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ORIGINAL ARTICLE

# Relative age effect: A head start for early-born football players

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## ABSTRACT

The aim of this study was to examine relative age effect (RAE) on distinctive variables and age groups in recreational football. Participants (N = 79,249) included male (n = 63,540) and female (n = 15,709) players aged 2 to 12 years. Data were gathered through an official database containing all licensed players in Denmark. Birthdate distributions were split by age category, sex, club size, year group size, and birth quarter (Q1 = January to March, Q4 = October to December). RAEs were calculated using chi-square analysis. Significant RAEs existed in all age categories (except females in U6 and below). The effect was most pronounced at the entry level among both males and females. Club size was not associated with RAEs, but were shown in smaller and midsized year groups, but were absent in larger year groups. The results of this study show that RAEs are present from early sport participation.
**Keywords**: Birthdate, Birth effects, Soccer, Early sport participation, Parents.

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## INTRODUCTION

The systematic practice of annual age grouping occurs across youth sports and countries. In football (soccer), such processes mean that children are regularly grouped with participants up to 12 months younger or older than themselves. These differences in chronological age among grouped athletes tend to negatively influence relatively younger players' likelihood of reaching both talent and senior elite status (Ryom et al., 2018) and increase the risk of dropout (Delorme et al., 2010). These effects are termed relative age effects (RAEs) and are defined as the overrepresentation of chronologically older participants within one selection category (Cobley et al., 2009). Despite the high number of RAE studies in the last decades, few studies have investigated RAEs in children's early sport participation.

Sport is often advocated as a valuable avenue that can foster beneficial experiences among youth (Fraser-Thomas et al., 2005). In fact, previous research implies that sport participation is associated with positive physiological and psychological outcomes, such as improved fitness and reduced cardiovascular risk in normal-weight and obese children (Andersen et al., 2008; Andersen, et al., 2006), enhanced self-esteem, academic achievement, and the development of leadership skills (Holt & Neely, 2011). Specifically, recreational soccer activities have also been shown to improve the well-being of 10- to 12-year-old male youth football players (Larsen et al., 2021). Such benefits might not be equally attainable for all youth. For instance, based on a PREFIT test, a Spanish study (Cupeiro et al., 2020) investigated the anthropometry and physical fitness among 3,147 children (3 to 5 year olds) and concluded that physical fitness was higher among relatively older youth. Such studies strengthen the case that relative age might also influence children's early sport participation.

Recently, a nationwide analysis among 101,991 Swiss football players (Romann et al., 2020), showed that the RAE only had a small—though consistent—effect on participation at grassroot levels. The analysis also indicated no significant RAEs on waiting lists (players signed up for football clubs) and among teams with no selections; in fact, only teams with selections showed RAE. The authors concluded that coaches' selections seem to be a key factor in perpetuating RAEs. Unfortunately, the analysis did not separate males and females from the early entry at 8 years of age, which prevented analysis of any influence of sex. Similarly, a nationwide study among male French youth football players also showed small and consistent RAEs for recreational football players at almost all levels (Delorme et al., 2010), but did not show any RAEs at the youngest age group, U7. Furthermore, in a systematic review, Smith et al. (2018) found small RAEs in female athletes across all sports, including football. While the results revealed that the magnitude of RAEs were highest in pre-adolescent athletes (U11) and at higher competition levels, it did not determine to what degree the RAE was present in the entry level. Thus, it is still not clear to what degree RAEs are occurring among male and female athletes in general, and among youth football players specifically. Contrary to these studies, Hancock, Ste-Marie, and Young (2013) discovered that only 20.3% of initiation ice hockey players (5-6 years of age) in Ontario were born in the fourth quarter of the year. Investigating RAEs across 10 other age divisions and competitive standards, the representation of athletes born in the fourth quarter was higher than in the initiation division, which highly indicates a rebalancing of RAEs over time. Hancock, Ste-Marie, and Young concluded that previous studies had overstated the importance of coaches' roles as it relates to RAEs and underestimated the influence of parents, as parent enrolment decisions might create an initial enrolment bias favouring relatively older athletes in early sport participation.

Contextual factors related to athletes' place of early development also influence the probability of sport participation, and to some extent, the development of sport expertise in countries such as Denmark (Rossing, 2018) and Sweden (Söderström et al., 2021). Since Musch and Grondin (2001) suggested in their original

review of RAE that broad socio-cultural values of modern youth sport and micro-system structures were all likely contributing to RAE prevalence, a number of studies have also investigated the connection between athletes' place of early development and the RAE. The results of these studies have varied, with some showing birthplace effects, but not RAEs among Canadian ice hockey youth players (Turnnidge et al., 2014) and professional athletes in ice hockey, basketball, baseball, and golf (Côté et al., 2006). In European sport, however, it appears that the magnitude of RAEs is influenced by demographic factors such geographic location (e.g., Portuguese male youth football players; (Almeida & Volossovitch, 2021). Moreover, the results from a recent Swedish study showed that the proportion of youth players in football districts influences whether male and female players, at age 15, continue to play football and whether they play at an elite level as young adults (Söderström et al., 2020).

Although district or community size seem to be related to athlete development and participation, both the development of talent and the differences in place of early development might be related to the structure of sport, which could be termed "i*nfrastructure*" (Hancock et al., 2021). In a European context, an inevitable structure within sports is the club system and the year group in which most athletes are embedded (Galatti et al., 2016). As competition has been highlighted as an inevitable mechanism for RAEs to exist (Musch & Grondin, 2001), the size of year groups might provide different opportunities for competition to exist. The depth of competition might rise in larger year groups, as coaches might be more willing to select players to specific teams according to the players' current abilities to ensure more equal training groups. Even though we acknowledge that clubs certainly differ within and across countries, researchers suggest that larger clubs influence how they can be more effective in advantages offered to members (Koski, 1995) and decreasing costs to a certain extent (Wicker et al., 2014), though they also experience larger problems regarding the recruitment and retention of volunteers (Wicker & Breuer, 2013). Recently, a Spanish study (Praxedes et al., 2019) revealed how all teams (U8 to U19) in elite clubs (n = 4) had significant RAEs, while low level clubs (n = 4) only had significant RAE among U14 to U18 teams—again demonstrating that factors other than club size might play a role. Nevertheless, the results of an interview study with Danish coaches and talent managers indicated that participants perceived smaller clubs as being disadvantaged in athlete development, as they often lack resources to facilitate continuous development of athletes (Rossing, 2018). These resources can be tied to both material and financial resources, but also the influence of parents, coaches, and peers, which can be termed "*social structure*" (Hancock et al., 2021).

The social structure surrounding the athletes from grassroots to elite levels includes coaches, parents, and peers. This framework connects to the RAE model proposed by Hancock, Adler, and Côté et al. (2013) that proposes that coaches influence RAEs by adopting higher expectations of relatively older children (i.e., Pygmalion effects). Relatively older athletes then influence RAEs by holding higher self-expectations than their peers (i.e., Galatea effects). Most relevant to the current study, however, is that parents can influence RAEs through Matthew effects (i.e., those with initial advantages continue to be advantaged), by enrolling their relatively older children earlier in life, perhaps because they view their children as advantaged compared to peers or simply put, more mature compared to peers. Clearly, RAEs are intricate and might be influenced by many factors (e.g., sex, club size, and year group size) depending on the country being explored. As such, continued and targeted investigation to better understand these effects is warranted.

In Denmark, youth players can be registered footballers from their birth and start on football-related activities in clubs at 2 years old. Similar to the initiation stage in Canadian hockey (Hancock, Ste-Marie, & Young, 2013), the Danish players cannot play matches arranged by the Danish FA before 5 years old. As Hancock, Adler, and Côté's (2013) model suggests, RAEs are initiated by parents' enrolment decisions at the earliest ages. Given the lack of studies on early entry into sport, this makes Danish youth football an interesting case

 

to study. Thus, the objectives of this study were to investigate (1) RAEs in a nationwide analysis of male and female football players (2 to 12 years old) who are registered as active players assigned in the database of the Danish Football Association (DBU) and (2) the influence of club size and year group size on RAEs.

## METHODS

### *Participants*

Following approval from the local ethical institution and the Danish Football Association, data were extracted in 2020 from an electronic database including 63,540 male (80.18%) and 15,709 female (19.82%) players aged 2 to 12 years old. This included officially registered players across 1,020 (male = 1003, female = 856) football clubs. Age categories ranged from U3 to U12 for both male and female football players (see Table 1).

Table 1. Distribution of participants by sex and year group.

| **Male** | | | **Female** | | |
|---|---|---|---|---|---|
| Year | n | % | Year | n | % |
| 2018 | 63 | 0.10% | 2018 | 25 | 0.16% |
| 2017 | 297 | 0.47% | 2017 | 70 | 0.45% |
| 2016 | 927 | 1.46% | 2016 | 200 | 1.27% |
| 2015 | 2221 | 3.50% | 2015 | 395 | 2.51% |
| 2014 | 4458 | 7.02% | 2014 | 657 | 4.18% |
| 2013 | 6815 | 10.73% | 2013 | 938 | 5.97% |
| 2012 | 8348 | 13.14% | 2012 | 1592 | 10.13% |
| 2011 | 9179 | 14.45% | 2011 | 2193 | 13.96% |
| 2010 | 10168 | 16.00% | 2010 | 2863 | 18.23% |
| 2009 | 10327 | 16.25% | 2009 | 3135 | 19.96% |
| 2008 | 10737 | 16.90% | 2008 | 3641 | 23.18% |
| **Total** | **63540** | **100.0%** | **Total** | **15709** | **100.0%** |

### *Procedures and data analysis*

In Denmark, the cutoff date for all sports is January 1st. Thus, the players were categorized into four quartiles (Q) according to their birth month, independent of their birth year (i.e., Q1 = January to March; Q2 = April to June; Q3 = July to September; and Q4 = October to December). The observed birthdate distributions were calculated for every quartile. The process of comparing observed birthdate distributions to expected equal distribution of births (i.e., 25% for each quartile) has rightly been questioned by Delorme et al. (Delorme et al., 2009; Delorme & Raspaud, 2009). Thus, for our study, the expected birthdate distributions were obtained from the *actual* live birth rates of Danish children (2013-2018), as registered by the Danish Office of Statistics (2020). Observed and expected birthrate distributions were compared using chi-square analysis (e.g., Q1 vs. Q4) with 95% confidence intervals. We also analysed RAEs in relation to football club size, which was defined by the total number of youth players (0-12 years of age) in each club. The club size categories were established by identifying the largest club size (i.e., a 518-member club for male footballers and a 145-member club among female footballers). Based on sheer size, the clubs were distributed into four groups including both male and female players and equal size; a) 131>, b) 131-260, c) 260-389 and d) 389<. As year groups (e.g. children born in 2009) vary in number of players and competition level, players were also categorized according to the size of their year group in each club. As year group size can potentially serve as a proxy for depth of competition, we categorized players from U6 to U12 into smaller (< 20), medium ( 20

to 40), and larger year groups (> 40). As there were limited female players within each year group, they were excluded from this analysis.

## RESULTS

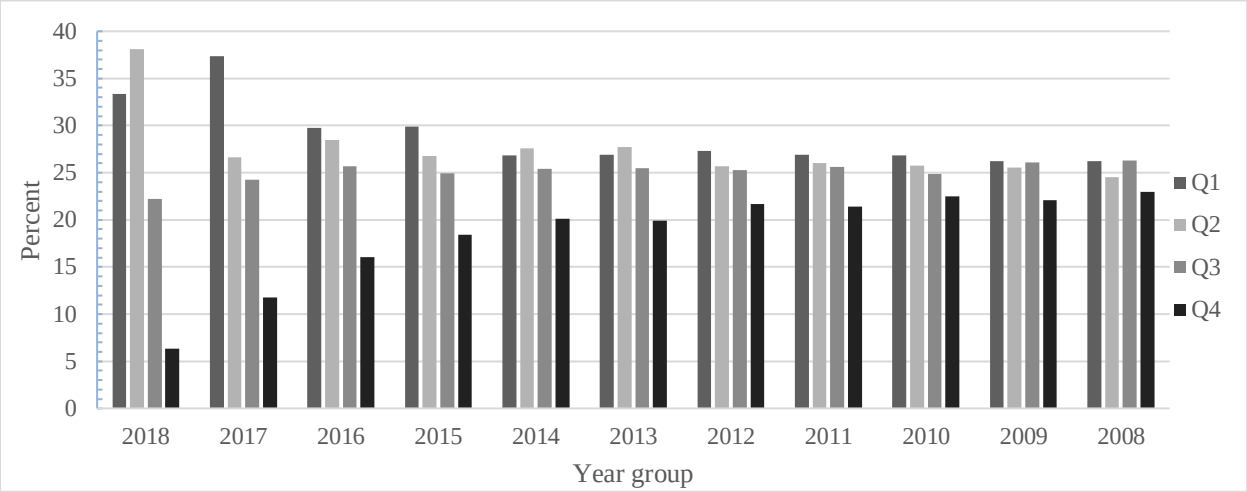


Figure 1. Quartile distributions of male youth players across age categories.

Table 2. Birthdate distribution analysis for male and female youth football players.

| Sex | Year | n | $x^2$ | *p* | w | Q1 % | Q2 % | Q3 % | Q4 % |
|---|---|---|---|---|---|---|---|---|---|
| | 2018 | 63 | 14.83 | .002 | 0.49 | 33.33 | 38.09 | 22.22 | 06.34 |
| | 2017 | 297 | 44.97 | .000 | 0.39 | 37.37 | 26.59 | 24.24 | 11.78 |
| | 2016 | 927 | 47.97 | .000 | 0.23 | 29.77 | 28.48 | 25.67 | 16.07 |
| | 2015 | 2221 | 93.14 | .000 | 0.20 | 29.89 | 26.74 | 24.94 | 18.41 |
| | 2014 | 4458 | 61.89 | .000 | 0.12 | 26.86 | 27.59 | 25.43 | 20.12 |
| Male | 2013 | 6815 | 79.59 | .000 | 0.11 | 26.91 | 27.73 | 25.46 | 19.89 |
| | 2012 | 8348 | 62.49 | .000 | 0.09 | 27.31 | 25.71 | 25.27 | 21.70 |
| | 2011 | 9179 | 48.75 | .000 | 0.07 | 26.93 | 26.01 | 25.63 | 21.43 |
| | 2010 | 10168 | 41.17 | .000 | 0.06 | 26.87 | 25.72 | 24.88 | 22.52 |
| | 2009 | 10327 | 33.91 | .000 | 0.12 | 26.22 | 25.56 | 26.09 | 22.12 |
| | 2008 | 10737 | 28.33 | .000 | 0.05 | 26.23 | 24.51 | 26.30 | 22.95 |
| | 2018 | 25 | 3.66 | .301 | 0.38 | 40.00 | 20.00 | 24.00 | 16.00 |
| | 2017 | 70 | 25.73 | .000 | 0.61 | 45.71 | 30.00 | 15.71 | 08.57 |
| | 2016 | 200 | 2.20 | . 531 | 0.10 | 26.50 | 26.00 | 23.50 | 24.00 |
| | 2015 | 395 | 11.47 | .009 | 0.17 | 26.33 | 27.34 | 28.35 | 17.97 |
| | 2014 | 657 | 4.73 | . 193 | 0.08 | 27.54 | 25.57 | 23.74 | 23.14 |
| Female | 2013 | 938 | 16.51 | .001 | 0.13 | 28.25 | 27.93 | 23.77 | 20.04 |
| | 2012 | 1592 | 17.77 | .000 | 0.10 | 28.01 | 24.81 | 26.58 | 20.60 |
| | 2011 | 2193 | 25.55 | .000 | 0.11 | 27.45 | 26.86 | 26.08 | 19.61 |
| | 2010 | 2863 | 35.17 | .000 | 0.11 | 28.89 | 24.97 | 25.39 | 20.75 |
| | 2009 | 3135 | 14.49 | .002 | 0.07 | 26.44 | 26.22 | 25.29 | 22.04 |
| | 2008 | 3641 | 26.51 | .000 | 0.09 | 26.37 | 26.42 | 26.23 | 20.98 |

As illustrated in Figure 1, RAEs were evident across all male age groups. Though the sample sizes are noticeably smaller for U2 to U4 age groups, a significant overrepresentation of relatively older athletes and a significant underrepresentation of relatively younger athletes was clearly evident (see Table 2). In fact, male players born in the fourth quarter of 2018 and 2019 represent only 6% and 11% of the proportion of players in their cohorts, respectively. This confirms that RAEs influence early entry into Danish football before the age at which competitions exist. Furthermore, the results show a rebalancing effect, since the proportion of male Q4-born players increases from ~6% in the U2 age category to ~23% in the U12 category.

Figure 2 illustrates the tendency for relatively older female players to be overrepresented in Danish football. Unlike male players, however, the trend was not significant for all age groups (i.e., U2, U4, and U6), and there was even an instance of Q3 athletes being most overrepresented in one age category (i.e., U5). Though not all results were statistically significant (possibly due to low sample sizes), the data show a clear tendency favouring relatively older female athletes, especially during the entry years into football.

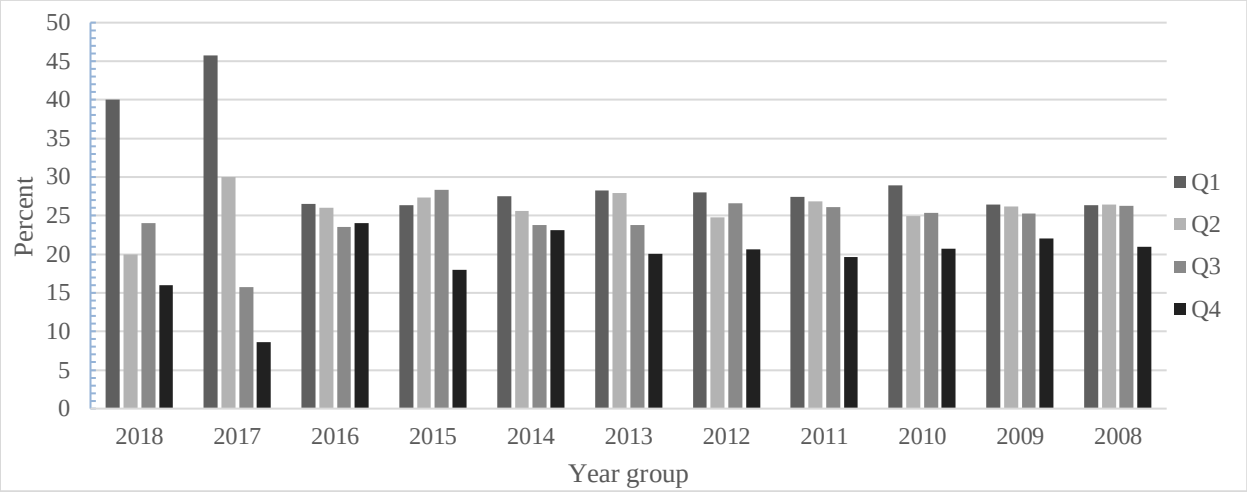


Figure 2. Quartile distributions of female youth players across age categories.

Focusing on club sizes, it was revealed that RAEs did not differ based on the size of one's football club. In fact, RAEs were present for all club sizes across both sexes (see Figures 3 and 4). Birthdate distributions showed an overrepresentation of players born in the first half of the year, with an underrepresentation of those born in the second half of the year. For most club sizes, Q4 athletes were significantly underrepresented (see Table 3).

Table 3. Birthdate distribution analysis for male and female youth football players.

| Sex | Interval | n | $x^2$ | *p* | Q1 % | Q2 % | Q3 % | Q4 % |
|---|---|---|---|---|---|---|---|---|
| Male | 3-131 | 32810 | 275.9464 | .000 | 27.36 | 25.59 | 25.58 | 21.44 |
| | 131-260 | 19144 | 116.2945 | .000 | 26.39 | 26.30 | 25.56 | 21.73 |
| | 260-389 | 8323 | 62.98729 | .000 | 26.51 | 26.68 | 25.32 | 21.47 |
| | 389-518 | 3171 | 21.86236 | .000 | 26.58 | 25.82 | 26.42 | 21.16 |
| Female | 3-38 | 7821 | 87.17662 | .000 | 27,66 | 25.68 | 25.99 | 20.64 |
| | 38-73 | 4545 | 52.4718 | .000 | 27,04 | 26.66 | 26.02 | 20.26 |
| | 73-109 | 1971 | 836.9987 | .000 | 25,92 | 26.94 | 25.46 | 21.66 |
| | 109-145 | 1113 | 14.81364 | .002 | 28,12 | 25.51 | 22.64 | 23.71 |

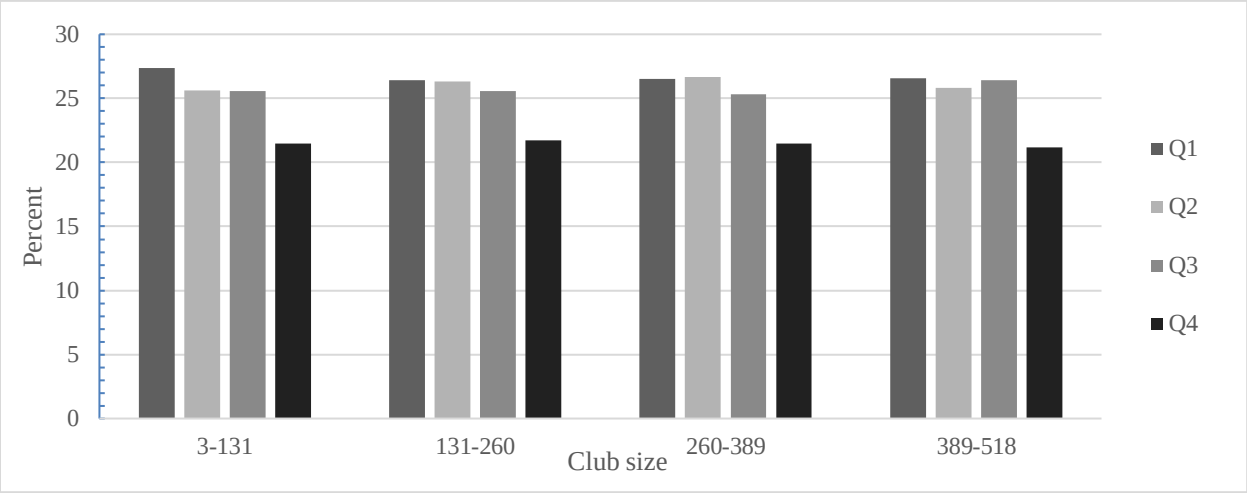


Figure 3. Quartile distributions of male youth players across club size categories.

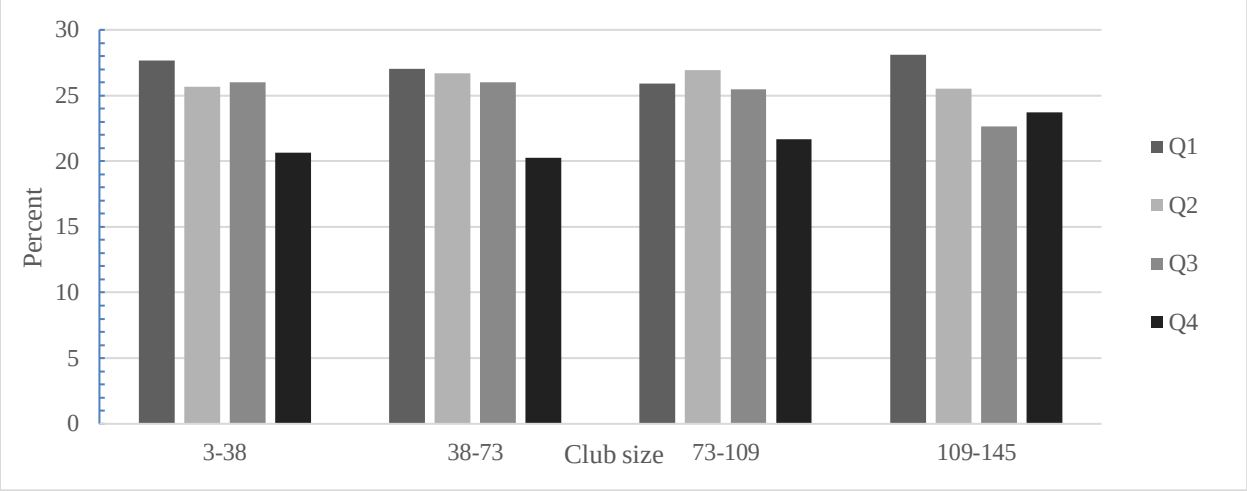


Figure 4. Quartile distributions of female youth players across club size categories.

Recall that we also examined RAEs and year group size. Analysis revealed significant RAEs for small (< 20 registrants in an player's club at their age category) and medium (20 to 40 registrants) year groups, but no RAE for large (> 40 registrants) year groups. Whereas the small year groups had an overrepresentation of relatively older athletes, medium year groups had the strongest overrepresentation for Q3-born athletes (see Figure 5 and Table 4).

Table 4. Birthdate distribution analysis for male youth player U6-12 across year group sizes.

| **Interval** | **n** | ***p*** | ***x*²** | **Q1 %** | **Q2 %** | **Q3 %** | **Q4 %** |
|---|---|---|---|---|---|---|---|
| 1-20 | 31573 | .000 | 235.162 | 27.36 | 25.59 | 25.58 | 21.44 |
| 21-40 | 20839 | .016 | 88.743 | 26.39 | 26.30 | 25.56 | 21.73 |
| >40 | 8941 | .062 | 48.113 | 26.51 | 26.68 | 25.32 | 21.47 |

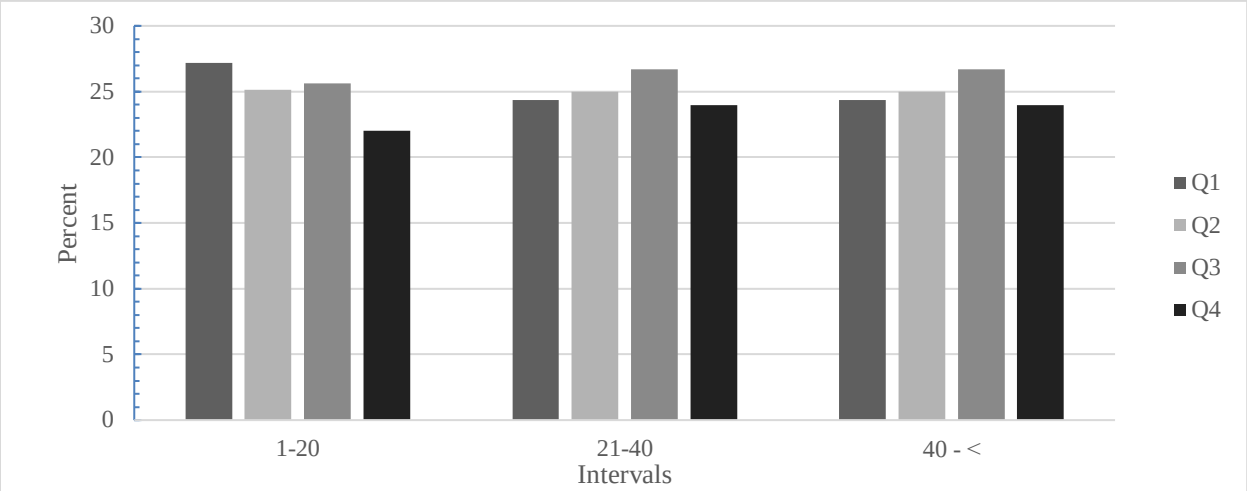


Figure 5. Quartile distributions of male youth players across year group size categories

## DISCUSSION

This study aimed to better understand factors that influence RAEs by examining birthdate distributions of Danish youth football players. The first key finding was that the RAE was most pronounced in the early sport participation years (for both males and females), as the proportion of Q1-born male players enrolled in U2 and U3 categories were 33% and 37%, while the proportion of Q1-born female players in same age categories were 40% and 46%. Second, the RAE was significant in most age categories (exceptions being female U2, U4, and U6 players), but RAE clearly dissipated within older age categories. Examples of this rebalancing effect are seen when examining the proportion of Q4 players. Among male players, this proportion increased from ~6% at U2 to ~23% at U12. For female players, the proportion increased from ~16% at U2 to ~21% at U12. The third key finding was that club size does not seem to yield RAE differences, as registration patterns across all club sizes and among both sexes were quite similar (i.e., Q1-born players overrepresented and Q4-born players underrepresented. Lastly, a typical RAE pattern was found within smaller and medium year groups, while larger groups showed non-significant results.

### *Parents' initial enrolment bias*

With such a low proportion of Q4-born players in the earliest years of participation, the results indicate that parents' initial enrolment bias might play a central role in the progression of RAEs in the early stages of participation. It is known that parents play an important role in children acquiring early sport experience, coaching, practice, and motivation (Witte et al., 2015), and that the impact and involvement of parents are larger in the beginning of children's sport careers than in adolescence (Côté, 1999). For instance, a study of parents' experiences over the initial period of a first child's sport involvement (Dorsch et al., 2015) found that the parents were highly guided by their own expectations (e.g., beliefs regarding their children's sport participation, interest, perception of parenting norms, etc…). The study also highlighted how parents compared their children with their teammates and opponents to assess their children's abilities. Such an orientation might also occur prior to choosing children's sport participation, leading some parents to be unwilling to send their children to sports such as football. As youth sport, especially football, has been characterized as a "*race to the bottom approach*" (Rossing et al., 2020) due to commonly used early selection and specialization procedures, parents of relatively younger children might delay their children's participation on the premise of protecting their well-being.

Though our data cannot not conclusively address why parents might enrol or withhold their children from youth sport, it is clear that this enrolment bias exists in Danish football. This extends the support for Hancock, Adler, and Côté's (2013) model positing that parents initiate RAEs through Matthew effects. Specifically, early entry into sport likely leads to more training, coaching, and competitive opportunities, which further advantages relatively older athletes in years where team selections exist. Meanwhile, relatively younger children miss out on the opportunities, which might disadvantage them later in their athletic careers, specifically when trying out for competitive teams and elite clubs. These findings are novel and more research is needed to understand the Matthew effect on RAEs; however, the results assist in providing a more versatile explanation for RAEs.

***Club size and year group***

A novelty of this study was its exploration of club and year group size as a potential variable that influences RAEs. However, the results clearly showed that the RAE was consistent across all club and year group categories (except large year groups), which indicate that the size of the club and year group does not increase the existence of RAE. Previous researchers have shown that, in Spain, the type of football club (elite vs. non-elite) might influence RAEs (Pizarro et al., 2019). However, unlike Scandinavian sport traditions, Spanish clubs seem to operate as either elite clubs or mass participation clubs from U8. This likely has considerable consequences on both the recruitment and practices of players between the types of Spanish clubs as they have different aims. In a Danish context, elite clubs are not allowed to formally recruit players, which therefore does not seem to explain the results.

Recently, a number of case studies have investigated how extremely successful year groups have influenced football players' development and participation from their entry to adolescence (Erikstad et al., 2021; Rossing et al., 2020). As most athletes in team sports, at least in Europe, are embedded in year groups during their development as children and youth, this is certainly a vital social structure. Illustrating this point, research on Danish and Norwegian football clubs (Rossing et al., 2020; Erikstad et al., 2020) showed how the coaches ensured that all players were recognized as players in their daily training sessions, but also at competition (e.g., providing them all equal playing time). Interestingly, the two successful case studies in Denmark and Norway exhibited similar year group sizes (33 and 40, respectively), indicating that year group size might be beneficial for a strong development environment. As the studies also clearly indicated that the synergy between coaches, parents, and peers highly influences participation and development opportunities, additional analyses on the size of year groups might be favourable.

The club and year group variables were included in the study as they potentially serve as social structures that could illuminate the depth of competition among youth players. However, the depth of competition might be difficult to extrapolate within a social structure such as size of club and year group, since competition, or what the Danish sociologist Anders Petersen (2016) calls a "*performance oriented society*", might permeate all levels of society and therefore is not shown in our categories of club and year group. Especially in football, children are being recruited into academies as young as six years of age with the ambition that they have better opportunities to reach elite level (Hill & Sotiriadou, 2016; Larkin & Reeves, 2018). Such practices are widespread across elite football clubs and national associations (Höner & Feichtinger, 2016). Even though elite clubs in Denmark are not allowed officially to recruit players under 12 years of age, Petersen (2016) points out that the current society is designed on the basis of logic of performance, in which our own performances determine our success in life. As competition is the primary engine of a "*performance oriented society*" (Petersen, 2016), it can influence the choices made by the parents—if parents' expect that their relatively younger children might not be successful when entering sports such as football, they might postpone their initial enrolment into sport.

 

### *Limitations*

Despite its unique contribution to the field, this study has limitations. First, this study examines RAEs in Danish soccer during the 2019/2020 season, which is not necessarily a reflection of the general situation over a longer period of time. Second, although participants were drawn from the DBU's official database, players might be enrolled in various clubs and teams that can differ in size, training quantity and quality, coaches' competencies, and many other factors that can influence their participation in local volunteering clubs. Nevertheless, this is the first study to include a complete nationwide database of both sexes across all age categories from their earliest entry into sport participation.

## CONCLUSION

This study aimed to investigate RAEs in a nationwide analysis among 2-12 year old football players. This study highlights that RAEs exist at the enrolment stage in sport participation among both male and female players and that it slowly decreases across older age groups, although small effects still exists. Future researchers should investigate the influence of parents' initial sport enrolment decisions on RAEs.

## AUTHOR CONTRIBUTIONS

Niels Nygaard Rossing conceptualized the study, while Kasper Raaby Pedersen obtained the data for it. Kasper Raaby Pedersen and Niels Nygaard Rossing performed a data analysis while all authors interpreted the data. Niels Nygaard Rossing, Knud Ryom and David J. Hancock wrote, reviewed and approved the final manuscript.

## SUPPORTING AGENCIES

No funding agencies were reported by the authors.

## DISCLOSURE STATEMENT

No potential conflict of interest were reported by the authors.

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