Longitudinal Changes in Physical Characteristics, Motor Abilities, and Game Performance in Youth Male Basketball Players Based on Biological Maturity

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PURPOSE

- Differences in biological maturity influence the physical and physiological development of youth athletes.
- However, the impact of these differences on game performance remains unclear.
- This study aimed to examine longitudinal changes in physical characteristics, motor abilities, and game performance in youth basketball players, categorized by biological maturity status.

METHODS

Thirty-one male youth basketball players participated in this study. Participants were categorized into two groups based on the difference between their chronological age (CA) and predicted age at peak height velocity (APHV) at baseline: a pre-PHV group (CA < APHV) and a post-PHV group (CA > APHV) (Table 1).

Physical characteristics were assessed by measuring height and body weight. Motor abilities were evaluated using a 20-m sprint test, change-of-direction (COD) deficit, countermovement jump (CMJ), and isometric knee extension force (IKEF) (Figure 1). The COD deficit percentage was calculated as follows: [(Pro-agility test time − 20 m sprint time) / 20 m sprint time] × 100 (*Freitas et al., 2022*)

Table 1. Physical Composition Across Maturity Groups

	pre-PHV (CA < APHV, n = 18)		post-PHV (CA > APHV, n = 13)	
	Baseline	6 months later	Baseline	6 months later
Chronological Age (yrs)	12.8 (0.3)	13.4 (0.3)	13.5 (0.6)	14.0 (0.6)
Year from APHV (yrs)	-0.6 (0.5)	0.1 (0.5)	0.9 (0.5)	1.4 (0.4)
Height (cm)	152.9 (5.9)	156.8 (5.8)	167.7 (5.8)	170.1 (5.0)
Body mass (kg)	40.4 (3.6)	44.2 (3.7)	56.5 (5.6)	59.9 (6.0)

Note : Mean (SD)

Game performance was measured using an inertial measurement unit (IMU) (Figure 2), including total distance traveled and the number of high-intensity actions (sprints, CODs, and jumps). Measurements were conducted at two time points: July 2024 (baseline) and January 2025 (six-month follow-up). A 2 (group: pre- vs. post-PHV) × 2 (time: baseline vs. follow-up) repeated-measures ANOVA was used to analyze changes in physical characteristics, motor abilities, and game performance associated with biological maturity over the six-month period.

Figure 1. Setup for Measuring Isometric Knee Extension Force (IKEF) Using a Handheld Dynamometer

Figure 2. Placement of the IMU (KINXON, Germany)

RESULTS

【Physical Characteristics】

The post-PHV group had greater height and body weight than the pre-PHV group (height; $p<0.001$, $\eta^2_p=0.607$, body weight; $p<0.001$, $\eta^2_p=0.721$). Both groups showed significant increases over six months group (height; $p<0.001$, $\eta^2_p=0.862$, body weight; $p<0.001$, $\eta^2_p=0.681$). There was a significant interaction for height ($p=0.005$, $\eta^2_p=0.243$) but not for weight (Figure 3).

* $p < 0.05$ vs pre-PHV group
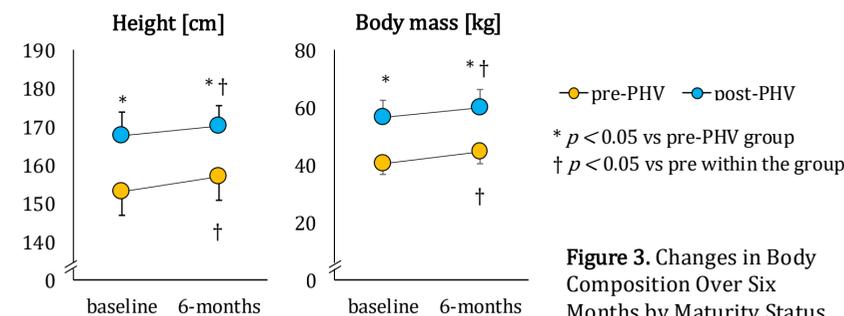† $p < 0.05$ vs pre within the group

Figure 3. Changes in Body Composition Over Six Months by Maturity Status

【Motor Abilities】

The post-PHV group had significantly better 20-m sprint time and CMJ than the pre-PHV group (sprint; $p=0.015$, $\eta^2_p= 0.208$; CMJ; $p=0.010$, $\eta^2_p=0.226$), but no significant change over time. No significant differences were observed for COD deficit or LEF (Figure 4).
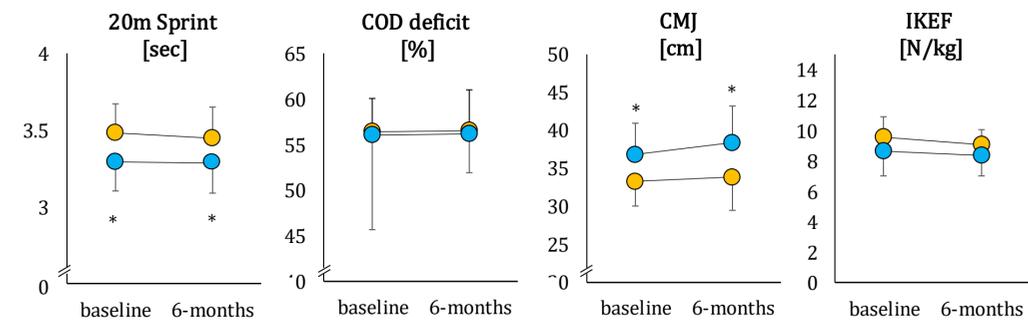
* $p < 0.05$ vs pre-PHV group   † $p < 0.05$ vs pre within the group

Figure 4. Changes in Motor Ability Over Six Months by Maturity Status

【Game Performance】

The pre-PHV group covered greater distances during games than the post-PHV group ($p<0.001$, $\eta^2_p=0.383$). At 6 months, the distance traveled by the post-PHV group increased ($p=0.027$, $\eta^2_p=0.175$). There was no interaction between group and time (Figure 5-A)).

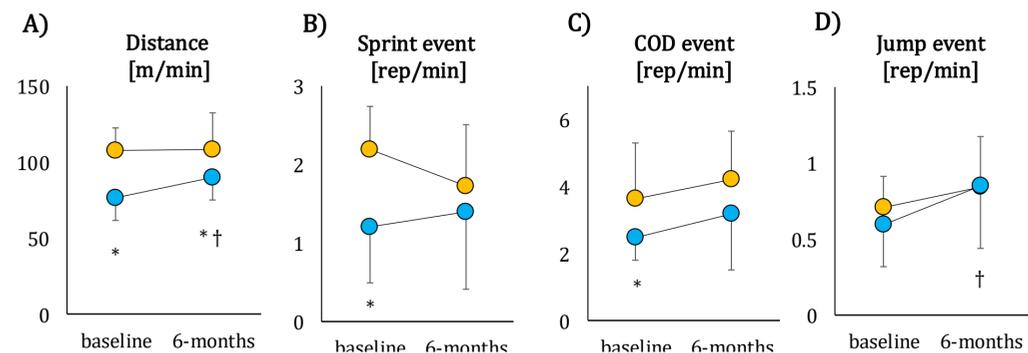* $p < 0.05$ vs pre-PHV group   † $p < 0.05$ vs pre within the group

Figure 5. Changes in Game Performance Over Six Months by Maturity Status

The pre-PHV group had more sprints frequency at baseline ($p=0.021$, $\eta^2_p=0.187$), but this difference disappeared after six months (Figure 5-B)). COD frequency was higher in the pre-PHV group ($p=0.025$, $\eta^2_p=0.179$) (Figure 5-C)). Jump frequency increased significantly in the post-PHV group after 6 months ($p=0.018$, $\eta^2_p=0.198$) (Figure 5-D)).

CONCLUSIONS

Longitudinal changes over six months showed different patterns in physical growth, motor performance, and game performance, depending on the athletes' biological maturity level. These findings highlight the importance of tailoring training approaches based on maturity status.

PRACTICAL APPLICATIONS

Coaches should consider both the degree of development of motor abilities at different maturity levels as well as game performance when designing training programs for youth basketball players.

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