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SPORTS PERFORMANCE

Performance, motivation, and enjoyment in young female basketball players: An interdisciplinary approach

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ABSTRACT

The purpose of this study was to examine the variation in accumulated basketball training experience, body size, functional performance, deliberate practice motivation, achievement and competitiveness motivation and sources of enjoyment among young female basketball players, partitioning the potential variation by individuals´ biological characteristics (menarche status) and contextual characteristics (competitive age group and competitive level). We considered 114 adolescent female basketball players aged 14.3 (1.8) years. We used multilevel regression and poststratification estimations. The adolescent female basketball players selected for state-level had more accumulated experience, were taller and with better functional performance. Conditional on the data, youth female coaches tend to value (probably over-value) size and function when selecting/promoting players, even at early age groups, likely contributing to an overrepresentation of early maturing girls in at early age groups. Players from club- and state-level were similarly highly motivated for deliberate practice and to achievement. Only for competitiveness, state-level players had higher values than club level players. The sources of enjoyment were influenced by context (competitive levels) for self-referenced competencies and others-referenced competencies. Structured programs of training and competition in youth female basketball provide a nurturing environment for the development of players´ engagement and commitment to training and excellence attainment.

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KEYWORDS
Young players; maturation; multilevel modelling; Bayesian methods

Introduction

A key question for researchers, coaches and governing bodies is "what is it that characterizes those who succeed?" (Elferink-Gemser et al., 2007). This question is frequently addressed at early stages of the development of children and adolescents engaged in organized training programs deliberately focused on training and development in that sport. It is often considered that specialization years are a decisive moment to lift an athlete's skill level, readiness and commitment (A. B. De Bruin et al., 2007; Gonçalves et al., 2011). However, this perspective tends to be exclusive and is applied to only a minority of the participants in youth sports structured programs.

It is generally assumed that the expertise attainment in sport is positively related to the accumulated number of hours of practice (J. Baker & Young, 2014; A. B. De Bruin et al., 2007; Gonçalves et al., 2011). Hence, the decision to persist engaged in youth sports organized programs is likely founded on a clear orientation towards competitive success and on a strong will to become an expert player, ready to practice at the standards of volume and intensity required by expert performance (Gonçalves et al., 2011). Given that young athletes are first of all adolescents, it may be reasonable to assume that achievement orientations and the will to become experts through deliberate practice may vary between players in contrasting competitive playing levels. Also, enjoyment in sports practice among young athletes may play a significant role in their engagement in practice to improve performance.

As organized youth sports entail a very structured selection process, early prediction of future outcomes and adult expertise attainment potential is aimed (J. Baker et al, 2018), and decisions are mostly based on physiological test performance (Pearson et al., 2006). However, the performance development of children and adolescent athletes is potentially influenced by a myriad of factors, including variability in growth and biological maturation or the complex environmental factors that may mislead the accuracy and specificity of most traditional physiological tests (Pearson et al., 2006). To examine variation between young players by their level of competition, research generally assumes unidisciplinary perspectives from either biological, psychological or behavioural variables, which is a clearly flawed approach (H. M. Carvalho et al., 2018). Interdisciplinary approaches are rarely adopted to interpret young athletes´ development, despite the longtime calls applied to talent identification and development (Johnston et al., 2018), and research in sports science (Burwitz et al., 1994; Piggott et al., 2018).

Even more when considering youth basketball, determinants of performance are multifactorial. It has been well

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documented about the importance of body size on playing positions and performance (E. J. Drinkwater et al., 2008). Basketball movement patterns involve high-intensity short-term activities, and intermittent in nature, such as sprinting, jumping or cutting (McInnes et al., 1995; Stojanovic et al., 2018). The physiological demands require both activities aerobic in nature (Ben Abdelkrim et al., 2007; McInnes et al., 1995), but also placing important energy demands on anaerobic metabolism. On the other hand, any sports context involves interpersonal interactions within it, as constrained by the organizational structure of the training and competition (Erickson & Cote, 2016). Hence, an interdisciplinary approach considering size, functional performance and behavioural attributes (and biological maturation in young athletes) will allow for a deeper understanding of players´ performance development and the path to expertise in basketball.

Available information with young athletes' development is mostly based on male populations, despite generalized girls' participation in organized sports (Johnston et al., 2018). Particularly with female adolescent basketball players, the limited data available considers mainly anthropometric and physiological attributes (Hoare, 2000; Montgomery et al., 2008). In this study we assumed an interdisciplinary approach to examine young female athletes' functional and behavioural characteristics, accounting for variation by age group, menarcheal status, and competitive level.

Finally, research questions and designs (e.g., limited sample size within a team or competitive level; Höner & Feichtinger, 2016), frequent small true between-individual variation at different levels (e.g., between individual differences in maturity status or training experience within a narrow age group or team of adolescent players) are often overlooked in sports science. The analysis and interpretation in sports science research are often dealt with traditional single-level approaches and using frequentist methods, albeit its limitations being been noted is several scientific areas (A. Gelman & Shalizi, 2013). As previously noted (H. M. Carvalho et al., 2018), multilevel regression modelling provides a flexible and robust alternative that intuitively considers the hierarchical data structure (A. Gelman & Hill, 2007). Moreover, estimations of small groups' characteristics within a higher level of observations may be improved upon the consideration of all data available. For this, better estimates and predictions may be derived using poststratification based on the multilevel regression models (A. Gelman & Hill, 2007; A. Gelman & Little, 1997), where information is partially pooled across similar groups, providing then aggregate estimations for a target population (A. Gelman & Hill, 2007), with limited or even non-existent data (Ghitza & Gelman, 2013). From a Bayesian perspective, model fit comprises samples from the joint posterior density of the parameters (McElreath & Koster, 2014). The interpretations use probabilistic of these parameters to simulate predictions and assess the quality of the model fit to data (McElreath & Koster, 2014). For multilevel model estimations, Markov chain Monte Carlo (MCMC) is used, which is generally superior to maximal likelihood methods (Bolker et al., 2013).

In the present study, we examined the variation in years of accumulated training experience, body dimensions, functional performance, deliberate practice motivation, achievement and competitiveness motivation, and sources of enjoyment among young female basketball players within and between age groups, menarcheal status and competitive levels among the female adolescent basketball, partitioning the potential variation by individuals´ biological characteristics (menarche status) and contextual characteristics (competitive age group and competitive level). Furthermore, in the present study, we illustrate the use of multilevel regression and poststratification to estimate the variation in outcomes of interest accounting for cross-classified nesting, which is often the case in an applied youth sports context, i.e. within and between variation by age groups, menarcheal status, and competitive levels.

Methods

Study design and sample

This study was based on a cross-sectional design. A total sample of 114 adolescent female basketball players aged, on average, 14.3 (SD = 1.8) years, with a range between 10.0 to 17.9 years, was considered. The players were classified by competitive level as club- (n = 84) and state-level (n = 30) selected by coaches to compete in the state teams. The latter competed with their respective clubs during the season at a regional level competition and were included among state selections in the 2018 competitive season (it should be noted that competitive seasons in Brazil typically run between March until November). Player´s selection for the state level teams was performed by the respective state-level team coaches. Club level players were from under 13, under 15 and under 17 teams from clubs that competed at regional level competition supervised by either the *Associação Regional de Basquetebol* (ARB) and by the *Federação Catarinense de Basketball* (Basketball Federation of Santa Catarina). At the time of the study, all players trained regularly (~300–360 min/wk) over a 9-month season (March to November). No player was injured at the time of testing or self-reported to have any moderate or more severe lower-limb injury (i.e. more than 7 days elapsing from the date of injury to the date of the player's return to full participation in team training and availability for competitive game play) during 6 months before the testing.

The study was approved by the Research Ethics Committee of the Federal University of Santa Catarina and by the Research Ethics Committee of the University of Campinas. Participants were informed about the nature of the study, that participation was voluntary and that they could withdraw from the study at any time. Players and their parents or legal guardians provided written informed consent.

Procedures

Chronological age was calculated to the nearest 0.1 years by subtracting a birth date from the date of testing. Menarcheal status was obtained through self-reported age at menarche, via interview performed by the coaches (female coaches in all cases). Distance to age at menarche was calculated to the nearest 0.1 years by subtracting menarche date from the date of testing. Players were grouped into three groups of menarcheal status: early (n = 27), average (n = 8) and late (n = 12). Reference age at menarche (mean = 12.89 years, 95% CI: 12.68 to 13.09 years) for

Brazil population was estimated based on data from five studies, summarizing data recorded from 1972 to 1992 (Duarte, 1993), using Bayesian multilevel modelling to perform a meta-analysis. Players classified as having early or late maturation were those whose age at menarche was minus or plus one year from the mean of age at menarche for the Brazilian population. To the best of our knowledge the reference data, even if somewhat outdated, is the available data for the regions of the present sample. Hence, caution is warranted given the secular trend of declining age at menarche (Danubio & Sanna, 2008), likely associated with the potential influences of environmental sources on age at menarche, such as nutritional status, ethnicity, family size, socio-economic background, among others. (Al-Sahab et al., 2010; Gama, 2008; Tanner, 1962).

Years of experience in formal basketball training and age when players first took part in organized basketball practices were obtained by interviews of the players and confirmed with their coaches and parents.

Stature was measured with a portable stadiometer (Seca model 206, Hanover, MD, USA) to the nearest 0.1 cm. Body mass was measured with a calibrated portable balance (Seca model 770, Hanover, MD, USA) to the nearest 0.1 kg. Reliability estimates for the observer are published elsewhere (Soares et al., 2019).

To examine functional performance we used the vertical jump with countermovement (Bosco et al., 1983), a short-term maximal running protocol, the Line drill (LD) test (H. M. Carvalho et al., 2017; Semenick, 1990) and an intermittent endurance test, the Yo-Yo Intermittent Recovery Level 1 test (Yo-Yo IR1) (Bangsbo, 1994). We considered the sum of the z-scores as an estimate of overall performance, i.e., functional performance index (lower-limb explosive strength, agility, and anaerobic power, and intermittent endurance). Note that z-scores were reversed for the LD performance; as lower times indicate better performance. The vertical jump with countermovement was tested on a jump mat (Multisprint System, Hidrofit, Brazil). Players started from an upright standing position and were instructed to begin the jump with a downward movement, which was immediately followed by a concentric upward movement, resulting in a maximal vertical jump. During jumping, hands were held on the hips during all phases of the jumping. Vertical jump was recorded in centimetres. In the LD protocol players ran 140 m as fast as possible in the form of four consecutive shuttle sprints of 5.8, 14.0, 22.2 and 28.0 m within a regulation basketball court. Players began the test one metre behind the baseline of the basketball court, where a pair of photoelectric cells (Multisprint System, Hidrofit, Brazil) was aligned with the baseline. Time was recorded in seconds. The Yo-Yo IR1 protocol is based on repeated 2 x 20-m runs back and forth between the starting, turning, and the finishing line at a progressively increased speed controlled by audio bleeps from a tape recorder. The athletes have a 10-s active rest period between each bout, jogging at a distance of 2 x 5-m. Players ran until they were no longer able to maintain the required speed; the test was completed when athletes failed twice to reach the finishing line in time. The covered distance was measured in metres. Tests were performed in two sessions separated by at least 48 hours, where the first session included the vertical jump and LD test, and the second session the Yo-Yo IR1. A standardized warm-up was taken by all athletes before testing. Details about the functional performance procedures and reliability estimates are available elsewhere (H. M. Carvalho et al., 2018, 2019; Leonardi et al., 2018; Soares et al., 2019).

Psychobehavioural factors were assessed using the Work and Family Orientation Questionnaire (Helmreich et al., 1978), the Deliberate Practice Motivation Questionnaire (A. B. De Bruin et al., 2008), and the Sources of Enjoyment in Youth Sports (Wiersma, 2001). The Work and Family Orientation Questionnaire is composed of 19 items, rated on a 5-point Likert scale (1 = completely disagree to 5 = completely agree), assessing four dimensions of achievement: personal unconcern, work, mastery, and competitiveness. For the present study, we only used the last three subscales in the present study, consistent with previous observations with similar samples of youth basketball (H. M. Carvalho et al., 2018; Gonçalves et al., 2011; Soares et al., 2019). The Deliberate Practice Motivation Questionnaire was originally designed for chess (A. B. De Bruin et al., 2007, 2008). The questionnaire is composed of 18 items, similarly rated on a 5-point Likert scale, considering two dimensions of deliberate practice: will to compete and will to excel. We used an adapted version for basketball, translated and validated to Portuguese (Gonçalves et al., 2011). The reliability of the adapted Portuguese version has been reported with data in youth basketball from the same age range of the present study elsewhere (Gonçalves et al., 2011).

The Portuguese version (Santos & Gonçalves, 2012) of the Sources of Enjoyment in Youth Sport Questionnaire (Wiersma, 2001) was used in this study. The questionnaire has 28 items and examines five dimensions: self-referenced competencies, others-referenced competencies, effort expenditure, affiliation with peers and positive parental involvement. Each questionnaire item is rated on a 5-point Likert scale (1 = completely disagree to 5 = completely agree). The questionnaire showed good reliability (Santos & Gonçalves, 2012).

Data analysis

Modelling approach

We used multilevel regression and poststratification (A. Gelman & Hill, 2007) estimation to examine variation by competitive level and age group for chronological age, anthropometric dimensions, age at menarche, functional performance, motivation for achievement and competitiveness and sources of enjoyment in youth sports among the Brazilian female basketball players. The outcome of each player was estimated as a function of her individual characteristics, i.e. age group, menarcheal status, and competitive level (for player *i*, with indexes *j*, *k*, and *l* for age group, menarcheal status, and competitive level, respectively):

$$y_i = \beta^0 + \alpha^{age\ group}_{j[i]} + \alpha^{menarcheal\ status}_{k[i]} + \alpha^{competitive\ level}_{l[i]}$$

The terms after the intercept are modelled as group effects (also referred to as random effects) drawn from normal distributions with variances to be estimated from the data:

$$\alpha_{j[i]}^{age\ group} \sim N(0, \sigma_{age\ group}^2),\ \text{for}\ j = 1,\ 2,\ 3$$

$$\alpha_{k[i]}^{menarcheal\ status} \sim N(0, \sigma_{menarcheal\ status}^2),\ \text{for}\ k = 1,\ 2,\ 3$$

$$\alpha_{l[i]}^{competitive\ level} \sim N(0, \sigma_{competitive\ level}^2),\ \text{for}\ l = 1,\ 2.$$

Considering the influence of body mass and training experience on functional performance (H. M. Carvalho et al., 2018; Leonardi et al., 2018; Lolli et al., 2017), we added body mass and years of training experience as a population-level effect when modelling functional performance outcomes. As for psychobehavioural outcomes, we added years of training experience as a population-level effect. In these cases, we standardized all variables in the models for computational and interpretative convenience.

Prior distributions

We used non-informative priors for population-level effects and weakly informative prior distributions for group-level, normal priors (0, 2). The choice of priors was made to allow the models to converge. We also intended for the results to reflect the knowledge available on the data.

Model-checking and computation

We used posterior predictive checks to compare models estimates with observed data, to ensure we had not overfitted our data (Vehtari et al., 2016). For each model, we run two chains for 2,000 iterations with a warm-up length of 1,000 iterations. Bayesian estimations were implemented via R statistical language (R Core Team, 2018), with "brms" package (Bürkner, 2017) which call Stan (Stan Development Team, 2015).

Results

Descriptive statistics of young Brazilian female basketball players are summarized in Supplementary Table 1. Fourteen players had not attained menarche at the time of observation. There was no substantial variation in the outcome variables by menarcheal status. Hence, we report estimates based on models considering aggregation by age group and competitive level. Poststratified estimates and 95% credible intervals for young female players considering both competitive level and age groups are summarized in Table 1. An advantage of Bayesian methods lies in the possibility of direct probabilistic comparisons of the posterior estimates and respective credible intervals.

Conditional on the data, the posterior estimates showed no substantial differences for chronological age and distance to menarche, considering players by competitive level in each age group each. For accumulated training experience in basketball, state-level players had higher experience in all age groups. For body size, state-level players were slightly higher than club level players, about 5 cm across all age groups. No substantial variation was observed between competitive levels across the age groups.

Conditional on the data, it was apparent that state-level female players showed better performance for vertical jump, Line Drill test, Yo-Yo IR1 performance and overall performance score than club level players. Considering age variation between players (Table 1), standardized differences between players by competitive level were at least large (see Figure 3). However, when body mass and training experience were accounted for, standardized differences by competitive level become trivial. Particularly, years of experience had a substantial positive relation with Line drill performance (population-level estimate = −0.37, 95% CI: −0.59 to −0.15; note that a negative exponent indicates a better time performance). As for jump, intermittent endurance and overall performance score, standardized differences between players by competitive level were at least large remained large and, in particular, independent of years of training experience. Furthermore, body mass had a negative substantial association with vertical jump (population-level estimate = −0.38, 95% CI: −0.66 to −0.11), Yo-Yo IR1 performance (population-level estimate = −0.24, 95% CI: −0.43 to −0.06) and overall performance score (population-level estimate = −0.26, 95% CI: −0.45 to −0.06).

As for the Deliberate Practice Motivation Questionnaire dimensions, there was a slight trend of decrease in the scores with the increase in age groups in both competitive levels, but there was no substantial variation between players by competitive level. As for Work and Family Orientation Questionnaire dimensions, only for competitiveness dimension was observed a trend of higher scores for players of state level, across all age groups. Also, this effect for competitiveness was independent of years of experience in basketball. Years of experience in basketball had a negative association with will to compete score (population-level estimate = −0.29, 95% CI: −0.56 to −0.04), from Deliberate Practice Motivation Questionnaire, and the work score (population-level estimate = −0.27, 95% CI: −0.52 to −0.03), from the Work and Family Orientation Questionnaire score.

As for Sources of Enjoyment in Youth Sports, all players presented a trend of high scores in all dimensions. There was no substantial influence of players' menarcheal status, competitive age-group, and accumulated training experience, except for other-referenced competences, on dimensions of sources of enjoyment. For other-referenced competences, more experienced players from state-level had higher scores compared with lees experienced and from club level players. On the other hand, club level players had substantially higher scores for other-referenced competences than state-level players.

Posterior estimates and uncertainty (95% and 50% credible intervals) were plotted by competitive level, accounting for variation by age group, for maturity indicator and training experience (Figure 1), body size (Figure 2), functional performance (Figure 3), Deliberate Practice Motivation Questionnaire dimensions (Figure 4), Work and Family Orientation Questionnaire dimensions (Figure 5) and Sources of Enjoyment for Youth Sports (Figure 6). Given the direct probabilistic comparisons of the posterior estimates and respective credible interval, and conditional on the data, players selected for state-level had more accumulated experience in basketball, were taller (likely also slightly heavier) and with better functional performance, with higher scores for competitiveness compared to club level players, and referenced their competence against their peers. On the other hand, players from club level showed higher values of self-referenced competencies compared to state-level players.

Table 1. Posterior estimations and 95% credible intervals of young female basketball players by competitive level and age group.

	Club-level			State-level		
	under 13	under 15	under 17	under 13	under 15	under 17
Chronological age, yrs	12.6 (12.5 to 12.8)	14.9 (14.6 to 15.1)	16.8 (16.4 to 17.1)	13.1 (12.8 to 13.5)	15.4 (15.1 to 15.7)	17.3 (16.9 to 17.6)
Distance to age at menarche, yrs[a]	0.04 (0.63 to 0.71)	2.07 (1.39 to 2.75)	4.75 (3.69 to 5.81)	0.38 (0.50 to 1.39)	2.40 (1.54 to 3.35)	5.08 (4.07 to 6.06)
Year of experience in basketball, years	2.17 (1.57 to 2.17)	4.22 (3.47 to 4.94)	5.30 (4.28 to 6.37)	5.54 (4.54 to 6.55)	7.59 (6.60 to 8.52)	8.67 (7.62 to 9.70)
Stature, cm	159.8 (157.7 to 161.9)	165.2 (162.5 to 167.5)	163.4 (160.4 to 166.6)	166.0 (162.7 to 169.6)	171.4 (168.1 to 174.6)	169.5 (166.1 to 173.0)
Body mass, kg	50.8 (51.1 to 57.3)	60.5 (57.1 to 64.2)	60.3 (55.6 to 65.6)	59.2 (54.1 to 64.5)	65.5 (60.9 to 70.2)	65.3 (60.3 to 70.5)
Countermovement jump, cm	23.7 (22.1 to 25.2)	24.7 (23.0 to 26.6)	24.9 (22.8 to 27.4)	26.5 (23.9 to 29.0)	27.6 (25.0 to 30.0)	27.7 (25.2 to 30.4)
Line drill test, s	36.61 (36.02 to 37.13)	35.00 (34.28 to 35.67)	34.99 (33.92 36.09)	35.53 (34.51 to 36.54)	33.88 (32.96 to 34.79)	33.91 (32.94 to 34.95)
Yo-yo IR1, m	477.6 (423.3 to 531.4)	536.9 (474.9 to 600.3)	577.9 (490.5 to 671.6)	561.4 (468.4 to 654.3)	620.8 (540.4 to 702.8)	661.9 (571.9 to 759.4)
Performance score, z-score	−1.13 (−1.76 to −0.49)	0.10 (−0.68 to 0.88)	0.32 (−0.71 to 1.35)	0.33 (−0.72 to 1.41)	1.58 (0.61 to 2.49)	1.78 (0.75 to 2.80)
Deliberate Practice Motivation						
Will to excel, 1-5	4.21 (3.94 to 4.47)	3.61 (3.32 to 3.88)	3.58 (3.17 to 3.82)	4.38 (3.99 to 4.78)	3.78 (3.42 to 4.14)	3.74 (3.33 to 4.16)
Will to compete, 1-5	4.43 (4.24 to 4.64)	4.09 (3.89 to 4.29)	4.03 (3.75 to 4.31)	4.46 (4.17 to 4.75)	4.11 (3.85 to 4.36)	4.06 (3.75 to 4.36)
Achievement and competitiveness motivation						
Mastery, 1-5	4.06 (3.89 to 4.24)	4.00 (3.80 to 4.19)	4.12 (3.87 to 4.35)	4.12 (3.87 to 4.38)	4.05 (3.79 to 4.31)	4.13 (3.86 to 4.42)
Work, 1-5	4.36 (4.18 to 4.53)	4.26 (4.06 to 4.45)	4.19 (3.92 to 4.44)	4.26 (3.97 to 4.53)	4.15 (3.89 to 4.40)	4.09 (3.78 to 4.37)
Competitiveness, 1-5	3.42 (3.19 to 3.62)	3.55 (3.33 to 3.78)	3.61 (3.33 to 3.94)	3.74 (3.41 to 4.06)	3.87 (3.55 to 4.20)	3.93 (3.60 to 4.28)
Sources of enjoyments in youth sports						
Self-referenced competencies, 1-5	4.54 (4.35 to 4.73)	4.59 (4.37 to 4.83)	4.60 (4.30 to 4.94)	3.93 (3.61 to 4.22)	3.98 (3.69 to 4.29)	3.99 (3.69 to 4.29)
Others-referenced competencies, 1–5	3.43 (3.19 to 3.67)	3.39 (3.11 to 3.67)	3.38 (3.38 to 3.74)	4.12 (3.75 to 4.48)	4.08 (3.73 to 4.43)	4.06 (3.67 to 4.42)
Effort expenditure, 1–5	4.73 (4.60 to 4.86)	4.68 (4.51 to 4.82)	4.71 (4.49 to 4.93)	4.82 (4.65 to 5.02)	4.77 (4.59 to 4.96)	4.81 (4.61 to 5.02)
Affiliation with peers, 1-5	4.48 (4.28 to 4.68)	4.41 (4.16 to 4.63)	4.39 (4.02 to 4.68)	4.39 (4.02 to 5.02)	4.62 (4.34 to 4.91)	4.60 (4.34 to 4.91)
Positive parental involvement, 1-5	4.57 (4.36 to 4.78)	4.39 (4.13 to 4.62)	4.37 (3.98 to 4.70)	4.71 (4.42 to 5.03)	4.53 (4.23 to 4.81)	4.51 (4.19 to 4.81)

[a]It was not possible to retain age at menarche at the time in 14 of the players that had not attained menarche at the observation date.

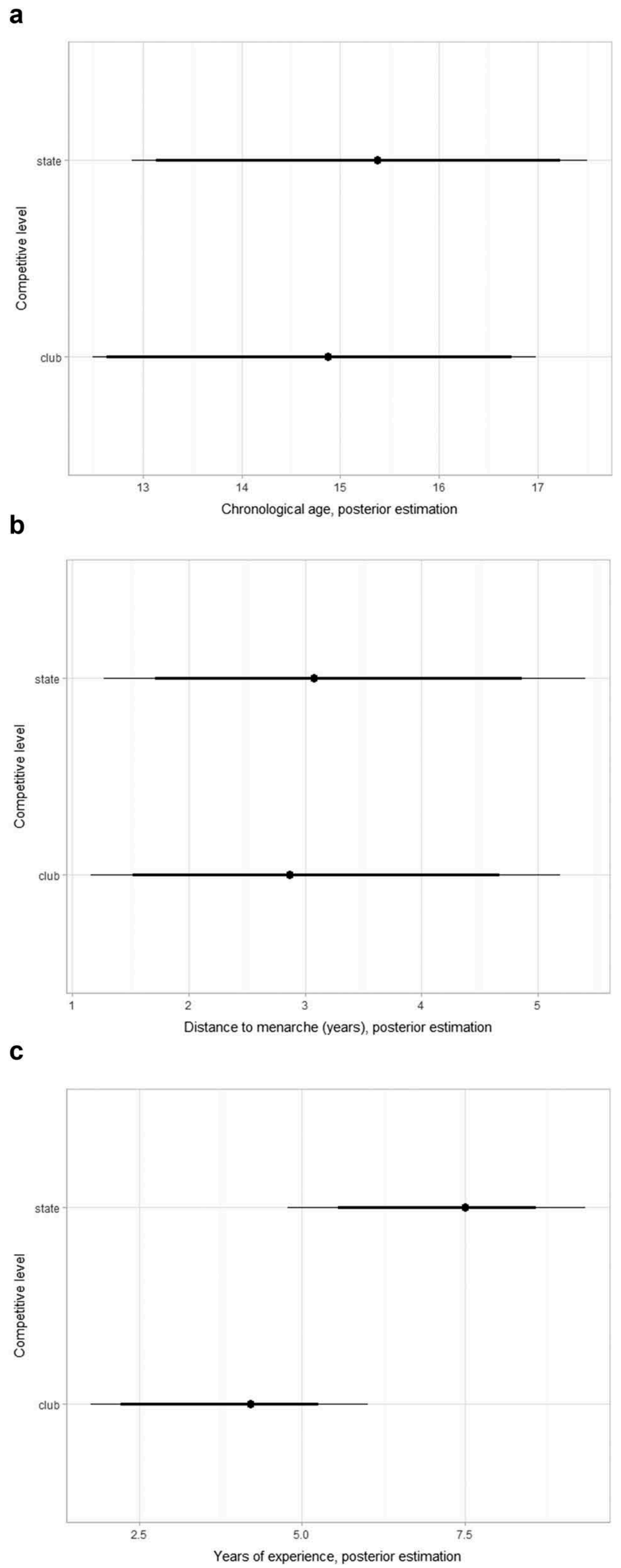

Figure 1. Posterior estimations for age (a), distance to menarche (b) and years of training experience (c) by competitive level, considering variation between age groups.

Discussion

There is limited interdisciplinary research considering youth sports development despite its great interest in sport sciences, even more considering female players (Johnston et al., 2018). Furthermore, there is an overemphasis on selection and talent development selection when considering young athletes. Hence, our use of competitive level as a discriminant factor is instrumental, must be regarded as a tool aiming to illustrate the selective bias that can influence coaches' decisions and the continuity of participation in sport.

In the present study, we focused on variation in accumulated basketball training experience, body size, functional performance, deliberate practice motivation, achievement and competitiveness motivation and sources of enjoyment in youth women's basketball, partitioning for individual biological (maturity status) and sport-specific accumulated experience variation, as well as contextual variation (competitive age groups and competitive level). Hence, we used Bayesian multilevel modelling to account for individual and contextual sources of variation. Within the present poll of club level female adolescent players, those selected for state-level teams had more accumulated training experience, were taller and heavier, and had better physiological performance, particularly in jump and Line drill test. There were no differences between players by competitive level for menarcheal status within age groups. As for psychological skills, particularly motivation for deliberate practice and achievement, we observed that the young female basketball players had high motivation values, regardless of their competitive level. An important finding was that the competitiveness dimension observed in state-level players showed higher scores compared to their club level peers. Although the young female basketball players in the present sample had high values in all dimensions of enjoyment in sports, playing in different competitive levels appears to exert a contrasting influence on how players evaluate their competence. While club level players value self-referenced competencies more, state-level players value more others-referenced competencies, i.e., how they compare their skill or performance with others.

Body dimensions of the adolescent female basketball players, on average, were comparable with age-specific 75th to 95th percentiles for stature, and comparable with age-specific 50th to 75th percentiles for body mass of US reference data (Kuczmarski et al., 2000). However, when matched with basketball samples, even the taller players selected for the higher competitive level and the older age groups (under-15 and under-17) teams in the present study had lower values for stature, on average, compared to adolescent female players from state and national level in Australia (E. J. Drinkwater et al., 2007), players attaining amateur level (Delextrat & Cohen, 2009), professional level at adult level (Garcia-Gil et al., 2018), or elite adult level considering as reference data from the Women's World Basketball Championships, held in Australia in 1994 (Ackland et al., 1997).

Adding to the previous observations, age at menarche in the present sample was, on average, 11.8 (95% CI: 11.5 to 12.1 years). Hence, attained the age at menarche in the present sample was earlier than observations based on Brazilian data (Duarte, 1993; Leonardi et al., 2018) and worldwide observations (Eveleth & Tanner, 1991).

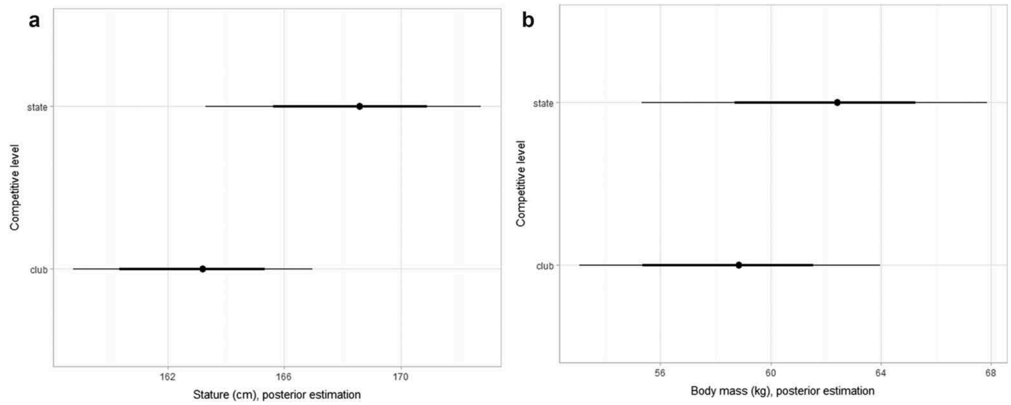

Figure 2. Posterior estimations for stature (a) and body mass (b) by competitive level, considering variation between age groups.

Consistent with previous observations that included part of the sample in the present study (H. M. Carvalho et al., 2019; Leonardi et al., 2018), the female basketball players considered in the study were, on average, advanced in maturity status. However, there was no substantial variation by competitive level in players´ age at menarche (see Supplementary Table 1). These results suggest that the overrepresentation of early maturing girls in competitive basketball at the early ages of selection is independent of the competitive level. These observations were also consistent with recent data in female Portuguese basketball, showing a trend of overrepresentations of early maturing girls within the teams selected to represent regional teams at the national championship (Ramos et al., 2018). However, caution is warranted in the interpretation of the Portuguese data, as acknowledged by the authors, as maturity status estimations were based on the maturity offset protocol, which has limited validity (R. M. Malina et al., 2006). The present data suggest that early maturing, bigger girls may be advantaged to be retained within youth basketball programs. At least in the context of our observation, basketball coaches should consider training strategies to allow late-maturing girls to remain engaged in sport. Particularly for stature, a late-maturing girl may have a greater potential to attain higher adult stature (R. M. Malina et al., 2004).

On the other hand, young female players selected to represent the state teams had more accumulated experience. Conditional on the data, the more advanced "sports age" was also relevant to explain differences between players by competitive level across all age groups observed. Also, more experienced female players had better functional performance, independent of their competitive level. These observations were consistent with previous cross-sectional and longitudinal data (H. M. Carvalho et al., 2019; Leonardi et al., 2018). Hence, the results imply that early specialization in female youth basketball may provide an advantage for functional capacities development. Adding to probable size advantages of early maturing girls, emphasis on early performance may be a contributing factor for the overrepresentation of early maturing girls across the observed age groups. Particularly at early age groups, coaches should be cautious interpreting players´ performance (i.e., excluding or promoting), given the influence of accumulated training stimulus on functional performance combined with pronounced increases in functional performance during pubertal growth (H. M. Carvalho et al., 2019).

Partitioning the influence of training experience on functional performance, the female players selected for the state team had better functional performance, in particular, maximal short-term performance (i.e., vertical jump and Line-drill test). These observations were consistent with the limited data available considering functional performance with female adolescent basketball players. It has been noted that female adolescent players from the national level had better short-term outputs compared with state-level players within the Basketball Australia's State and National programs (E. J. Drinkwater et al., 2007). Allowing for differences in procedures, it was also noted among contrasting levels of female under-14 players that players from the best ranked regional teams in the annual Portuguese Festival of Youth Basketball had better overall functional performance (Ramos et al., 2018). However, the limited data available did not account for the confounding influence of maturity status and training experience on functional performance.

Youth sports developmental models often consider psychological dispositions and mental skills, besides motivation characteristics (Murr et al., 2018). Given the importance of accumulated training experience on the functional performance of young athletes, and likely influence on sport selection, the deliberate practice framework is generally assumed in the context of youth sports programs in team sports, such as basketball. Hence, personality-related dispositions and skills such as motivation characteristics, achievement and competitiveness motivation or deliberate practice motivation may provide important insights about the dispositions to be engaged and committed to a long and rocky road of more specialized and demanding practice for aspiring elites.

Conditional on the data, the Brazilian adolescent female basketball players showed high scores across the dimensions of deliberate practice motivation and achievement and competitiveness motivation. However, state-level players only had substantially higher values for competitiveness dimension

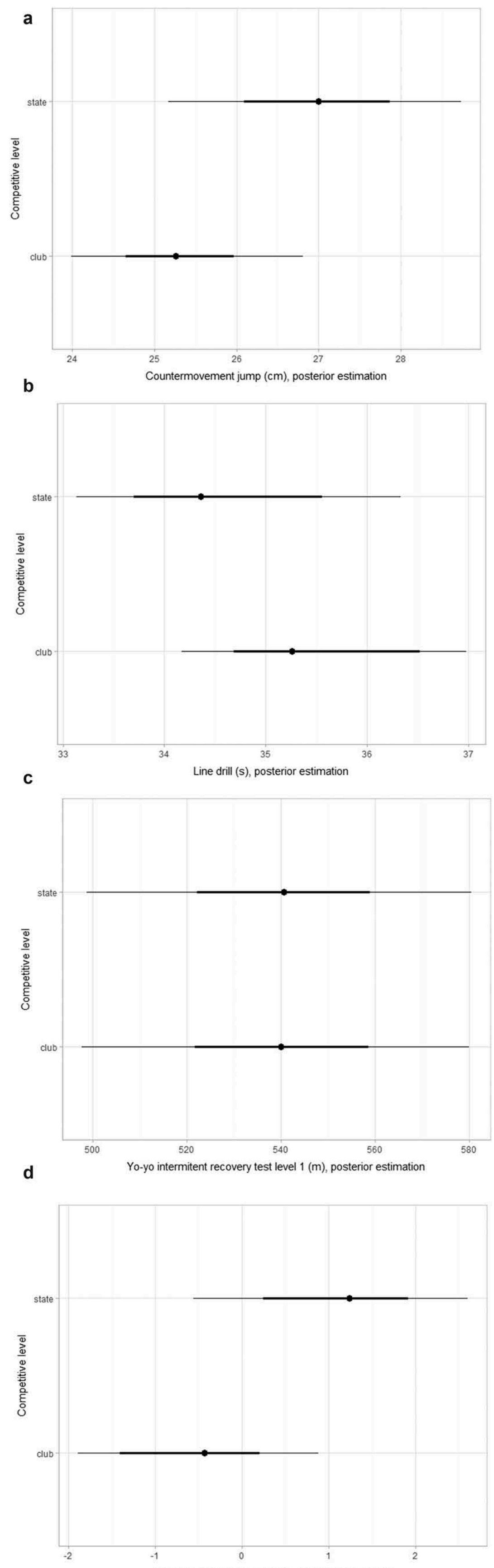

Figure 3. Posterior estimations for countermovement jump (a), Line Drill test (b), Yo-yo IR1 (c) and performance score (d) by competitive level, considering variation between age groups.

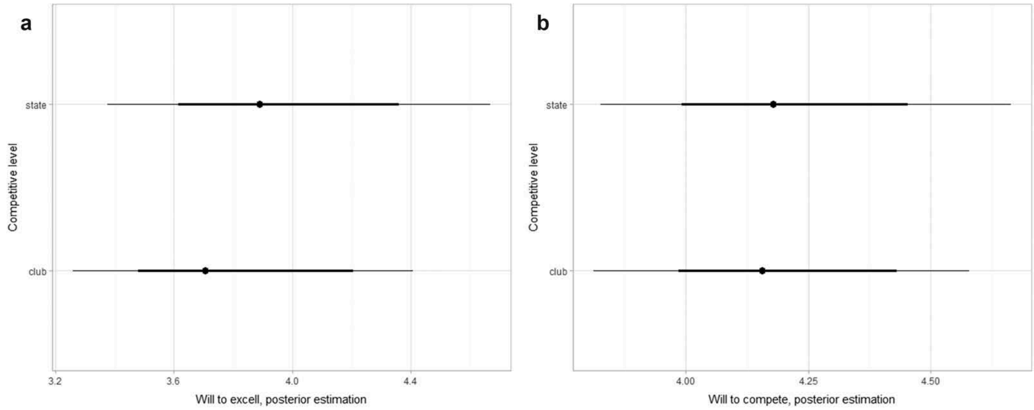

Figure 4. Posterior estimations for Will to excel (a) and Will to compete (c) scores by competitive level, considering variation between age groups.

compared to club level players, across all age groups. These observations contrast with the comparable data considering under-16 female Portuguese players from the national training centres of the Portuguese Basketball Federation, and from clubs competing at a national level (Gonçalves et al., 2011). In the Portuguese sample, players from the Portuguese Basketball Federation training centres had substantially higher scores for almost all dimensions of deliberate practice motivation and achievement and competitiveness motivation compared to players from clubs competing at the national level. These divergences might reflect the contextual differences between youth and adult basketball between the observed countries. Within the Portuguese context, a path to achieve professional adult basketball for both players from the Portuguese Basketball Federation training centres and the national level players was available and proposed for players. In contrast, a path to achieve a professional adult level in female Brazilian basketball remains less clear nowadays for the young female players in the present sample. This may explain the trend of lower scores in all motivation dimensions, as age groups were older, independent of accumulated experience. The young athletes could potentially perceive the limited opportunities to remain engaged in competitive female basketball.

Overall the female adolescent basketball players in the present sample perceived their experience in organized basketball structured practice as enjoyable. As noted in another context of sports practice (J. Baker & Young, 2014), the present observations do not fit well with the deliberate practice framework, mostly based on musicians' expertise (Ericsson et al., 1993). Interestingly, it appears that there is a contrast in the players´ enjoyment source for referenced competence related to the different competitive levels environments. Also, there was a relation between accumulated years of experienced and other-referenced competences. These observations suggest that coaches should be aware that with the increase in training experience and competitive level female adolescent, players may find more enjoyable to compare themselves against their peers and be valued by their improved performance or ability against their peers.

Conditional on the data, the Brazilian youth female basketball contexts appear to provide a nurturing environment for players´ development. Overall, the female adolescent players were highly motivated for deliberate practice, achievement, and competitiveness, and perceived their experience in structured basketball practice sports as highly enjoyable. These observations considering psychological dispositions of adolescent female basketball players are of particular relevance given the recent calls promoting bio-banding as a new paradigm for youth sports and training. Our data highlight the need for caution when assuming that youth sports training and competitive environments have a negative influence on young players´ psychological dispositions, and consequently potentially leading to dropout.

Conclusion

Assuming an interdisciplinary perspective, it was apparent in the present sample that adolescent female basketball players selected for higher competitive levels had more accumulated experience, were taller and with better functional performance. All players were similarly highly motivated for deliberate practice and to achievement and perceived their experience in structured youth basketball as highly enjoyable. Overall, the present data highlight the relation between functional performance and psychological dispositions of adolescent female basketball players with biological characteristics and contexts of practice (e.g., accumulated training experience or different competitive levels). The context of structured youth female basketball potentially provides a positive environment for players´ engagement and commitment to training and excellence attainment. Conditional on the data, youth female coaches tend to value (probably overvalue) size and function when selecting/promoting players, even at early age groups. Hence, coaches should refine their pedagogical strategies, accounting for the importance of the interactions among physical growth and biological maturity status, functional performance, and psychological characteristics, particularly among female adolescent athletes.

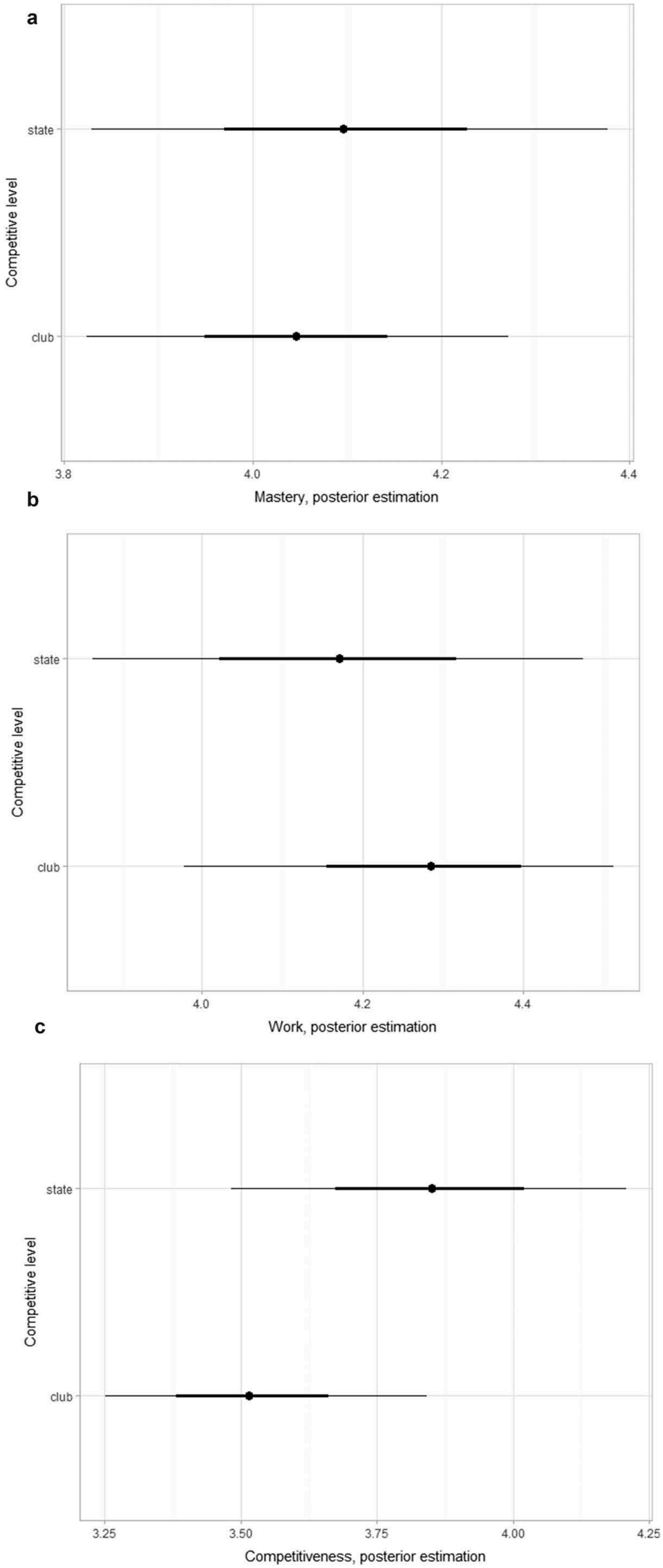

Figure 5. Posterior estimations for mastery (a), work (b) and competitiveness (c) scores by competitive level, considering variation between age groups.

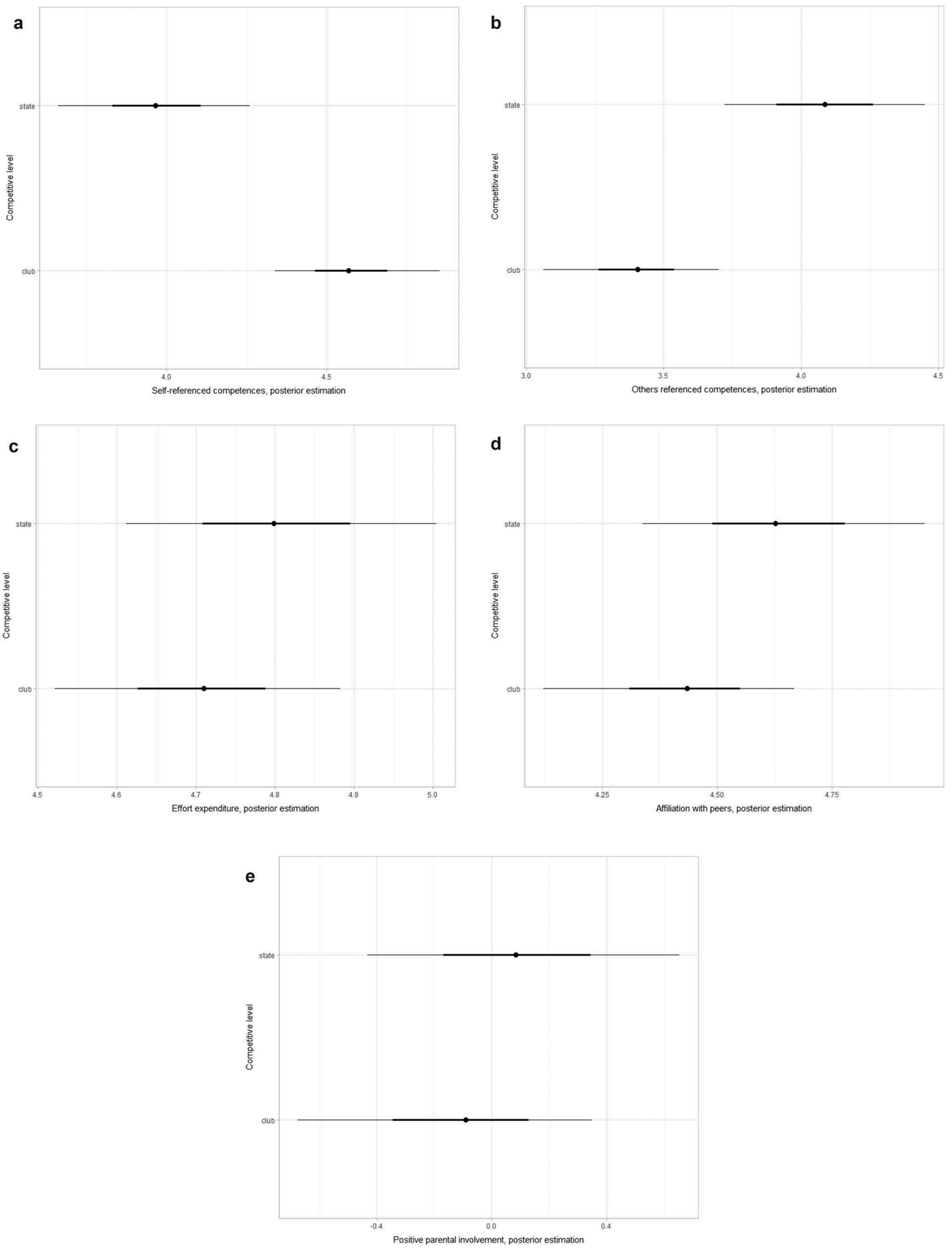

Figure 6. Posterior estimations for self-referenced competencies (a), other-referenced competencies (b), effort expenditure (c), affiliation with peers (d), and positive parental involvement (e) scores by competitive level, considering variation between age groups.

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Disclosure Statement

No potential conflict of interest was reported by the authors.

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References

Ackland, T. R., Schreiner, A. B., & Kerr, D. A. (1997). Absolute size and proportionality characteristics of World Championship female basketball players. [Clinical Trial Research Support, Non-U.S. Gov't]. *Journal of Sports Sciences*, *15*, (5), 485–490. http://www.ncbi.nlm.nih.gov/pubmed/9386206

Al-Sahab, B., Ardern, C. I., Hamadeh, M. J., & Tamim, H. (2010). Age at menarche in Canada: Results from the National longitudinal survey of children & youth. *BMC Public Health*, *10*, 736. https://doi.org/10.1186/1471-2458-10-736

Baker, J., Schorer, J., & Wattie, N. (2018). Compromising talent: Issues in Identifying and selecting talent in sport. *Quest*, *70*(1), 48–63. https://doi.org/10.1080/00336297.2017.1333438

Baker, J., & Young, B. (2014). 20 years later: Deliberate practice and the development of expertise in sport. *International Review of Sport and Exercise Psychology*, *7*(1), 135–157. https://doi.org/10.1080/1750984X.2014.896024

Bangsbo, J. (1994). *Fitness training in footbal - a scientific approach*. HO Storm.

Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. [Review]. *British Journal of Sports Medicine*, *41*(2), 69–75. discussion 75. https://doi.org/10.1136/bjsm.2006.032318

Bolker, B. M., Gardner, B., Maunder, M., Berg, C. W., Brooks, M., Comita, L., Crone, E., Cubaynes, S., Davies, T., De Valpine, P., Ford, J., Gimenez, O., Kéry, M., Kim, E. J., Lennert-Cody, C., Magnusson, A., Martell, S., Nash, J., Nielsen, A., … Ramula, S. (2013). Strategies for fitting nonlinear ecological models in R, AD Model Builder, and BUGS. *Methods in Ecology and Evolution*, *4*(6), 501–512. https://besjournals.onlinelibrary.wiley.com/doi/abs/10.1111/2041-210X.12044

Bosco, C., Luhtanen, P., & Komi, P. V. (1983). A simple method for measurement of mechanical power in jumping. *European Journal of Applied Physiology and Occupational Physiology*, *50*(2), 273–282. http://www.ncbi.nlm.nih.gov/pubmed/6681758

Bürkner, P.-C. (2017). Brms: An R Package for Bayesian multilevel models using stan. *Journal of Statistical Software*, *80*, 1–28.

Burwitz, L., Moore, P. M., & Wilkinson, D. M. (1994). Future directions for performance-related sports science research: An interdisciplinary approach. *Journal of Sports Sciences*, *12*(1), 93–109. https://doi.org/10.1080/02640419408732159

Carvalho, H. M., Gonçalves, C. E., Collins, D., & Paes, R. R. (2018). Growth, functional capacities and motivation for achievement and competitiveness in youth basketball: An interdisciplinary approach. *Journal of Sports Sciences*, *36*(7), 742–748. https://doi.org/10.1080/02640414.2017.1340654

Carvalho, H. M., Gonçalves, C. E., Grosgeorge, B., & Paes, R. R. (2017). Validity and usefulness of the line drill test for adolescent basketball players: A Bayesian multilevel analysis. *Research in Sports Medicine*, *25*(3), 333–344. https://doi.org/10.1080/15438627.2017.1314296

Carvalho, H. M., Leonardi, T. J., Soares, A. L. A., Paes, R. R., Foster, C., & Gonçalves, C. E. (2019). Longitudinal changes of functional capacities among adolescent female basketball players. *Frontiers in Physiology*, *10* (2019), 339. https://doi.org/10.3389/fphys.2019.00339

Danubio, M. E., & Sanna, E. (2008). Secular changes in human biological variables in Western countries: An updated review and synthesis. *Journal of Anthropological Sciences*, *86*, 91–112. http://www.ncbi.nlm.nih.gov/pubmed/19934470

De Bruin, A. B., Rikers, R. M., & Schmidt, H. G. (2007). The influence of achievement motivation and chess-specific motivation on deliberate practice. *Journal of Sport and Exercise Psychology*, *29*(5), 561–583. http://www.ncbi.nlm.nih.gov/pubmed/18089893

De Bruin, A. B., Smits, N., Rikers, R. M., & Schmidt, H. G. (2008). Deliberate practice predicts performance over time in adolescent chess players and drop-outs: A linear mixed models analysis. *British Journal of Psychology*, *99*(4), 473–497. https://doi.org/10.1348/000712608X295631

Delextrat, A., & Cohen, D. (2009). Strength, power, speed, and agility of women basketball players according to playing position. *Journal of Strength and Conditioning Research*, *23*(7), 1974–1981. https://doi.org/10.1519/JSC.0b013e3181b86a7e

Drinkwater, E. J., Hopkins, W. G., McKenna, M. J., Hunt, P. H., & Pyne, D. B. (2007). Modelling age and secular differences in fitness between basketball players. *Journal of Sports Sciences*, *25*(8), 869–878. https://doi.org/10.1080/02640410600907870

Drinkwater, E. J., Pyne, D. B., & McKenna, M. J. (2008). Design and interpretation of anthropometric and fitness testing of basketball players. [Review]. *Sports Medicine*, *38*(7), 565–578. http://www.ncbi.nlm.nih.gov/pubmed/18557659

Duarte, M. F. S. (1993). Physical maturation: A review with special reference to Brazilian children. *Cadernos De Saude Publica*, *9*(Suppl 1), 71–84. http://www.ncbi.nlm.nih.gov/pubmed/15448822

Elferink-Gemser, M. T., Visscher, C., Lemmink, K. A., & Mulder, T. (2007). Multidimensional performance characteristics and standard of performance in talented youth field hockey players: A longitudinal study. *Journal of Sports Sciences*, *25*(4), 481–489. https://doi.org/10.1080/02640410600719945

Erickson, K., & Cote, J. (2016). An exploratory examination of interpersonal interactions between peers in informal sport play contexts. *PloS One*, *11* (5), e0154275. https://doi.org/10.1371/journal.pone.0154275

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, *100*(3), 363–406. https://doi.org/10.1037/0033-295X.100.3.363

Eveleth, P. B., & Tanner, J. M. (1991). *Worldwide variation in human growth*. Cambridge University Press.

Gama, A. (2008). Age at menarche in Portuguese rural women from Oleiros. *Annals of Human Biology*, *35*(6), 639–655. https://doi.org/10.1080/03014460802471197

Garcia-Gil, M., Torres-Unda, J., Esain, I., Dunabeitia, I., Gil, S. M., Gil, J., & Irazusta, J. (2018). Anthropometric parameters, age, and agility as performance predictors in elite female basketball players. *Journal of Strength and Conditioning Research*, *32*(6), 1723–1730. https://doi.org/10.1519/JSC.0000000000002043

Gelman, A., & Hill, J. (2007). *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press.

Gelman, A., & Little, T. C. (1997). Poststratification into many categories using hierarchical logistic regression. *Survey Methodology*, *23*(2), 127–135. https://www150.statcan.gc.ca/n1/pub/12-001-x/1997002/article/3616-eng.pdf

Gelman, A., & Shalizi, C. R. (2013). Philosophy and the practice of Bayesian statistics. *British Journal of Mathematical and Statistical Psychology*, *66*(1), 8–38. https://doi.org/10.1111/j.2044-8317.2011.02037.x

Ghitza, Y., & Gelman, A. (2013). Deep interactions with MRP: Election turnout and voting patterns among small electoral subgroups. *American Journal of Political Science*, *57*(3), 762–776. https://doi.org/10.1111/ajps.12004

Gonçalves, C. E., Silva, M., Carvalho, H. M., & Gonçalves, A. (2011). Why do they engage in such hard programs? The search for excellence in youth basketball. *Journal of Sports Science & Medicine*, *10*(3), 458–464. http://www.ncbi.nlm.nih.gov/pubmed/24150618

Helmreich, R. L., Beane, W., Lucker, G. W., & Spence, J. T. (1978). Achievement motivation and scientific attainment. *Personality and Social Psychology Bulletin*, *4*(2), 222–226. https://doi.org/10.1177/014616727800400209

Hoare, D. G. (2000). Predicting success in junior elite basketball players–the contribution of anthropometic and physiological attributes. [Comparative Study Research Support, Non-U.S. Gov't]. *Journal of Science and Medicine in Sport*, *3*(4), 391–405. http://www.ncbi.nlm.nih.gov/pubmed/11235005

Höner, O., & Feichtinger, P. (2016). Psychological talent predictors in early adolescence and their empirical relationship with current and future performance in soccer. *Psychology of Sport and Exercise*, *25*(2016), 17–26. https://doi.org/10.1016/j.psychsport.2016.03.004

Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent identification in sport: A systematic review. *Sports Medicine (Auckland, N.Z.)*, *48*(1), 97–109. http://www.ncbi.nlm.nih.gov/pubmed/29082463

Kuczmarski, R. J., Ogden, C. L., Grummer-Strawn, L. M., Flegal, K. M., Guo, S. S., Wei, R., Mei, Z., Curtin, L. R., Roche, A. F., & Johnson, C. L. (2000). CDC growth charts: United States. *Advance Data*, (314), 1–27. http://www.ncbi.nlm.nih.gov/pubmed/11183293

Leonardi, T. J., Paes, R. R., Breder, L., Foster, C., Gonçalves, C. E., & Carvalho, H. M. (2018). Biological maturation, training experience, body size and functional capacity of adolescent female basketball players: A Bayesian analysis. *International Journal of Sports Science & Coaching*, *13*(5), 713–722. https://doi.org/10.1177/1747954118772489

Lolli, L., Batterham, A. M., Weston, K. L., & Atkinson, G. (2017). Size exponents for scaling maximal oxygen uptake in over 6500 humans: A systematic review and meta-analysis. *Sports Medicine (Auckland, N.Z.)*, *47*(7), 1405–1419. https://doi.org/10.1007/s40279-016-0655-1

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Human Kinetics.

Malina, R. M., Claessens, A. L., Van Aken, K., Thomis, M., Lefevre, J., Philippaerts, R., & Beunen, G. P. (2006). Maturity offset in gymnasts: Application of a prediction equation. *Medicine & Science in Sports & Exercise*, *38*(7), 1342–1347. https://doi.org/10.1249/01.mss.0000227321.61964.09

McElreath, R., & Koster, J. (2014). Using multilevel models to estimate variation in foraging returns. Effects of failure rate, harvest size, age, and individual heterogeneity. *Human Nature (Hawthorne, N.Y.)*, *25*(1), 100–120. https://doi.org/10.1007/s12110-014-9193-4

McInnes, S. E., Carlson, J. S., Jones, C. J., & McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences*, *13*(5), 387–397. https://doi.org/10.1080/02640419508732254

Montgomery, P. G., Pyne, D. B., Hopkins, W. G., & Minahan, C. L. (2008). Seasonal progression and variability of repeat-effort line-drill performance in elite junior basketball players. *Journal of Sports Sciences*, *26*(5), 543–550. https://doi.org/10.1080/02640410701654298

Murr, D., Feichtinger, P., Larkin, P., O'Connor, D., & Honer, O. (2018). Psychological talent predictors in youth soccer: A systematic review of the prognostic relevance of psychomotor, perceptual-cognitive and personality-related factors. *PloS One*, *13*(10), e0205337. https://doi.org/10.1371/journal.pone.0205337

Pearson, D. T., Naughton, G. A., & Torode, M. (2006). Predictability of physiological testing and the role of maturation in talent identification for adolescent team sports. *Journal of Science and Medicine in Sport*, *9*(4), 277–287. https://doi.org/10.1016/j.jsams.2006.05.020

Piggott, B., Muller, S., Chivers, P., Papaluca, C., & Hoyne, G. (2018). Is sports science answering the call for interdisciplinary research? A systematic review. *European Journal of Sport Science*, *19*(3), 267–286. https://doi.org/10.1080/17461391.2018.1508506

R Core Team. (2018). *R: A language and environment for statistical computing*. http://www.R-project.org/

Ramos, S., Volossovitch, A., Ferreira, A. P., Barrigas, C., Fragoso, I., & Massuca, L. (2018). Differences in maturity, morphological, and fitness attributes between the better- and lower-ranked male and female U-14 Portuguese elite regional basketball teams. *Journal Of Strength And Conditioning Research / National Strength & Conditioning Association 34*(3), 878–887. https://doi.org/10.1519/JSC.0000000000002691

Santos, A. J., & Gonçalves, C. E. (2012). Tradução do sources of enjoyment in youth sport questionnaire e do developmental assets profile para Jovens Atletas Portugueses. *Annals of Research in Sport and Physical Activity*, *3*, 11–36. http://dx.doi.org/10.14195/2182-7087_3_1

Semenick, D. (1990). Tests and measurements: The line drill test. *Strength & Conditioning Journal*, *12*(2), 47–49. http://journals.lww.com/nsca-scj/Fulltext/1990/04000/TESTS_AND_MEASUREMENTS__The_Line_Drill_Test_.7.aspx

Soares, A. L. A., Kós, L. D., Paes, R. R., Nascimento, J. V., Collins, D., Gonçalves, C. E., & Carvalho, H. M. (2019). Determinants of drop-out in youth basketball: An interdisciplinary approach. *Research in Sports Medicine*, *28*(1), 84–98. https://doi.org/10.1080/15438627.2019.1586708

Stan Development Team. (2015). *Stan: A C++ Library for Probability and Sampling*. http://mc-stan.org/

Stojanovic, E., Stojiljkovic, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., & Milanovic, Z. (2018). The activity demands and physiological responses encountered during basketball match-play: A systematic review. *Sports Medicine (Auckland, N.Z.)*, *48*(1), 111–135. https://doi.org/10.1007/s40279-017-0794-z

Tanner, J. M. (1962). *Growth at adolescence* (2nd ed.). Blackwell Scientific Publications.

Vehtari, A., Gelman, A., & Gabry, J. (2016). Practical Bayesian model evaluation using leave-one-out cross-validation and WAIC. *Statistics and Computing*, 27,1413–1432. https://doi.org/10.1007/s11222-016-9696-4.

Wiersma, L. D. (2001). Conceptualization and development of the sources of enjoyment in youth sport questionnaire. *Measurement in Physical Education and Exercise Science*, *5*(3), 153–177. https://doi.org/10.1207/s15327841mpee0503_3