Maturity-Associated Longitudinal Variations in Resistance Exercise-Induced Acute Hormonal Responses in Young Male Athletes

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Background

- Resistance training is recognized as an effective method to improve young athletes' performance (e.g., muscle strength and motor skills) *(Lesinski et al., 2016)*.
- Participating young athletes in strength and conditioning programs that are tailored to their developmental stage is widely recommended *(Lloyd et al., 2016)*.
- A cross-sectional study showed that exercise-induced hormonal responses would be related to biological maturity *(Sekine et al., 2022)*.
- The longitudinal changes of exercise-induced hormonal responses within the same individual as maturation progresses are unclear.

Purpose

The purpose of this study was to examine the maturity-associated longitudinal changes of the exercise-induced hormonal response in male adolescents among different maturity levels.

Methods

1. Experimental Approach

Fifteen junior high school male basketball players (Age: 12.9 ± 0.6 yrs, Height: 163.1 cm, Body mass: 51.7 kg) volunteered to participate. According to the difference between the predicted age at peak height velocity (APHV) and the chronological age (CA) estimated at baseline measurement, the participants were assigned to the pre-PHV group (CA < APHV, n = 7, CA: 12.9 ± 0.6 years, APHV: 13.4 ± 0.6 years) and post-PHV group (CA > APHV, n = 8, CA: 13.0 ± 0.5 years, APHV: 12.2 ± 0.6 years). To examine the acute hormonal responses to resistance exercise in young athletes, the levels of testosterone and cortisol were assessed before (pre), immediately after (post), and 15 minutes after the training program. The training protocol included basic resistance exercises using the body weight (RE–BW), which apply a relative load on the athlete and can be performed in any environment. The testosterone to cortisol ratio (T:C ratio) was calculated as an indicator of the positive anabolic state. Measurements were performed in May from 2018 (baseline) to 2019 (12 months later), and the participant's consecutive 1-year data were utilized. A three-factors (2 [groups] × 2 [years] × 3 [measurement time]) repeated measures of analysis of variance were performed for the 1-year biological maturity-associated changes to the exercise-induced hormonal responses.

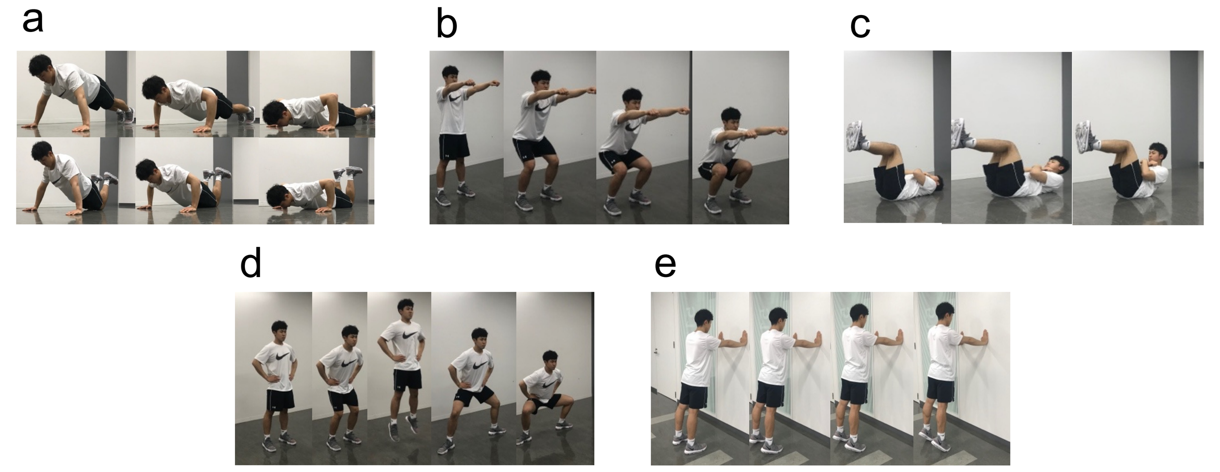
2. Participants

	pre-PHV (CA < APHV, n = 7)		post-PHV (CA > APHV, n = 8)	
	Baseline	12 months later	Baseline	12 months later
Chronological Age (yrs)	12.9 (0.6)	13.9 (0.6)	13.0 (0.5)	14.0 (0.5)
Year from APHV (yrs)	-0.5 (0.2)	0.5 (0.2)	0.8 (0.6)	1.8 (0.6)
Height (cm)	158.3 (5.4)	165.1 (5.6)	167.1 (6.3)	172.1 (6.4)
Body mass (kg)	47.5 (6.6)	53.2 (4.0)	56.2 (7.9)	63.4 (9.5)

APHV: Age at Peak Height Velocity CA: Chronological Age

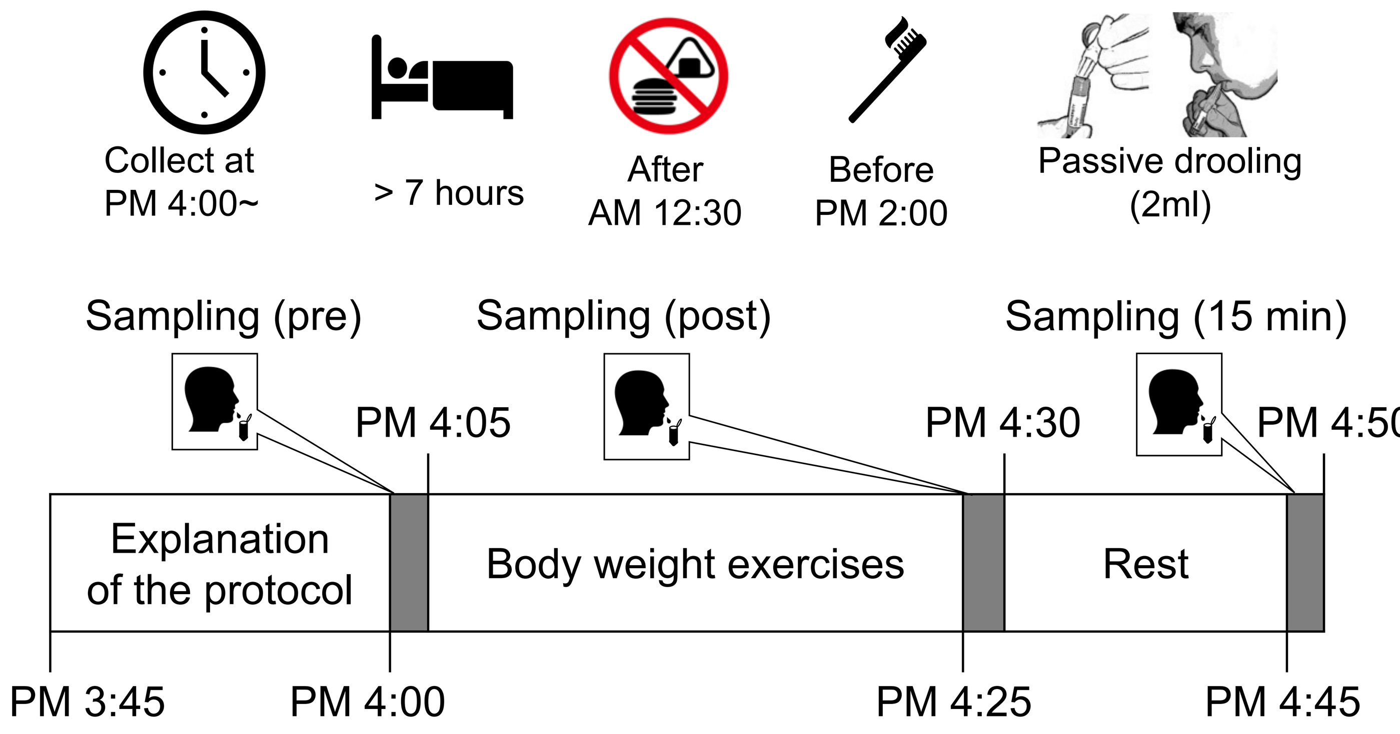
3. Body Weight Exercise

	Exercises	Ex. Time	Sets	Rest Time	Tempo
a.	Push Ups	20 sec.	3	60 sec.	1 rep / 1 sec.
b.	Squat (parallel)	20 sec.	3	60 sec.	1 rep / 1 sec.
c.	Drop Squat (wide)	20 sec.	3	60 sec.	1 rep / 1 sec.
d.	Calf Raise	20 sec.	3	60 sec.	1 rep / 1 sec.
e.	Abs. Crunch	20 sec.	3	60 sec.	1 rep / 1 sec.



4. Saliva Collection & Analysis

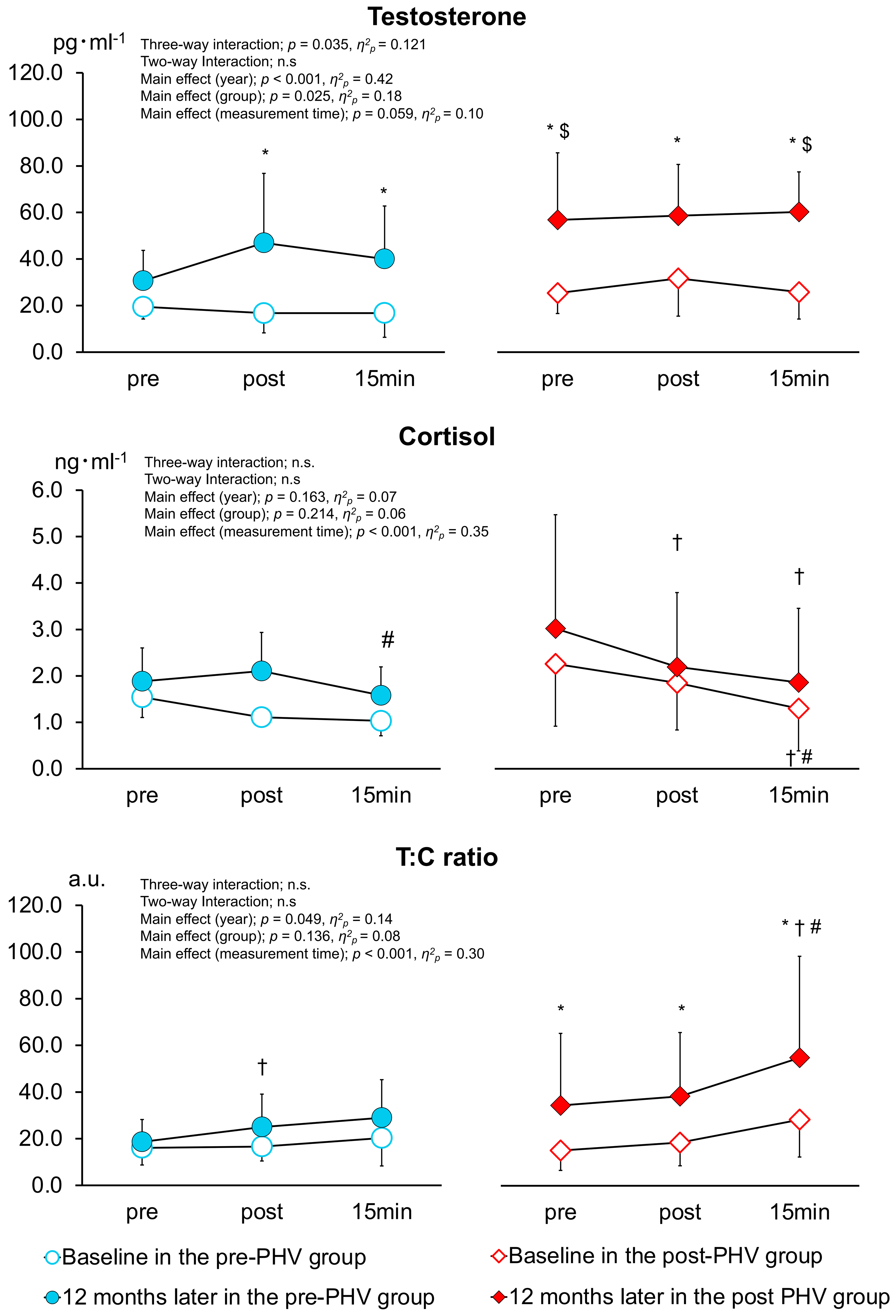
3-1. Saliva collection



3-2. Enzyme-Linked ImmunoSorbent Assay (ELISA)

Collected saliva → Centrifuge (3000 rpm) and stored at -80℃ until assay.
Targets：**Testosterone**, **Cortisol** (DiaMetra srl.), and
The ratio of Testosterone and Cortisol (**T:C ratio**) *(Gaviglio et al.,2015)*

Results



* $p < 0.05$ vs Baseline within the group at the same measurement time
† $p < 0.05$ vs pre, # $p < 0.05$ vs post within the group
$ $p < 0.05$ vs 12 months later in the pre-PHV group at the same measurement time

Testosterone

- The significantly higher testosterone levels in the post-PHV group which was recognized at the baseline were observed 12 months later.
- No changes in testosterone responses after exercise in either of the two measurement years.

Cortisol

- The exercise-induced decrease in cortisol levels was observed in both PHV groups.
- The volume and/or intensity were insufficient to increase the cortisol concentration.

T:C ratio

- The increase was by the decrease in cortisol secretion, not the increase in testosterone secretion.
- Positive anabolic states in the post-PHV group might be influenced by the interactive effects of the longitudinal increase of testosterone level and the exercise-induced decrease of cortisol secretion.

Conclusion

In junior high school age, the maturity level is insufficient to occur the exercise-induced testosterone secretion responses although the testosterone levels increase as the maturity process naturally.

Practical Application

When setting training goals for adolescent athletes, the resistance exercise-induced anabolism by testosterone should be lower priorities than other performance-improving variables (i.e., muscle strength, sprinting speed, agility, and jump).

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