The Role of Growth and Maturation during Adolescence on Team-Selection and ShortTerm Sports Participation

Running title: Growth, team selection and sports participation

List of authors: Adam D.G., Baxter-Jones[1], Erin N., Barbour-Tuck[1], Donovan Dale[1], Lauren B. Sherar[2], Camilla J. Knight[1], Sean Cumming[2], Leah Ferguson[1], Kent Kowalski[1], Louise Humbert[1]

[1]College of Kinesiology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. Email: e.barbourtuck@usask.ca, d.dale79@gmail.com, leah.ferguson@usask.ca, louise.humbert@usask.ca, baxter.jones@usask.ca

[2]National Centre for Sport and Exercise Medicine School of Sport, Exercise & Health Sciences, Loughborough University, Loughborough, U.K. Email: L.B.Sherar@lboro.ac.uk

[1] School of Sport and Exercise Sciences, Swansea University Bay Campus, Swansea, U.K. Email: c.j.knight@swansea.ac.uk

[2] Department for Health, University of Bath, Bath, U.K. Email: S.Cumming@bath.ac.uk

Abstract

Background: During adolescence, deselection from sport occurs during team try-outs when month of birth, stage of growth and maturation may influence selection.

Aim: The purpose of this study was to identify differences in growth and maturity related factors between those selected and deselected on to youth sports teams and identify short-term associations with continued participation.

Subjects and methods: Eight hundred and seventy participants, aged 11 to 17 years, were recruited from six sports tryouts in Saskatchewan, Canada: baseball, basketball, football, hockey, soccer and volleyball. 244 of the initial 870 (28%) returned for follow-up at 36 months. Chronological (years from birth), biological (years from age at peak height velocity (APHV)) and relative (month of birth as it relates to the selection band) ages were calculated from measures of date of birth, date of test, height, sitting height and weight. Parental heights were measured or recalled and participants adult height predicted. Reference standards were used to calculate zscores. Sports participation was self-reported at try-outs and at 36-month follow-up.

Results: There was an over representation of players across all sports born in the first and second quartiles of the selection bands ($p < 0.05$), whether they were selected or deselected. Z-scores for predicted adult height ranged from 0.1 (1.1) to 1.8 (1.2) and were significantly different between sports ($p < 0.05$). Height and APHV differences ($p<0.05$) were found between selected and deselected male participants. In females only weight differed between selected and deselected female hockey players ($p < 0.05$); no further differences were found between selected and deselected female participants. Four percent of deselected athletes exited sports participation and 68% of deselected athletes remained in the same sport at 36 months, compared with 84% of selected athletes who remained the same sport.

Conclusions: It was found that youth who attended sports team’s try-outs were more likely to be born early in the selection year, be tall for their age, and in some sports early maturers. The majority of both the selected and deselected participants continued to participate in sport 36 months after try-outs, with the majorly continuing to participate in their try-out sport.

Key words: children, youth, relative age effect, talent identification, exercise

Introduction

According to the 2018 ParticipACTION Report Card on Physical Activity for Children and Youth in Canada, 76% of 11-15 year olds participated in organized sport (ParticipACTION Canada 2018). Although, many young children have the opportunity to participate on inclusive community recreational sports teams, by adolescence team selection becomes less inclusive and relies mostly on selection at team try-outs. Deselection from school sports in Canada begins largely in grade 9 (13-14 years), as high school teams try to remain competitive. Many youth discontinue or quit sport during adolescence, sometimes because of being cut from a sports team (Fraser-Thomas et al. 2008; Gleddie et al. 2019). However, questions have arisen over the lack of due consideration to the potential impact of key growth and maturation processes occurring during adolescence on the selection process (Vaeyens et al. 2008), and the consequences on sports participation for those deselected from sports teams.

There is a long history of selecting children to sports teams according to chronological age (CA) bands, over either 12 or 24 months (Crampton 1908; Cumming et al. 1972; Goldberg & Boiardo 1984; Baxter-Jones 1995; Rogol et al. 2018). For example, an under 15 team will be made up of 13 and 14 year olds, an under 13 team, 11 and 12 year olds, etc. The assumption underlying this grouping method is that adolescents of similar ages will be of similar sizes and abilities and will thus receive age-appropriate instruction and be evenly matched in competition (Malina et al. 2019). In practice, this is rarely the case, as a child born within the first month of a 24-month age band will have up to 23 months more growth and maturation than a child born in the last month of the same age band. This difference of age between individuals in the same age band is referred to as a relative age (RA), and its consequence is known as the relative age effect (RAE) (Musch & Grondin 2001). Concerns have been expressed as to whether CA bands are optimal, or appropriate, for adolescent competition (Baxter-Jones 1995; Rogol et al. 2018), particularly during the years surrounding puberty when children of the same CA can be up to five years in difference in biological maturity (e.g. years from age at peak height velocity (APHV)), termed biological age (BA). The idea of using BA rather than CA bands has been termed bio-banding (Rogol et al. 2018; Malina et al. 2019).

Advanced BA is accompanied by morphological and physiological advantages in outcomes such as height, weight, heart volume, lung function, aerobic power, and muscular strength, to name but a few (Baxter-Jones 1995). Disregarding BA in the process of selection can results in youth being chosen not so much for their skills but for their size and/or fitness in comparison to their teammates; a combination of their genetic potential and their growth and maturity status. The bias found in youth sports, particularly males sports, favoring taller, and stronger athletes, means that the individual with greater biological ages are more likely to be selected on to sports teams (Malina 1994). The greater size and strength of later versus earlier maturing adolescents may mask, or be mistaken for, greater sport specific skill (Armstrong 2017). In other words, youth sports participants with a later relative age (born later in the selection period) and/or later maturation (younger BA at a given CA) are more likely to be deselected, even if they have the greatest potential for that sport (Malina et al. 2019).

It is unknown if being selected or deselected for a team influences short-term (over 36 months) or even long-term (cessation of involvement in sport over the entire life period) participation in that sport. This is concerning as long-term participation in sport is known to have physical, social and psychological benefits (Stryer et al. 1998; Biddle 2003; Warburton et al. 2006; Moeijes et al. 2019). For example, sports participation and physical activity have been shown to increase positive mood, lower anxiety increase positive self-perceptions, and enhance self-esteem (Biddle 2003; Fox 2003; Veliz & Shakib 2012). Unique to sporting situations is the ability to foster the development of skills in the areas of self-discipline, competitiveness, sportsmanship, leadership, self-confidence, and coping with success as well as adversity (Stryer et al. 1998). Child and youth athletes also have higher levels of aerobic power and muscular power, and lower body fat than their non-athletic counterparts (Baxter-Jones & Helms 1994), all characteristics that contribute to long-term cardiovascular health. As such, there is a need for a better understanding of the role of team selection on continued participation or exit from sport.

Further research on the influences of birth month, growth and maturation on youth sport selection is warranted, as is the consequences of such selections on future sports participation. Therefore, this study aimed to identify if there were differences in birth month, growth and maturity factors between boys and girls selected and deselected on to provincial sports teams. In addition, the relationship between selection and deselection on continued participation in that sport was investigated. It was hypothesized that those selected would be born early in the selection band, be older and more mature and would be more likely to remain in the sport.

Methods

Participants

Participants were involved in the Saskatchewan Sports Participation Study (2013-2017). In 2013, through consultation with Sask. Sport Inc., six sporting bodies were recruited: (i) Saskatchewan Hockey Association; (ii) Saskatchewan Soccer Association; (iii) Basketball Saskatchewan; (iv) Baseball Saskatchewan; (v) Saskatchewan Volleyball; and (vi) Football Saskatchewan. Between February 2014 and February 2015 recruitment took place at: (i) male and female hockey Bantam camps (U-15); (ii) male and female high performance development stream soccer camps (U-12, U-13, U-14 and U-15); (iii) male and female basketball provincial team try-outs (U-15); (iv) male baseball bantam selection try-outs (U-15); (v) male and female volleyball high performance program camps (U-15, U-16 and U-17); and (vi) male Team

Saskatchewan Selection camp (U-16). All sporting associations used Dec 31st as their cut-off dates for age bands.

Recruitment and baseline assessment occurred at the selection camps. The sporting bodies provided lists of names of those selected for teams. Follow-up data were collected at 36 months through online or mailed out questionnaires, or by telephone assisted questionnaires. Thirty-six months was chosen as this was the duration of the funding provided. Individual's who appeared at more than one sport try-out camp were asked to identify their main sport and their data collected at other sport try-outs was excluded.

Data was collected on participant demographics, anthropometrics and parental heights at baseline. At baseline and 36 months the self-report Sports Participation Activities (SPA) questionnaire was administered. Child assent and parental consent were obtained for all participants included in the study and all procedures were approved by the University of Saskatchewan Behavioural Research Ethics Board.

Eight hundred and seventy participants were recruited across all the sports try-outs: 393 hockey players (269 male and 124 female); 138 soccer players (74 male and 64 female); 86 basketball players (51 male and 35 female); 100 volleyball players (35 male and 65 female); 78 male football players; and 75 male baseball players. Athletes were between the ages of 11-17 years at baseline.

Follow-up data was obtained from 28% of the sample at 36 months: 244 subjects, 89 hockey players (50 male and 39 female); 48 soccer players (23 male and 25 female); 27 basketball players (14 male and 13 female); 36 volleyball players (11 male and 25 female); 26 male football players; and 18 male baseball players.

Chronological age

Chronological age (CA) was calculated by subtracting the date of birth from the date at try-out. CA categories were constructed using 1-year intervals from the midpoints of the age; for example, the 10-year age group included participants from 9.50 to 10.49 years of age.

Biological age

A biological age (BA) was identified by predicting the years from attainment of peak height velocity (PHV). PHV is a somatic maturation milestone found in both males and females. To predict when PHV would occur a maturity prediction equation from anthropometric measures was used (Mirwald et al. 2002); based on age, sex, height, sitting height and weight. The age from PHV, or maturity offset, estimates how many years the subject is from his or her age-atPHV. A positive (+) maturity offset represents the number of years the participant is beyond PHV, whereas a negative (–) maturity offset represents the number of years the subject is prior to PHV. BA categories were constructed using 1-year intervals such that the -1.0 BA category included those with a BA of -1.51 to 0.49.

Relative Age

Chronological age cut-off (month of birth) were identified for each team. Months of birth were quartiled for both 12 month and 24-month age bands. For example, if the team used a 12month age band with a cut-off of January 1, then the first quartile one would contain athletes born between January 1 and March 31. For a 24 month age band then the first quartile would contain athletes born between January 1 and June 30 of the first year.

Anthropometry

Height, sitting height and weight were collected following the protocols of the International Society for the Advancement of Kinanthropometry (Ross & Marfell-Jones 1991). Using a portable stadiometer (Seca Portable Stadiometer, Hamburg, Germany) height and sitting height were measured in participants, without shoes, holding their heads in the Frankfurt plane, with a precision of 0.1 cm. Body weight (kg) was measured with children in light clothing and with a 0.1 kg precision using a portable digital scale (Toledo Scale Company, Thunder Bay, Ontario, Canada). All measures were performed twice and a mean calculated; a third measurement was taken if there was a difference of more than 0.1 cm or 0.4 kg. Using reference data from the World Health Organization's 2014 Canadian data (World Health Organization 2014), each participant's height and weight were normalised by calculating z-scores.

Parental heights were collected by direct measurement at tryouts or self-report at tryout or via correspondence. Self-report parental heights were corrected for the over-estimation commonly seen when reporting heights using the following equations:

male $y= 2.316 + 0.955x$ female $y=2.803 + 0.953x$, with y the adjusted value in inches and x the self-reported height measurement in inches

(Epstein et al. 1995).

Predicted adult height was estimated using (i) mid-parental heights (Tanner et al. 1970):

male = ((mothers height (cm) + 13 cm) + (fathers height (cm))/2 female = ((mothers height (cm)) + (fathers height (cm) – 13 cm))/2 and (ii) the Khamis-Roche Method (Khamis & Roche 1994) using the following equation:

Predicted adult stature = $\beta_0 + \beta_1$ stature + β_2 weight + β_3 mid-parent stature

Where β_0 is the intercept and $\beta 1$, β_2 and β_3 are the chronological age grouped coefficients found in the tables reported by Khamis and Roche (1994).

Analyses

The data are expressed as means and standard deviations. Distribution of birth dates by quartiles were investigated by chi-squared goodness of fit tests to assess for bias towards the first quartiles of months of birth, using either 12 or 24 month bands. Independent t-tests and ANOVA were used to determine group differences. Statistical analysis was performed using a commercial software package (SPPS 25, IBM). $P < 0.05$ was considered statistically significant, unless otherwise noted.

Results

When considering the entire sample, more participants were born within the first two birth months quartiles (i.e. first 6 months of a 12 month band or first 12 months of a 24 month band) ($p<0.05$); graphically displayed in figure 1 for selected and deselected participants. In both groups there was a significant overrepresentation of the first two birth month quartiles ($p<0.05$). The distributions of birth month quartiles for each sex, sport and age group are shown in Tables 1 and 2. Significant skewness in birth month distributions were found in both age groups of male hockey players ($p<0.05$), selected football and volley players ($p<0.05$) and deselected baseball players ($p<0.05$). In females the only significant differences in birth month distribution were found in both selected and deselected hockey players ($p<0.05$).

(Figure 1 here)

(Tables 1 and 2 here)

Tables 1 and 2 show the means and standard deviations for growth parameters for males and females respectively. Selected male hockey players (Table 1) reached APHV earlier than those who were deselected ($p<0.05$) and were predicted to have a greater adult stature ($p<0.05$). Selected female hockey players (Table 2) had greater weight and predicted adult stature than deselected players ($p<0.05$). Selected male basketball players were taller, heavier, older, had taller fathers and had an earlier age at PHV ($p<0.05$). The only difference found in female basketball players was that selected individual's fathers were shorter than deselected players father's ($p<0.05$). No differences were found between selected and deselected female soccer players. Selected male U15 were younger and shorter than those deselected ($p<0.05$), whereas U17 selected male volleyball players were chronologically older, reached PHV earlier and were taller ($p<0.05$) with greater predicted adult stature ($p<0.05$) compared to deselected U17. Selected U16 male volleyball players had earlier predicted age at PHV, were taller than reference norms and had greater predicted stature ($p<0.05$). No significant differences were found between selected and deselected female volleyball players try-out groups ($p>0.05$). Selected male baseball and football players had earlier ages of PHV ($p<0.05$) and selected football players were found to be chronological older, taller and heavier ($p<0.05$), compared with deselected players.

Thirty-six months after the try-outs it was found that 4% of the deselected participants no longer participated in any sport, compared to 1% in the selected group. Of all the participants attending try-outs, 81% identified the try-out sport as their main sport in which they participated. In contrast at 36 month follow-up, 75% of all participants continued to identify the try-out sport as their main sport. Comparing between selected and deselected participants at follow-up it was found that 84% and 68% respectively identified the try-out sport to still be their main sport. Specifically in selected athletes, participation in their try-out sport had increased at follow-up compared to try-out, in soccer (96% at 36 months compared to 84% at baseline), volleyball (90% at 36 months compared to 75% at baseline), basketball (100% at 36 months compared to 83% at baseline) and football (57% at 36 months compared to 51% at baseline). In contrast, selected hockey (86% at 36 months compared to 89% at baseline) and baseball (33% at 36 months compared to 89% at baseline) players showed a decrease in the percentage of participants claiming it was their main sport at follow-up compared to try-outs. In those participants who were deselected, the percentage identifying their main sport to be the same at follow-up as at tryouts dropped in soccer (79% at 36 months compared to 88% at baseline), volleyball (71% at 36 months compared to 84% at baseline), hockey (79% at 36 months compared to 85%t baselin), basketball (75% at 36 months compared to 76% at baseline) and baseball (13% at 36 months compared to 78% at baseline) but had increased in football (56% at 36 months compared to 31% at baseline).

Discussion

This study aimed to identify differences in birth month, growth and maturity factors between individuals selected and deselected on to provincial sports teams at team try-outs. It was found that a relative age effect (RAE) was present in all of the participants at the initial tryouts, with an over representation of those born within the first two quartiles of a selection band, regardless of being selected or deselected or the sport being banded by either 12 or 24 months. This RAE phenomenon was also observed in specific sex, sport, and age groupings. It was also found that all participants in the sample (both selected and deselected), apart from soccer players, were taller than reference averages for their age. In addition, there was an observed bias in selected male basketball, volleyball and football players in that they were chronologically older, taller and were more mature than deselected players. Chronological age and maturity status did not affect selection in female athletes. Only selected female hockey players demonstrated a size difference from deselected players. These results taken together suggest that both male and females with smaller age related stature, late maturation or whose birth month fell towards the end of the selection period were less likely to participate in team try-out for provincial sports teams; and that selection of more mature, older and larger individuals is sport specific, and more prevalent in male sports.

The continued participation in sport was also investigated, and it was found that a very small percentage of the deselected athletes were no longer participating in sport 36 months after the try-outs. Success at try-outs did not appear to be indicative of continued sports participation.

Maturation is accompanied by significant gains in size, physiological development and thus enhanced performance and the maturity-related gradient of selection/deselection in children's sports is well documented (Sherar et al. 2007; Malina et al. 2017). For example, advanced maturation has contributed to the selection of male youth soccer players, and exclusion of later maturing youth, beginning as early as 12 years of age (Malina et al. 2017). A similar maturational advantage for selection has been observed in elite male and female junior tennis players, and male youth hockey players (Sherar et al. 2007; Myburgh et al. 2016). The current findings affirm this same bias in selected male hockey, basketball, U16 volleyball, baseball and football players who were all determined to have earlier ages of PHV, and were thus more mature for their CA, than their deselected counterparts. Maturation likely contributed to the greater height and/or weight in selected male football players, basketball and volleyball players. A size advantage, not attributable to advanced maturation, was found in selected female hockey players in the present study who were heavier but did not have a greater BA than deselected players. In contrast, selected male U15 soccer players were shorter than deselected players.

While the theory remains anecdotal, we suggest that this may be because in Saskatchewan, larger children and adolescents are recruited in to sports such as football, hockey and basketball resulting in more skilled smaller soccer players. This may be because soccer has not achieved the same level of popularity in Saskatchewan as other male sports such as hockey. In Europe, where men's soccer is more popular, the results of team soccer tryouts show similar trends to those of

Canadian hockey tryouts (Helsen et al. 2005; Sherar et al. 2007), and current findings for hockey and football.

Other than in female hockey, there were no maturational or size differences identified between selected and deselected female sport participants. One reason why we may not have found a maturity bias in female sports could be because of a lower competitive level of female sports (i.e. not as hard to get selected), or because males tend to be more competitive and motivated to win in a sports setting (Findlay & Bowker 2009; Deaner et al. 2015). Alternatively, the maturation-related physiological changes that occur in females (compared with males), such as increased relative fat mass, widening of hips, and breast development (Siervogel et al. 2003; Sherar et al. 2011; Barbour-Tuck et al. 2018), may not be conducive to performance and as such, later maturing or younger females may be equally selected as earlier maturing or older females.

A promising alternative to CA banding is bio-banding, an attempt to maturity-match athletes; based on, for example, percentage of adult height attained at tryouts (Malina et al. 2019). This type of maturity based banding is likely more important in male youth than female youth sports because of the higher prevalence of maturity-based selection in male sport. Biobanding also has the potential to mitigate the relative age effect (RAE) and the variance in skill within CA bands.

Training, competition and selection groupings are often based on specific birth date cutoffs that are used to categorize athletes into one – or two-year CA bands. Although the primary purpose is to avoid age differences during competition, children born shortly after the cut-off data are older than the late-born children in the same age band. It has been noted in many sports teams, both youth and professional, that birthdates are heavily skewed towards the beginning of the selection year. Potentially this is because relatively older players perform at a higher level, and because coaches tend to rate players born earlier in the selection year as having greater performance potential (Barnsley & Thompson 1988; Baxter-Jones & Helms 1994; Fumarco et al. 2017; Ibáñez et al. 2018; Figueiredo et al. 2019). Similar to more mature compared to less mature athletes, relatively older compared to relatively younger athletes have already undergone greater morphological and physiological changes, giving them an advantage in characteristics such as size, cardiovascular size and function, respiratory function, and muscular strength and power (Baxter-Jones 1995). The current study found a significant bias towards the first two birth month quartiles in selected male football and volleyball players, and female hockey players; and that selected male football, basketball and U17 volleyball players were significantly older than deselected players. Interestingly, the deselected male baseball players had a bias towards the first two quartiles. This may be because baseball is less popular or competitive and has a much shorter season in Saskatchewan than, for example, hockey, which has previously demonstrated strong bias towards older and more mature individuals (Sherar et al. 2007). Those participants who were selected for baseball may have been unsuccessful in hockey early on and thus became more committed to skill acquisition in baseball. Again, there were no differences observed between selected and deselected females with the exception of hockey players. This may be due to the timing of maturational and age related changes in females. Almost all of our female athletes were over the age of 12 (and most over the age of 14), an age when most females will have gone through peak height velocity (PHV) and other advantageous physiological changes, resulting in homogeneity of age- and maturity- related attributes between selected and deselected groups.

In the current study, it was also found that there was bias towards the first two birth month quartiles when sports, sex, and selected/deselected data was aggregated. This suggests that by the time of adolescent tryouts for provincial sport teams, RAE had likely already had a profound effect on youth sport participation. In other words, individuals with an early birth date quartile had already been preferentially selected, or self-selected for previous teams contributing to an overrepresentation in the current adolescent sample. For example, club soccer players in Saskatchewan are separated into “Premier”, “Division II”, and “Division III” teams as early as U11 (9 and 10 years of age). Either by coach-, parental- or self-selection, it is most likely that only those in the Premier and Division II league would attend a provincial tryout.

Time is the great equalizer and earlier maturation or advanced age that presents as greater size in adolescents, does not predict greater final adult height (Vizmanos et al. 2001). Only female hockey and male hockey players, and male basketball players in the current cohort are likely to have greater final adult stature as indicated by greater predicted adult stature, and greater paternal height respectively.

The physical and psychosocial benefits of sport involvement are well recognised (BaxterJones & Helms 1994; Biddle 2003; Fox 2003; Veliz & Shakib 2012). However, the large dropout rates from sports programs during adolescences has been identified by sports psychologist as an area of concern (Fraser-Thomas et al. 2008; Gleddie et al. 2019). Although numerous situational factors (e.g. as lack of playing time, program seriousness, motivation, etc.) have been cited among youths’ reasons for dropout (Gould et al. 1982), level of maturation is also known to contribute to dropout decisions, as does the result of being cut from a team (Fraser-Thomas et al. 2008). The physical affects for athletes who had been cut from a team seem largely dependant on whether or not the individual remained an athlete (Blinde & Stratta 1992). It is noted that deselected athletes rarely try out the following school year for the same team they were cut from, and that being cut deterred athletes from trying out for future teams in any sport (Gleddie et al. 2019). It has also been observed that physical activity levels decrease in students who have been cut (Gleddie et al 2019). These observations were not replicated in the present study. Two-thirds of deselected subjects continued to be involved in the same sport, 36 months after team deselection, with the majority of the other third changing sport. Only 4% of the deselected subjects were no longer involved in any sport at 36 month follow-up. Although exiting from sport was not an issue in the present study, the myriad benefits of sport participation suggests that those working with youth and youth athletes should concern themselves with caring for and supporting the physical, emotional and social well-being of their charges (Gleddie et al. 2019). Those who are cut from teams should be encouraged to continue participation in sport in some capacity.

Limitations and Future Direction

This study is unique in its survey of a diverse set of sports, the inclusion of males and females, and the 36 month follow-up, adding important information about the contributors and consequences of selection and deselection from a sports team. There are however, limitations to the study. The majority of the female participants were maturationally homogenous, being past the age of menarche and PHV, making maturational comparison difficult. Similarly, individuals trying out for provincial teams are likely to already be elite contributing to the homogeneity of the sample in terms of skills, abilities, maturation and sports experience. Future studies wishing to examine the influence of maturation in female sport selection should recruit individals before the age of pubertal onset, and the time at which tiered selection begins. Finally, while the overall samples size for the study was large, once split into sport, sex, and selection groups, each sample became much smaller, making it harder to find statistical significance between group means. The smaller sport-specific sample sizes also questions the generalizability of the findings and the ability of to make inferential conclusions.

Conclusion

The findings from this large and sports-diverse cohort study suggest that there is a selection bias towards more mature and larger individuals. This result varied by sport and sex, being more common in males and more specific to football, hockey, basketball and volleyball, than soccer and baseball. Furthermore, this bias appears to begin prior to the age of 11 years when provincial level try-outs start. This suggest that those attending try-outs are already a bias homogeneous sample and this may explain in part why selection had relatively little effect on sports participation 36 months later. Coaches should be aware that try-out participants show a basis in favour of being born within the start of the selection age band, are likely older, taller and more mature than individual who chose not to attend selection try-outs.

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Disclosure statement

The authors report no conflicts of interest.

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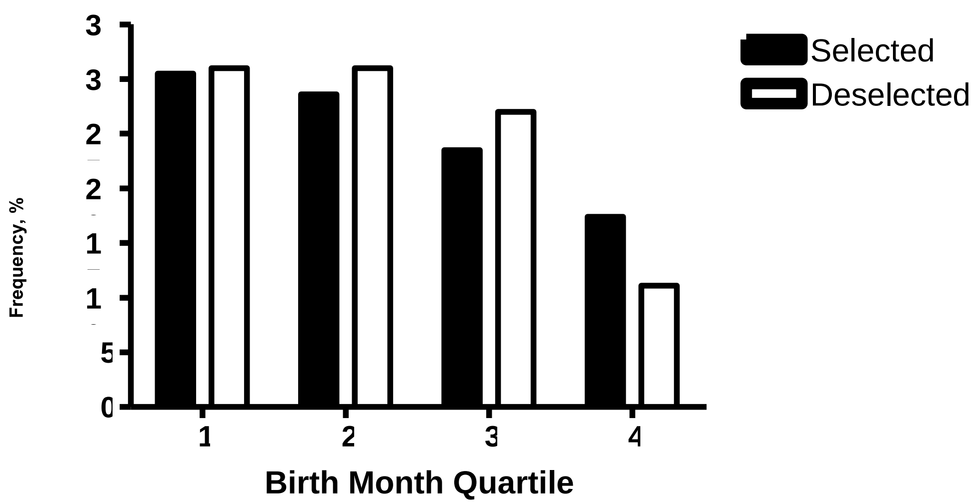

Figure 1: Distribution of birth month quartiles by team selection

Twelve month age-band: Birth month quartile 1=January 1st to March 31st; 2=April 1st to June 31st ; 3= July 1st to September 30th ; 4= October 1st to December 31st

Twenty-four month age-band: Birth month quartile 1= year one January 1st to June 31st ; 2= year one July 1st to December 31st ; 3= year two January 1st to June 31st ; 2= year two July 1st to December 31st

	Foot		Base		Soc								Volley					
	U1		U1		U1		U1		U1		U1		U1		U1		U1	
Desele	Select	Desele	Select	Desele	Select	Desele	Sele	Desele	Select	Desele	Sele	Desele	Select	Desele	Select	Desele	Select	Desele
3	4	3	1	6	6	2	2	5	7	7	2	4	1	4	5	4	4	0
14.2±	14.8±0.	14.5±	14.9±	14.9±	14.2±(	14.7±	13.7±	13.4±	12.7±	12.8±	14.9±	11.7±	16.8±(	16.7±	15.5±	15.9±	14.9±	
13.6±	13.1±0.	13.5±	13.2±(	13.6±	14.1±	13.7±	14.1±	14.0±	13.3±(	13.9±	13.2±	13.8±	13.6±(	13.8±	13.4±0.	13.8±	13.2±	
170.9±	176.7±1	170.7±	176.7±	173.8±	163.1±	172.4±	160.7	159.5±	163.7±	155.5	176.7	145.0±	186.2±	179.5±	*186.2±*	175.4	181.7±	
0.8±	1.2±0.	0.8±	1.1±	0.7±	-	0.6±	-	0.1±	1.2±	0.1±	1.1±	-	1.5±	0.6±	1.9±0.	0.3±	1.63±	
61.8±1	76.6±1	67.4±	69.3±	65.7±	54.8±	61.9±1	47.5±	52.1±1	50.3±	44.6±	69.3±	45.4±	73.5±	72.0±1	72.3±	73.2±	67.3±	
0.9±	2.0±1.	1.2±	1.3±	0.9±	0.3±	0.6±	-	0.5±	0.8±	0.1±	1.3±	0.9±	0.9±	0.8±	1.2±	1.1±	1.0±	
178.5±	176.3±	176.1±	177.0±	177.1±	173.3±	175.3±	175.8	176.3±	173.9±	172.8	177.0	175.1±	181.5±	175.1±	182.9±	176.9	183.6±	
164.9±	166.6±	165.6±	168.9±	165.8±	164.6±	163.8±	162.6	163.2±	164.8±	163.2	168.9	165.1±	166.8±	166.1±	173.1±	169.3	169.3±	
178.3±	177.8±	177.2±	179.4±	177.9±	175.5±	176.1±	175.7	176.3±	175.9±	174.6	179.4	176.6±	180.6±	176.6±	184.5±	179.6	182.9±	
189.9±	189.5±	187.8±	189.8±	188.0±	182.5±	186.1±	185.0	185.3±	192.2±	185.3	189.8	184.7±	189.5±	183.7±	195.5±	184.1	195.0±	
19 /22/35. 4	14/2* /36/ 8	20 /25/19. 6	0 /42/2: 33	38/18/1	33 /0/17/ 50	23 /18/32/ 7	9 /43/2 19	0 /40/20. 40	0 /57/14 29	14 /57/29	50 /0/50. 0	25 /0/25/ 50	39/6* /44/ 1	25 /25/0/ 50	20 /40/0/ 40	25 /50/25/	15 /15/31. 9	

Table 1: Male

	Hock		Basket
	U1		U1
	Select	Desele	Select
n	11	15	1
Age	14.6±	14.7±	14.7±(
APHV	13.4±(	13.6±	13.1±(
Height	173.4±	171.9±	180.5±1
Height (z-	0.8±	0.6±	1.7±1.
Weight	66.7±	66.1±1	70.8±1
Weight (z-	1.1±	1.0±	1.6±1.
Fathers	177.4±	178.1±	178.1±
Mothers	165.9±	165.4±	165.7±
Mid-Parent	178.2±	178.1±	178.4±
Predicted Adul	188.7±	187.4±	192.8±
Birth month	33/23/1	31/21/1	22/7* /14/

** P<0.05 betwee

Soc								Volle					
U		U		U		U		U		U		U	
Sele	Desel	Sele	Desele	Sele	Desel	Sele	Desel	Sele	Desel	Sele	Desel	Sele	Desel
5	2	2	4	1	6	2	1	1	1	6	1	8	6
14.4	12.7	13.6	13.5	12.7	12.7	12.1	11.8	16.8±(	16.5	15.8	15.59	14.5	14.5
12.6	11.4	12.0	12.1	12.0	11.9	11.9	11.8	12.7	12.7	12.2	12.4	12.0	11.7
158.9	165.1	163.0±	160.4	157.7	158.9	155.(	154.1	175.9	172.0	175.	171.9	170.5	174.9
-	1.2±	0.6±	0.3±	0.2±	0.6±	0.6:	0.4±	1.9±	1.4±	1.8:	1.4±	1.3±	2.0±
54.7±	56.2±	55.6	53.6	47.1	49.2	45.2	45.7	67.1±	62.3	65.6	62.7	65.3	64.6±
0.3±	1.0±	0.6±	0.5±	0.0±	0.4±	0.4:	0.4±	1.4±	0.8±	1.2:	0.9±	1.4±	1.3±
176.7	179.3	176.6	178.7	177.3	178.1	173.:	177.3	182.9	181.4	186.:	181.2	180.4	183.6
163.5	165.4	164.3	166.8	168.1	163.2	174.	166.0	165.9	166.5	167.:	167.7	166.6	171.5
163.6	178.1	164.2	166.3	164.2	164.1	167.	165.2	170.2	167.5	170.:	168.0	166.9	171.0
167.2	180.6	173.8	173.0	175.4	175.	177.4	177.5	178.3	174.6	179.4	176.5	177.7	182.4
/0/0/	/0/10	/25/3:	/0/25/	/40/40	/17/17	/0/ 100/0	/30/5(	/15/31/	/43/21	/50/17	/12/25/	/12/63/	/50/17/

Table 2: Fem

	Hoc		Baske	
	U		U	
	Sele	Desel	Sele	Desel
r	7	5	1	2
Age	14.3	14.2	14.4	14.4
APHV	12.1	12.2	12.2	12.1
Height	165.3	163.5	166.8	166.2
Height (z-	0.7±	0.5±	0.9±	0.9±
Weight	61.5±8	56.2	60.8±	59.8
Weight (z-	1.1±0	0.5±	0.9±	0.9±
Fathers	178.6	177.5	176.6	181.1
Mothers	167.2	165.0	170.3	165.7
Mid-Parent	166.6	164.5	166.9	166.7
Predicted Ad	176.3±	173.24	177.4	174.7
Birth month	24/32/	18/28/	18/46/9/27	12/29/17/

** P<0.05 betw