League academy representative acknowledged there were very few Q4 players but noted that all ten of the players retained and loaned to professional clubs after the age of 18 were born in Q4 (Andronikos et al., 2016). Notwithstanding this issue, the retention data are consistent with a recent study of 17 lower-league football development programmes in England, which showed that the equivalent H1:H2 RAE was stronger in the U15 than U9 age group (Lovell, Towlson, Parkin, Portas, Vaeyens, & Cobley, 2015).

Conclusion

It is remarkable that after more than three decades of systematic research into the RAE in football and many other sports the effect persists and remains so strong. In this study we have highlighted the role of selection pressure as a likely moderator of the effect size in football, which is evident in the much larger effect seen in a category one academy than in one of the regional leagues from which players are selected. The present study also highlights the ongoing challenge faced by relatively young players in the years after they have been recruited to an academy, which is potentially greater than that faced by the older players in their age group. In mitigating these effects, a key challenge for recruitment and coaching staff is how best to become aware of relative age when assessing players both outside and within the academy, and how to scale their judgments accordingly. Only once this is achieved can youth players be confident of a level playing field on the highly competitive journey toward professional status.

Data availability

The authors confirm that the data supporting the findings of this study are available wihtin the article.

Disclosure statement

No potential conflict of interest was reported by the authors.

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