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Relative age, talent identification and youth skill development: Do relatively younger athletes have superior technical skills?

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Abstract: Relative age effects (RAEs) refer to differences among individuals in age-based cohorts typically used in sport. These effects usually favour relatively older members of the cohort and are thought to result from differences in maturation and experience among athletes of different chronological age. Recently, researchers suggested that relatively younger participants may not be as disadvantaged as previously thought. In two studies, we examined whether relatively younger athletes who were able to survive in a system that advantages their relatively older counterparts would develop superior technical skills. In study one, participants aged 13-15 years (n=140) drawn from a regional handball talent selection camp in Germany demonstrated a general relative age effect but no differences between relatively older and relatively younger athletes in physical body size (i.e., height/weight) or technical skills. In study two, similar tests were considered with a larger sample (n=478) and revealed similar results. Furthermore, there were no differences between those selected for the national youth team and those not selected. Differences in RAEs do not seem to be due to technical skills or body size variables. Moreover, the homogeneity of these results suggests causes of the relative age effect occur early in development.

Keywords:

birth-date, maturation, expertise, skill acquisition

There are a range of primary and secondary factors influencingg the development of expertise in sport (Baker & Horton, 2004). One secondary factor believed to affect access to high quality training and coaching is relative age. Relative age effects (RAEs) refer to chronological age differences between individuals within annually age-grouped cohorts (Barnsley, Thompson, & Barnsley, 1985). In most youth sports, annual or biannual age-groupings, which are thought to create homogenous groups within the competition system of each sport, unfortunately create a sport structure that perpetuates RAEs. For example, consider a youth competing in a talent-development program for athletes 10 years of age. If the youth is born very early in the competition year (i.e., is relatively older), he would be ten percent older than relatively younger opponents born at the end of the competition year (cf. Helsen, Starkes, & van Winckel, 2000).

First to report RAEs in sport were Grondin, Deschaies, and Nault (1984), who presented data for Canadian ice-hockey and volleyball demonstrating an unequal distribution across birth quartiles. At recreational, competitive, and senior professional levels more players were born shortly after the cut-off date for their respective sports. Similar findings have been noted in Canadian ice-hockey within developmental leagues (Barnsley & Thompson, 1988; Barnsley et al., 1985). In many sports, RAEs are not new phenomena. Wattie, Baker, Cobley, and Montelpare (2007) found RAEs in Canadian ice-hockey hall of fame athletes going back over

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four decades. For professional soccer in Germany, Cobley, Schorer, and Baker (2008) demonstrated RAEs for players and coaches (but not for referees) since the beginning of the Bundesliga (Highest Federal league) in the early 1960s. In more recent years, RAEs have been confirmed internationally for male athletes on many different levels of competition and in a variety of sports, including Australian Rules football (Abernethy & Farrow, 2005), baseball (Thompson, Barnsley, & Stebelsky, 1991), basketball (Delorme & Raspaud, 2009), soccer (Helsen, Starkes, & Van Winckel, 1998, 2000; Helsen, Van Winckel, & Williams, 2005; Jimenez & Pain, 2008), handball (Schorer, Cobley, Büsch, Bräutigam, & Baker, in press; Schorer, Baker, Lotz, & Büsch, in press), ice-hockey (Wattie et al., 2007), rugby (Till et al., in press), and volleyball (Barnsley et al., 1985). Findings for female athletes are less consistent. Vincent and Glamser (2006) found marginal RAEs at the National level for female soccer players but not at the state level. Schorer, Cobley, et al. (in press) observed a significant over-representation of relatively older athletes (i.e., from the first quartile) in young female handball players, but these effects were smaller than for male athletes. In general, RAEs are confirmed with few exceptions for a variety of sports for both genders over a range of competition and development levels (Cobley, Baker, Wattie, & McKenna, 2009).

Our understanding of the mechanisms behind RAEs is much less developed. To date, two hypotheses have been forwarded to explain relative age differences. Most often cited are maturational differences (e.g., Barnsley & Thompson, 1988), which assumes that greater height and mass provide an advantage for relatively older athletes in sports where size is important (Malina, 1994; Malina, Bouchard, & Bar-Or, 2004; Norikazu, Atsushi, & Toru, 2007). The relevance of height and weight in youth sport is supported by a study of Brewer, Balsom, Davis, and Ekblom (1992), who found that elite junior soccer players were above the 95th percentile of normative data for their population.

A second, related, hypothesis considers the role of selection processes. The above mentioned maturational differences, which are stronger in the early years of athlete development, lead to an increased probability of selection by coaches for higher tiers of competition (Schorer, Cobley, et al., in press; Sherar, Baxter-Jones, Faulkner, & Russell, 2007), which perpetuates a vicious cycle for the relatively younger. Because they are less likely to make it into the selection, relatively younger athletes have less access to training with highly qualified coaches and better medical resources (Helsen et al., 1998). Additionally, they are less likely to gain match experience at higher levels of competition (considered essential to developing expertise, Baker & Horton, 2004), thereby increasing the differences between relatively older and relatively younger athletes. Recently, researchers have discovered that relatively younger participants may not be as disadvantaged as previous research suggested. One study by Ashworth and Heyndels (2007) found that relatively younger soccer players had higher salaries than their relatively older counterparts. Further, Baker and Logan (2007) found that relatively younger ice-hockey players were more highly sought after during the National Hockey League draft. In the study by Schorer, Cobley, et al. (in press) relatively younger athletes had a higher probability of becoming members of the adult national team. More specifically, early selections (i.e., the first regional and national selections) showed clear RAEs with significant over representations of relatively older athletes; however, the adult national team had approximately the same percentage of players born in the first and fourth quartiles indicating an over representation of relatively younger players relative to the population from which players were drawn. Although the specific mechanisms of these effects are not known, Schorer, Cobley, et al. (in press) proposed that systems that perpetuate relative age effects may turn out to be beneficial for some relatively younger players who develop superior technical or tactical skills in order to compete successfully against their older, generally bigger opponents. Ultimately, they hypothesize, relative age effects result in those relatively younger players who survive the system having a larger repertoire of skills and therefore demonstrating superior performance. We explore this idea in the present study.

Below we summarize two studies examining these relationships in German handball. Overall, our objectives were to a) establish relative age effects in two samples of handball players being considered for national team selection, b) consider differences between relatively older and relatively younger players on variables related to body size and technical skill development, and c) consider differences between those selected for the National team versus those not-selected.

Study 1

In this first study, we consider the above relationships with a sample of participants being considered for national handball team selection in Germany. During this preparation camp for national selection, five regional D-squads tested their teams (Wohlrab, Landgraf, & Feldmann, 1998). By the end of the week, an All-Star-team was selected by the coaches based on their impressions over the week. Based on the preliminary research done to date (Baker & Logan, 2007; Schorer, Cobley, et al., in press), we hypothesized that the sample would show an overall relative age effect and that the relatively youngest players would have higher scores in technical skills while relatively older ones would have larger body sizes, although these hypotheses were largely exploratory.

Methods

Athlete data were acquired during the “Südcamp 2008” of the Southern German Handball Federation in Tailfingen. Participants were between 13-15 years of age and most of them passed two selection levels (district and region/state). For this study, 69 female and 71 male athletes provided their birth-date, height (in cm), and weight (in kg). Their height ranged from 1.54-1.81m for the female and from 1.66-1.96m for the male players. Their body mass was between 46-73kg for females and 52-88kg for males. To test for RAEs, birth-months of the players were re-coded to reflect the athlete’s birth quartile (Q). Because the handball annual age-grouping starts with the 1st of January, quartiles were calculated accordingly: Q1: January-March, Q2: April-June, Q3: July-September; and Q4: October-December. As with most of the previous research, comparisons were drawn on the assumptions of an equal distribution (see Cobley et al., 2008). For Germany, a recent study by Schorer, Baker, et al. (in press) demonstrated equal distributions between quartiles. Chi-square analyses were conducted to test for differences in quartile distributions among the overall sample as well as between players selected for the All-Star-team and those not selected.

In addition to these tests we conducted a technical talent assessment where respondents were required to throw ten balls as precisely and as quickly as possible alternating between the upper two corners of the goal. This task was chosen by the national coaches because it represents one of the main skills athletes at this age need to have acquired since it is the basis for most throwing skills in handball. The players had to pick up the ball from a box positioned twelve meters away from the goal in the middle of the field and then throw the balls after three approaching steps from approximately nine metres. The duration of these ten throws was measured by an electronic watch. Due to time limitations during the camp only 43 male and 48 female players were able to perform the test. During these ten throws two independent raters evaluated the over arm throw (German: Schlagwurf) in four different categories (run up, shooting position, throwing movement, and final position). Scores demonstrated a high degree of inter-rater-reliability ($\rho_{(overall)}$=.97) and the ratings for both judges were amalgamated into a general technical rating (Pabst, Büsch, Wilhelm, & Schorer, 2009). Additionally, the speed of throws was measured by Speed-Trac (Sport Thieme, Germany) and the percentage of correct hits to the goal corners provided a measure of throw accuracy. This task resulted in four dependent variables (1) test duration, (2) expert ratings, (3) throw speed, and (4) throw accuracy.

Instead of using a descriptive statistical approach, a more exploratory data analysis was conducted for physiognomic data and technical skill data, because cell sizes were small and varied among the quartiles (cf. Sedlmeier, 1996). Figures are presented as boxplots, based on a rank scale, which are less influenced by outliers. The line in the middle of the box is the median. The box shows 25% and 75% quartiles and the lines above and below show the highest and lowest values that are not outliers. Circles (1.5 to 3.0 standard deviations) and asterisks (more than 3.0 standard deviations) above or below these lines indicate outliers. The width of the boxes allows a relative comparison of cell sizes per group (cf. Benjamini, 1988; Sedlmeier, 1996).

For the inferential statistical analysis, a conservative Exact Test by Kruskal-Wallis for independent samples was calculated, which works well with small samples and rank scales. For the Monte Carlo sampling the default values corresponding to a sample size of 10,000 and confidence levels of 99% were used. Due to the small sample size, the exact or asymptotic p-value seemed inappropriate; therefore, Monte Carlo p-values are reported. When applicable, post-hoc comparisons of independent samples were calculated using Mann-Whitney-U-Tests (alpha criterion set on .05 and for technical skills alpha was Bonferroni adjusted). For calculating effect sizes and power, G*Power 3.0.10 was used (Faul, Erdfelder, Lang, & Buchner, 2007).

Results

The results are presented in three sections. First, we provide the analyses of overall relative age effect. Second, we test birth quartile differences in physiognomic variables (i.e., weight and height). In the final section, we investigate differences between quartiles in the technical skill test. For all three sections, we differentiate those selected for the all-star game and those not selected, to test whether the selection affected the strength of the RAE (as hypothesized by Musch & Grondin, 2001)

The analysis of the overall sample revealed a significant relative age effect, $\chi^2(3, n=140) = 24.29$, $p<.01$, $w=.42$. Differentiating between selected and not-selected players, significant differences from the normal distribution were found for selected players, $\chi^2(3, n=43) = 6.76$, $p=.04$, $w=.40$, and for not-selected players, $\chi^2(3, n=97) = 18.59$, $p<.01$, $w=.44$. Comparing distributions of not-selected players to selected players, no significant differences were found, $\chi^2(3, n=97) = 3.51$, $p=.33$, $w=.19$, $1-\beta=.45$ (see Figure 1).

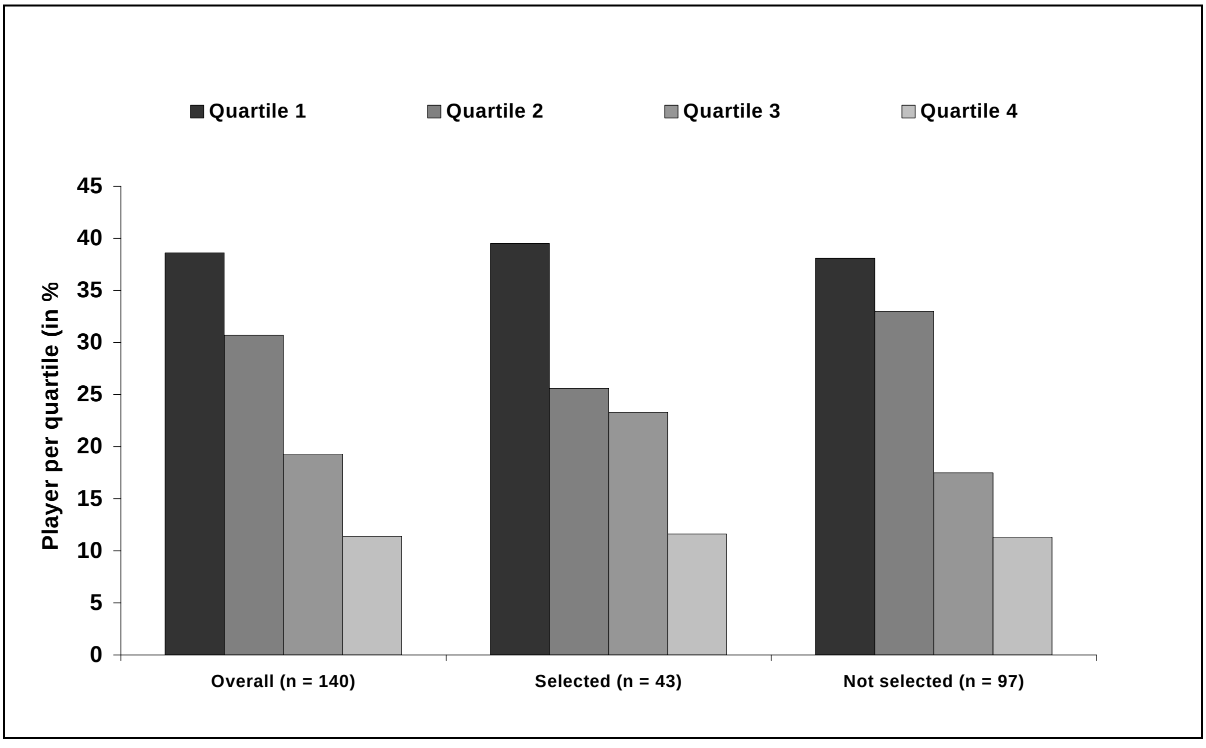

Figure 1. Distribution of players' birth quartiles overall (*n*=140) as well as differentiated between selected (*n*=43) and non-selected (*n*=97) for study 1.

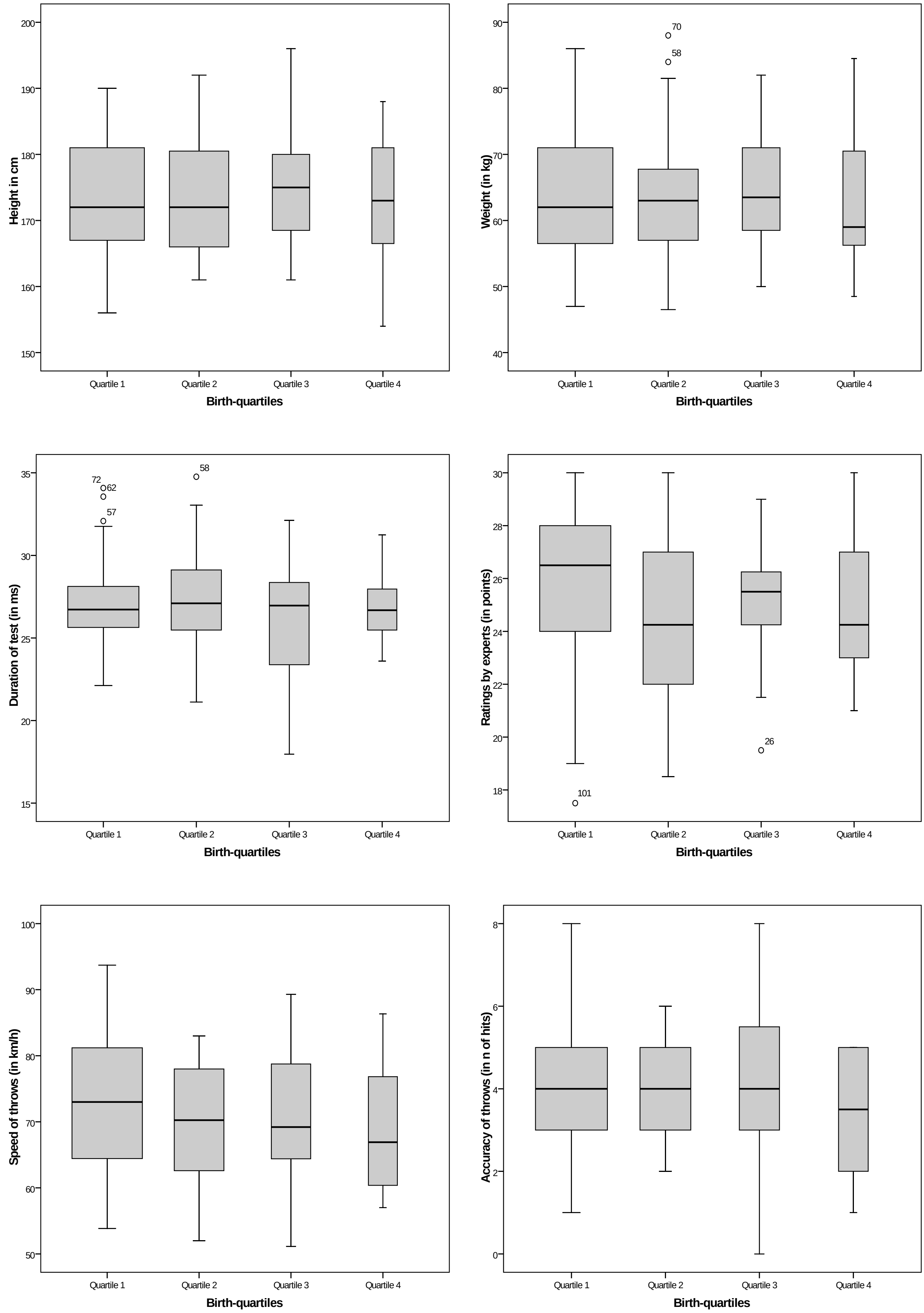

Figure 2. Boxplots for height (in cm/upper left), weight (in kg/upper right), test duration (in secs/middle left), expert ratings (in points/middle right), throw speed (in km/h/lower left), and throw accuracy (in n of hits/lower right) differentiated by birth quartile.

As can be seen in Figure 2 (upper row), there were no differences among the birth quartiles for either height, $H(3)=1.20$, $p=.76$, or weight, $H(3)=0.55$, $p=.91$. Further, differentiating between selected and not-selected players revealed no differences between the groups; height, selected: $H(3)=6.31$, $p=.09$, not-selected: $H(3)=2.87$, $p=.41$, and weight, selected: $H(3)=2.14$, $p=.56$, not-selected: $H(3)=0.59$, $p=.90$. Finally, we considered differences between players from different quartiles concerning their technical skills. As can be seen in Figure 2 (middle and lower rows), there were no differences among the groups for any of the four technical variables. Inferential statistics confirmed no significant differences for (1) expert ratings, $H(3)=3.10$, $p=.38$, (2) throw accuracy, $H(3)=1.77$, $p=.64$, (3) throw speed, $H(3)=1.46$, $p=.70$, and (4) test duration, $H(3)=0.90$, $p=.83$. Similarly, no differences were found between selected and not-selected players, (1) expert ratings, selected: $H(3)=0.95$, $p=.83$, not-selected: $H(3)=4.39$, $p=.22$, (2) throw accuracy, selected: $H(3)=0.22$, $p=.98$, not-selected: $H(3)=3.35$, $p=.35$, (3) throw speed, selected: $H(3)=1.48$, $p=.71$, not-selected: $H(3)=1.51$, $p=.68$, and (4) test duration, selected: $H(3)=2.94$, $p=.42$, not-selected: $H(3)=4.46$, $p=.22$.

Discussion

Analyses indicated very little difference among the birth quartiles for the study outcomes (height, weight, or technical skills). Furthermore, these variables did not differentiate who was selected versus who was not-selected. While these results are intriguing from a theoretical point of view, one main methodological limitation in this study needs to be considered that warrants caution in our discussion of the results. The sample size of this study was rather small, which resulted in cell sizes of five or less especially for the relatively younger and selected athletes. This small number is reached even without differentiating between genders, a known moderator of RAEs (Cobley et al., 2009; Schorer, Cobley, et al., in press). For the comparisons of birth quartile distributions to normal distributions these limitations are not as important as for testing the difference hypothesis on physiognomic factors (Malina, 1994; Malina et al., 2004; Norikazu et al., 2007) and technical skills (Schorer, Cobley, et al., in press).

Based on the limitations noted above, a replication of this study was needed with a larger number of participants. While replications are often not seen as an attractive alternative for researchers, their necessity for the consolidation and improvement of a scientific disciplines is unquestionable (Amir & Sharon, 1990). We undertake this task in Study Two.

Study 2

The national handball try-outs in Germany provide the opportunity to collect data from up to 480 young athletes. Out of this sample, up to 80 players are chosen for a second selection camp out of which the German national youth team is selected. This larger sample should allow for hypothesis testing inferential statistics, at least for the combined data set.

The aims of Study Two were the same as in Study One. We investigated whether a sample of female and male players considered for the youth national team would show an overall RAE and whether body seize and technical skill measures would differ between relatively older and younger athletes or predict who was selected for the National team. In addition to these objectives from the first study, we examined differences between male and female sub-groups. Based on the preliminary research done to date (i.e., Baker & Logan, 2007; Schorer, Cobley, et al., in press) and similar to Study 1, we hypothesized that the sample would show an overall relative age effect and that the relatively youngest players would have higher scores in technical skills and the relatively older ones would have larger body seizes. We also hypothesized that these effects would be smaller in female than in male players.

Methods

Athlete data were acquired during the 2009 try-outs for the female and male German national youth teams. Participants in these camps were between 13-15 years of age and most of them passed through two previous selection levels (district and region/state). Their height ranged from 1.53-1.86m for the female players and from 1.62-1.98m for the males. Their body mass ranged from 43-85kg and from 55-106kg for the females and males respectively. By the end of these try-outs, lists of female and male candidates for the national youth teams were aggregated. For this study, 238 female and 240 male athletes provided their birth-date, height (in cm), and weight (in kg). To test for RAEs, birth-months of the players were re-coded to reflect the athlete's birth quartile (Q). Similar to Study One, quartiles were calculated as Q1: January-March, Q2: April-June, Q3: July-September; and Q4: October-December and comparisons were drawn on the assumption of an equal distribution (Cobley et al., 2008; Schorer, Baker, et al., in press). Chi-square analyses were conducted to test for differences in quartile distributions among the overall sample as well as between players selected for the second national selection level and those not selected. Additionally, the technical skill test described in Study One was performed by 469 out of the 478 try-outs participants. Nine participants were not able to fulfil this test due to injuries. Due to the amount of time necessary to evaluate the technique of the throws it was impossible to conduct this rating during the try-outs. Therefore, only accuracy and mean speed of throwing were utilized as dependent variables for the technical test.

Results

As in Study One, results are presented in three main sections: overall RAEs, differences between the birth quartiles for height and weight, and differences for technical skills (i.e., throwing speed, throwing accuracy, and test duration). In each section we also consider males and females separately.

As expected, significant overall RAEs were revealed, $\chi^2(3, n=478) = 41.72$, $p<.01$, $w=.29$. As can be seen in Figure 3, RAEs were also found in the female, $\chi^2(3, n=238) = 20.49$, $p<.01$, $w=.29$, and male sub-groups, $\chi^2(3, n=240) = 24.23$, $p<.01$, $w=.32$.

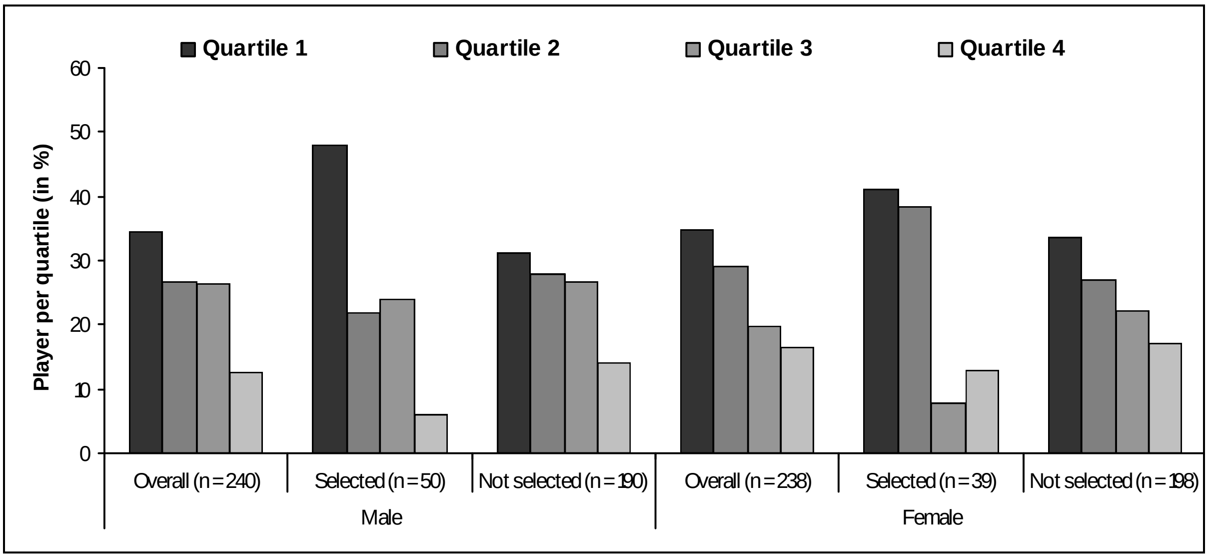

Figure 3. Distribution of male players' birth quartiles (left side) overall (n=240) as well as differentiated between selected (n=50) and non-selected (n=190) and female players birth quartiles (right side) overall (n=238) as well as differentiated between selected (n=39) and non-selected (n=198) for study 2.

Differentiating between selected and not-selected female players, significant differences from the equal distribution were found for both selected, $\chi^2(3, n=39) = 13.82$, $p<.01$, $w=.59$, and not-selected players, $\chi^2(3, n=199) = 11.99$, $p<.01$, $w=.24$. Comparing the distributions of the not-selected players against the selected players, significant differences were also found, $\chi^2(3, n=199) = 65.81$, $p<.01$, $w=.41$. Considering male athletes, significant differences from the normal distribution were revealed for selected players, $\chi^2(3, n=50) = 18.00$, $p<.01$, $w=.60$, and not-selected players, $\chi^2(3, n=190) = 12.53$, $p<.01$, $w=.26$; further, significant differences were also found between these distributions, $\chi^2(3, n=190) = 36.36$, $p<.01$, $w=.39$.

Because there were few players in the third and fourth quartile for the selected players (as small as only 3 players), only differences between quartiles in the combined group were considered for height, weight and technical skills. For the physiognomic variables Kruskal-Wallis-tests revealed no significant differences between birth quartiles for height, $H(3)=1.00$, $p=.80$, or for weight, $H(3)=0.72$, $p=.87$, for males. As can be seen in Table 1, similar results were found for the females. There were no significant differences between birth quartiles for height, $H(3)=1.32$, $p=.72$, or for weight, $H(3)=0.57$, $p=.90$.

For males, no significant differences between groups could be revealed for mean speed of throws, $H(3)=3.72$, $p=.29$, and accuracy of throwing, $H(3)=1.55$, $p=.67$. For females, no significant differences between birth quartiles were revealed for mean speed of throws, $H(3)=2.08$, $p=.56$, or for accuracy of throwing, $H(3)=2.79$, $p=.43$.

Table 1. Comparison of means (standard deviations) per birth quartiles concerning height (in m), weight (in kg), accuracy of throws (n out of ten), and mean speed of throw (in km/h).

Gender	Dependent variable	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Male	Height	1.82 (0.07)	1.81 (0.07)	1.82 (0.07)	1.81 (0.06)
	Weight	75.3 (8.6)	74.5 (7.8)	74.7 (9.9)	74.3 (7.7)
	Accuracy of throwing	3.81 (1.96)	3.66 (1.71)	3.47 (1.81)	3.38 (1.54)
	Mean speed of throws	63.7 (6.8)	64.8 (7.3)	62.3 (6.4)	64.8 (8.4)
Female	Height	1.68 (0.06)	1.67 (0.07)	1.67 (0.06)	1.67 (0.07)
	Weight	61.3 (7.4)	60.7 (7.1)	61.1 (7.7)	60.8 (8.1)
	Accuracy of throwing	3.97 (1.78)	3.66 (1.82)	3.38 (1.67)	3.71 (1.66)
	Mean speed of throws	54.3 (5.5)	54.3 (5.7)	53.8 (5.5)	52.8 (5.1)

Discussion

As expected (Schorer, Cobley, et al., in press), young handball talents showed a general relative age effect; however, contrary to our hypotheses, there were no relative age differences in any of the player-specific outcomes examined in this study. Players across the birth quartiles were similar in height, weight, and technical skills (i.e., test duration, expert rating, throw speed and accuracy). Moreover, there were no differences between players selected for the national youth team and those not selected.

While we were able to overcome one of Study One's limitations by differentiating between genders, the small number of selected athletes limited the sophistication of our analyses. As in Study One, the cell sizes for the third and fourth quarter within the selected male and female groups became too small to conducted differentiated parametric analyses. An attempt to use data from the previous selection year was not possible, because the technical test was altered for the selection of 2009. This analysis may be possible in the future, provided the test remains constant for the next two to three years. By choosing random comparison samples, null-hypothesis testing – as suggested by our results – should be possible.

General Discussion

Taken together, results from these studies support previous work (e.g., Cobley et al., 2008; Schorer, Cobley, et al., in press) suggesting that the primary mechanism driving relative age effects acts early in the athlete development process and that latter levels of selection, such as being selected for the national youth team, do not add to the effect. If this result bears out in further research, it provides important information for reducing or eliminating relative age effects. Specifically, that the earliest levels of talent identification and selection need to be targeted and modified to provide a more balanced selection process.

On the other hand, these results do little to explain the preliminary work by Baker and Logan (2007) as well as by Ashworth and Heyndels (2007) indicating that relatively younger athletes are more highly valued than their relatively older counterparts. The clear similarities among the birth quartiles in this study indicates either that relatively younger athletes are superior on some other outcome not measured in this study (e.g., tactical or decision-making skill) or that a similar advantage for relatively younger athletes is not present in handball (which would be contrary to Schorer, Cobley et al., in press). Both explanations might be influenced by missing moderator variables. Playing position, for instance, has been seen as important for understanding the RAE in handball (Schorer, Cobley, et al., in press), soccer (Ashworth and Heyndels, 2007) and ice hockey (Edwards, 1994; Grondin & Koren, 2000). As a result, the expected difference between relatively younger and relatively older would need to be considered relative to playing position, which, unfortunately, was not possible with the sample investigated here.

It is also possible that a very homogenous group of players is being considered as 'talented' right from the first regional level of selection (which in handball occurs around 10 years of age). As the present results indicate, they have similar stature and weight (similar results have been noted in ice-hockey by Baker, Cobley, Montelpare, Wattie, & Faught, in press; Sherar et al., 2007). It is possible that compensation for the relatively younger occurs during earlier selection levels since the developmental differences are typically much larger pre-puberty than post-puberty. Additionally, it would be helpful to expand the measures of growth and maturation beyond simple measures of height and weight to more objective measures of biological maturity. These measures would rule out whether relatively younger athletes are simply maturing more quickly than their relatively older peers.

Another reason for the homogeneity of the groups in technical skills might be the consistency in types and amounts of training after the first selection. As Helsen et al. (1998) hypothesized more qualified training on technical skills might happen in their selection team training resulting in similar movement patterns for the players, although the 'homogeneity of training' hypothesis does not explain the results by Baker and Logan (2007) or Ashworth and Heyndels (2007). Furthermore, observation of individual players at most levels of play clearly suggests a degree of individual difference even among players with the same coach (reflecting a given coach's 'signature'). It is possible that the technical skill examined in the present study (throwing) was too simple and as a result a large degree of homogeneity across the birth quartiles is not surprising. Future work may consider more sophisticated measures of technical skills to consider whether these differences are affected by RAEs.

Overall, future studies considering differences between relatively younger and older athletes should investigate the very first selection level, to investigate why relatively younger athletes are selected for further talent developmental programmes as well as later levels of selection to determine why specific selection decisions are being made. Especially helpful would be longitudinal data showing the development of technical as well as perceptual and tactical skills in players across the selection process. From a broader perspective, recent studies (including the data presented here) reinforce the need for a more elaborate theory of RAEs, which considers the complex interaction among moderator variables and main effect predictors. A comprehensive understanding of this phenomenon would facilitate behavioural and policy changes to eliminate this inequality.

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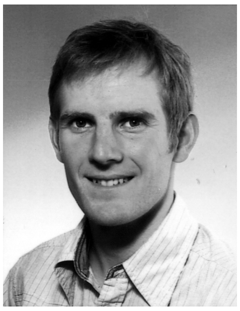

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