

## Developmental Assets in Adolescent Basketball Players: Influence of Age, Maturation, Size and Functional Capacities

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### Abstract

Sports participation has been referred as having important influence in positive youth development (PYD) in many life-long aspects, as social, physical, physiological and intellectual components. The aim of this study was to verify influences of body size, growth-related changes and age in developmental assets. This cross-sectional design study considered 45 male adolescent basketball players aged  $13.6 \pm 1.5$  years. Participants were engaged in a club structured training program and competed at state level competition, supervised by the *Federação Paulista de Basketball* (São Paulo's state basketball Federation). There was substantial variation between athletes for all variables. Inspection of credible intervals showed a substantial variation in body size and functional capacity indicators between players grouped by age group and by maturity status. However, substantial variation by both age group or maturity status was present for DAP dimensions. No relation was observed between DAP dimensions with body size and functional capacity, partitioning the substantial variation between players by age group and maturity status. In the present study there was no substantial variation in developmental assets of adolescent basketball players by age or estimated maturity status. Also, from a multidimensional perspective, there was no influence of body dimensions and functional capacities with developmental assets.

**Keywords:** youth basketball, psychological characteristics, talent and development, multilevel modelling

### Introduction

Developmental assets comprise relationships, opportunities provided by adults and peers, values, skills, abilities, and a positive self-perception developed over time (Strachan, Côté and Deakin, 2009). It relates a person's internal and external factors with positive youth development, including personal characteristics such as commitment to learning and positive identity and contextual characteristics such as family support, school attendance, and having available community resources. Participation in sport plays an important role in the developmental process, extending from personal and immediate outcomes such as enjoyment, positive expectations, and personal assets and skills to more long-term and distant positive effects (Holt et al., 2013). As well as positive outcomes, such as high levels of enjoyment, support from others and motivation can lead to

a positive development, developmental assets can influence negatively on youth development.

Sport participation programs can provide a powerful context to promote positive environments (Vierimaa, Erickson, Côté and Gilbert, 2012) and have been linked to various aspects of healthy development throughout life (Fraser-Thomas, Côté and MacDonald, 2010). Youth sport programs are often highly selective and performance-oriented, where focus is on talent selection and development, sometimes disregarding the concept of positive youth development, which focus on highlighting the capacity for change in young people in a direction favouring both societal and individual welfare (Reverdito et al., 2017). In basketball, size and functional performance are frequently overvalued by coaches, albeit the important maturity associated variation among adolescent players and its substantial variation on players' characteristics (Carvalho, Gonçalves, Col-

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lins and Paes, 2018). To our best knowledge, there is limited information considering the influence of age and maturity status on developmental assets in young athletes exposed to basketball training programs. Maturity status is given by the state of maturation of an individual at the time of the observation and is an important influence during talent selection, since children at the same age can vary the rate of maturity, one reaching adulthood earlier than the other. The transition from adolescence to adulthood is marked by a period of profound changes in terms of drives, emotions, motivations, psychology and social life (Blakemore, Burnett and Dahl, 2010). Different maturity timing and tempo can impact athlete's development in sport, both considering biological, physiological and social development (Rees et al., 2016). It is often noted the overrepresentation of early mature that are selected or promoted in youth sports, likely due to transient advantages of earlier biological development compared to their late maturing peers. Consequently, it has been advocated the possibility to classify young athletes' competition levels considering maturity status instead of chronological age. This process of grouping athletes based on attributes associated with growth or maturation, rather than chronological age has been referred as Bio-banding (Cumming et al., 2017a; Cumming et al., 2017b), which is a complement to support talent selection, as well as technical and psychological aspects of the athlete's development.

Considering the preceding observations, we examined whether developmental assets varied differently between adolescent basketball players when grouped by age group or by maturity status. Furthermore, we examined whether body dimensions and functional capacities, which in general are expected to vary substantially by age and/or maturity status, are related to developmental assets.

## Methods

### Participants

This cross-sectional design study considered 45 male adolescent basketball players aged  $13.6 \pm 1.5$  years. Participants were engaged in a club structured training program and competed at state level competition, supervised by the *Federação Paulista de Basketball* (São Paulo's state basketball Federation). The club was in a sub-urban region of São Paulo metropolitan region that are in vulnerable social conditions. Athletes were engaged in six to ten hours training per week, according to the age group. Players and their parents were informed about the nature and purposes of the study, their participation was voluntary, and they could withdraw at any moment. All participants and their parents or legal guardians provided written consent. The study was approved by the *Research Ethics Committee of the University of Campinas*.

### Procedures

Players were measured in August 2017, before the competitive season. Athletes performed a standardized warm-

up before assessment of functional capacity performance. Chronological age was calculated by the difference between data collection and each athlete's birth date. The maturity offset protocol was used to estimate age peak height velocity (PHV) and to classify players as: pre-PHV ( $\text{PHV} \leq -1.00$  year), circum-PHV ( $-1.00 < \text{PHV} < +1.00$  year) or post-PHV ( $\text{PHV} \geq +1.00$  year) (Mirwald, Baxter-Jones, Bailey and Beunen, 2002). The limitations of the offset protocol are recognized; thus we recognize that players may have been assigned to the wrong maturity status group.

Anthropometry measures were taken by a single experienced observer following standardized procedures (Lohman, Roche and Martorell, 1988). Stature and sitting height were measured with a portable stadiometer (Seca model 206, Hanover, MD, USA) to the nearest 0.1 cm. Leg (subischial) length was estimated as stature minus sitting height. Body mass (BM) was measured with a calibrated portable balance (Seca model 770, Hanover, MD, USA) to the nearest 0.1 kg.

Functional capacity performance included the Line Drill test (Carvalho, Gonçalves, Grosgeorge and Paes, 2017; Semenick, 1990), for basketball specific short-term maximal effort, and the Yoyo Intermittent Recovery test level 1 (Yo-Yo IR1) (Bangsbo, Iaia and Krstrup, 2008), as a measure of intermittent aerobic endurance. We derived a performance score, which was consisted by the sum of the z-scores of both functional performance tests (Line drill test performance was inverted as a lower time indicates a better performance) as a measure of overall functional capacity. The Line Drill test consists of a short-term maximal effort which is normally used by coaches as a drill for agility training within a standardized basketball court (International Basketball Federation, 2014). Briefly, players are required to run 140m as fast as possible four consecutive shuttle sprints with different distances (5.8, 14.0, 22.2 and 28.0m). Time was recorded by video analysis of each player crossing the reference baseline with available video analysis software *Kinovea* – 0.8.15 (<http://www.kinovea.org>). Reliability of video recording for time measurement is detailed elsewhere (Carvalho et al., 2018). Briefly, in the Yo-Yo IR1 players should run back and forth repeated 2 x 20m between the starting, at a progressively increased speed controlled by audio bleeps from an audio player previously tested. Athletes have an active rest period between each route, jogging 2 x 5m. Covered distance until exhaustion was considered in meters by the researcher. Reliability estimates were reported are available elsewhere (Carvalho et al., 2017).

The Portuguese version of the Developmental Assets Profile (DAP) questionnaire (Santos and Gonçalves, 2012) was used to assess players' development assets within the sport. The questionnaire is composed by 58 items considering external and internal factors from a personal perspective, such as support (4 items), boundaries and expectations (5 items), commitment to learning (4 items), positive values (3 items) and positive identity (5 items). Statements in the DAP were rated as 'Not at all or rarely' (1), 'Some-

what or Sometimes' (2), 'Very Often' (3) and 'Extremely or almost always' (4).

## Statistical Analysis

### Bayesian Modelling

Bayesian methods handle parameters as random variables combining both sample data and prior distribution information to estimate posterior information (Gelman et al., 2013). Conditional on the data, Bayesian estimation provide directly interpretable and meaningful probabilities statements, particularly useful in small sample size studies which is often a limitation in sport science research. In the present study we initially examined variation between players for all variables, summarized as posterior means and standards deviations. We used Bayesian multilevel linear regressions to examine whether players varied when grouped by age group or by maturity status at level 2 for all variables. Lastly, we included in the multilevel linear regression model maturity offset, body mass, stature and performance score as population level effects (also referred as fixed effects in frequentist methods), using a varying intercepts models and assuming considering nesting at level 2 by age group (reflecting the athletes' context of practice). In this model we standardized (z-scores) on both dependent variables and independent variables for convenience of interpretation on the same scale for all variables, and to allow easier and faster model implementation.

### Priors

We used uninformative priors for population-level parameters and Cauchy priors (0, 0.5) for group-level effects in the initial steps of the analysis approach. For the last mod-

el including multiple independent variables (which were standardized), we used weakly informative priors, normal (0, 1) for population level effects, and Cauchy priors (0,0.5) for group-level effects.

### Model Estimation and Checking

The models were implemented via Markov Chain Monte Carlo (MCMC) simulation using Hamiltonian Monte Carlo and its extension, the No-U-Turn Sampler. The MCMC simulations were implemented in using Stan probabilistic programming language (Stan Development Team, 2015), obtained using "brms" package (Burkner, 2017) available as a package in the R statistical language (R Core Team, 2015). We ran four chains for 2000 interaction with a warm-up length of 1000 interaction to ensure convergence of the chains. The convergence of the Markov chains was examined by visual inspection of the trace-plots. We used posterior predictive checks to confirm that we did not omit relevant interactions (Gelman et al., 2013).

## Results

Descriptive statistics for the all sample, grouped by age group and maturity status are summarized in Table 1. There was substantial variation between athletes for all variables. Inspection of credible intervals showed a substantial variation in body size and functional capacity indicators between players grouped by age group and by maturity status. However, substantial variation by both age group or maturity status was present for DAP dimensions. No relation was observed between DAP dimensions with body size and functional capacity, partitioning the substantial variation between players by age group and maturity status.

**Table 1a**

Descriptive statistics (mean and 95% confidence intervals) for the all sample and for players by age group

	All sample	Age group		
		Under-13	Under-15	Under-17
Chronological age, yrs	13.65 (13.17 to 14.12)	12.00 (11.63 to 12.39)	13.99 (13.68 to 14.30)	15.86 (15.34 to 16.38)
Maturity offset, yrs	0.42 (-0.01 to 0.85)	-1.14 (-1.54 to -0.74)	0.85 (0.53 to 1.17)	2.16 (1.63 to 2.71)
Stature, cm	169.5 (165.7 to 173.2)	159.1 (154.0 to 164.8)	174.1 (170.2 to 178.2)	176.3 (169.6 to 183.0)
Body mass, kg	62.5 (58.1 to 66.9)	55.18 (47.9 to 63.6)	66.9 (61.3 to 72.2)	65.17 (57.73 to 72.94)
<i>Functional performance</i>				
Yoyo, m	763 (663 to 863)	673 (424 to 858)	800 (665 to 954)	829 (663 to 1083)
Line Drill, s	35.25 (34.37 to 36.05)	37.48 (36.41 to 38.54)	34.60 (33.75 to 35.45)	32.88 (31.46 to 34.30)
Performance Score, z	0.01 (-0.53 to 0.53)	-1.55 (-2.24 to -0.83)	0.52 (-0.06 to 1.09)	1.46 (0.47 to 2.40)
<i>Developmental Assets</i>				
Support	3.65 (3.51 to 3.80)	3.66 (3.48 to 3.85)	3.66 (3.49 to 3.83)	3.62 (3.36 to 3.81)
Boundaries and expectations	3.42 (3.26 to 3.56)	3.45 (3.26 to 3.68)	3.42 (3.25 to 3.60)	3.33 (3.02 to 3.56)

	All sample	Age group		
		Under-13	Under-15	Under-17
Commitment to learning	2.81 (2.57 to 3.05)	2.85 (2.57 to 3.18)	2.78 (2.49 to 3.05)	2.83 (2.49 to 3.18)
Positive values	2.69 (2.46 to 2.91)	2.69 (2.41 to 2.97)	2.66 (2.39 to 2.92)	2.72 (2.41 to 3.07)
Positive identity	3.15 (2.95 to 3.33)	3.22 (2.96 to 3.52)	3.06 (2.79 to 3.30)	3.20 (2.88 to 3.57)

**Table 1b**

Descriptive statistics (mean and 95% confidence intervals) for the all sample and for players by estimated maturity status category

	Maturity Status		
	Pre-PHV	Circum-PHV	Post-PHV
Chronological age, yrs	11.80 (11.28 to 12.34)	13.22 (12.81 to 13.61)	15.10 (14.71 to 15.49)
Maturity offset, yrs	-1.55 (-1.92 to -1.18)	0.09 (-0.20 to 0.38)	1.82 (1.53 to 2.10)
Stature, cm	152.1 (147.9 to 156.4)	168.9 (165.6 to 172.2)	179.7 (176.4 to 182.9)
Body mass, kg	48.50 (41.53 to 56.32)	63.50 (58.25 to 68.80)	69.82 (64.47 to 75.16)
<i>Functional performance</i>			
Yoyo, m	523 (347 to 712)	655 (524 to 785)	1004 (858 to 1140)
Line Drill, s	37.65 (36.25 to 39.01)	35.81 (34.79 to 36.79)	33.40 (32.40 to 34.43)
Performance Score, z	-1.69 (-2.50 to -0.91)	-0.53 (-1.13 to 0.05)	1.44 (0.84 to 2.04)
<i>Developmental Assets</i>			
Support	3.68 (3.49 to 3.91)	3.62 (3.42 to 3.79)	3.66 (3.49 to 3.84)
Boundaries and expectations	3.50 (3.28 to 3.79)	3.45 (3.27 to 3.65)	3.34 (3.11 to 3.54)
Commitment to learning	2.85 (2.54 to 3.20)	2.80 (2.52 to 3.08)	2.79 (2.50 to 3.07)
Positive values	2.70 (2.40 to 3.00)	2.69 (2.42 to 2.97)	2.68 (2.40 to 2.95)
Positive identity	3.18 (2.94 to 3.45)	3.13 (2.91 to 3.35)	3.13 (2.91 to 3.34)

## Discussion

This study examined whether developmental assets varied differently between adolescent basketball players when grouped by age group or by maturity status. In particular, we used a multidimensional approach to examine the relations of body dimensions and functional capacities, which are expected to vary substantially by age and/or maturity status, with developmental assets.

It has been reported participation in sport programs may promote positive youth development because its powerful context to promote positive environments, besides its link with healthy development throughout life (Côté and Hancock, 2016; Fraser-Thomas, Côté and MacDonald, 2010; Benson, Scales and Syvertsen, 2011). Positive youth development through sports programs might play a vital role facilitating development of youth at risk, especially those who are underfunded and overburdened, developing youth's physical, intellectual, emotional and social aspects

(Fraser-Thomas, Côté and Deakin, 2005). The present data was based on observations within an organized basketball program from an underserved context in the São Paulo metropolitan region. The present sample showed higher values for developmental assets compared with Brazilian underserved youth participating in extra-curricular sports programs (Reverdito et al., 2017). Also, the present sample results were comparable with observations within organized Portuguese school sports programs (Santos, Carvalho and Gonçalves, 2018). Overall, the present results provide support the potential benefits of organized youth sports programs, including participation in organized competitive youth sports, probably promoting quality of support (interactions with coaches and other significant peers) offered within an organized club program in contrast to an extensive extra-curricular sports program for underserved communities.

Overall, the results showed that developmental assets variation between the adolescent basketball players was not substantially influenced by chronological age or biological maturity status. The stability of developmental assets with chronological age is consistent with previous observation in youth sports (Santos and Gonçalves, 2016). However, to the best of our knowledge, there is no available data considering the influence of biological maturation on developmental assets among young athletes. Overall, our results suggest that maturity- and age-associated variation, implying substantial differences in body size and functional performance between players, do not influence the development of personal characteristics (such as commitment to learning and positive identity), contextual characteristics (such as family support, school attendance) and having available community resources.

Body dimensions and physiological performance are important determinants of performance in basketball (Drinkwater, Pyne and McKenna, 2008), hence highly valued by coaches when selecting or promoting young athletes. The lack of relation of size and basketball-specific functional performance with developmental assets suggest that playing advantages in youth basketball, whether by size or physiological performance advantages, do not influence directly in personal development. Hence, young players' perceptions and personal development may be more related with other external factors than biological determinants. These likely include the role of coaches, parents and peers (Fraser-Thomas et al., 2010; Reverdito et al., 2017; Santos et al., 2018).

The present multidimensional approach is particularly relevant when considering recent calls to organize youth competitions classifying players by estimated maturity status, bio-banding (Cumming et al., 2017a; Cumming et al., 2017b). These calls are based on the argument that classification by maturity status could help players' development, affecting their performance skills and their behavioural characteristics (Cumming et al., 2017a; Cumming et al., 2017b). Conditioned on the data, the personal development of young players likely to be sufficiently promoted

positively in the current training and competitive youth sports programs.

Also, as a possible limitation of the bio-banding proposal, the present study is limited by the estimation of biological maturity status. It has been noted a poor agreement between maturity classifications based on skeletal age and those based on percentage of predicted mature height and predicted age at peak height velocity (Malina, Silva, Figueiredo, Carling and Beunen, 2012). Considering our study observations, the offset protocol has been noted to have limited sensitiveness to rank young players correctly by maturity status, thus caution interpreting and generalizing our results is warranted.

## Conclusion

In youth sports, basketball in particular, positive youth development has been considered as a main positive consequence of youth sports programs participation. In the present study there was no substantial variation in developmental assets of adolescent basketball players by age or estimated maturity status. Also, from a multidimensional perspective, there was no influence of body dimensions and functional capacities with developmental assets. The present data about young athletes' personal development and their perceptions about sport experience provides important information to promote positive youth development through organized sports. Potential implication may be even more relevant in contexts of social vulnerability such as the context considered in the present study.

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## Activos de desarrollo en jugadores de baloncesto adolescentes: influencia de la edad, maduración, tamaño y capacidades funcionales

### Resumen

Se ha mencionado que la participación deportiva tiene una influencia importante en el desarrollo positivo de la juventud (PYD) en muchos aspectos de la vida, como componentes sociales, físicos, fisiológicos e intelectuales. El objetivo de este estudio fue verificar las influencias del tamaño corporal, los cambios relacionados con el crecimiento y la edad en los activos de desarrollo. Este estudio de diseño transversal incluyó a 45 jugadores adolescentes de baloncesto de  $13.6 \pm 1.5$  años. Los participantes se involucraron en un programa de entrenamiento estructurado en clubes y compitieron en una competencia a nivel estatal, supervisada por la *Federação Paulista de Basketball* (Federación estatal de baloncesto de São Paulo). Hubo una variación sustancial entre los atletas para todas las variables. La inspección de intervalos creíbles mostró una variación sustancial en el tamaño corporal y los indicadores de capacidad funcional entre los jugadores agrupados por grupo de edad y por estado de madurez. Sin embargo, una variación sustancial por grupo de edad o estado de madurez estuvo presente para las dimensiones DAP. No se observó ninguna relación entre las dimensiones de DAP con el tamaño corporal y la capacidad funcional, dividiendo la variación sustancial entre jugadores por grupo de edad y estado de ma-

durez. En el presente estudio no hubo una variación sustancial en los activos de desarrollo de los jugadores de baloncesto adolescentes por edad o estado de madurez estimado. Además, desde una perspectiva multidimensional, no hubo influencia de las dimensiones corporales y las capacidades funcionales con los activos de desarrollo.

**Palabras clave:** baloncesto juvenil; características psicológicas; talento y desarrollo; modelo multinivel.

### **Ativos de desenvolvimento em adolescentes jogadores de basquetebol: influência da idade, maturação, tamanho e capacidades funcionais**

#### **Resumo**

A participação esportiva tem sido referida como uma importante influência no desenvolvimento positivo de jovens (PYD) em muitos aspectos ao longo da vida, tais quais componentes sociais, físicos, psicológicos e intelectuais. O objetivo deste estudo foi verificar influências do tamanho corporal, mudanças relacionadas ao crescimento e idade nos ativos de desenvolvimento. Esse estudo de desenho transversal considerou 45 adolescentes do sexo masculino jogadores de basquete de  $13.6 \pm 1.5$  anos. Os participantes estavam engajados em um programa de treinamento de clube estruturado e competiam no nível estadual, supervisionado pela *Federação Paulista de Basketball* (Federação estadual de São Paulo). Não houve variação substancial entre os atletas para todas as variáveis. A observação dos intervalos de confiança mostrou uma variação substancial nos indicadores de tamanho corporal e capacidade funcional entre os jogadores agrupados por grupo etário e estágio de maturação. Entretanto, uma variação substancial foi encontrada tanto pelo grupo etário quanto para o estágio de maturação nas dimensões do DAP. Não foi observada relação entre as dimensões do DAP com o tamanho corporal e capacidade funcional, considerando a variação substancial entre os jogadores por agrupamentos grupo etário e estágio de maturação. No presente estudo, não houve variação significativa nos ativos de desenvolvimento de jogadores de basquete pela idade e nem pelo estágio maturacional estimado. Também, pela perspectiva multidimensional, não houveram influências do tamanho corporal e das capacidades funcionais com os ativos de desenvolvimento.

**Palavras-chave:** Basquetebol de jovens; características psicológicas; talento e desenvolvimento; modelação multinível.

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