BJSM Online First, published on February 28, 2008 as 10.1136/bjsm.2007.040386

Is Explosive Performance Influenced by Androgen Concentrations in Young Male Soccer Players?

Authors:

Carlo Baldari[1], Luigi Di Luigi[2], Gian Pietro Emerenziani[1], Maria Chiara Gallotta[3], Paolo Sgrò[2], and Laura Guidetti[3]

[1] Unit of Endocrinology, Department of Health Sciences, University of Rome “IUSM”, Rome, Italy
[2] Unit of Sport Sciences, Department of Health Sciences, University of Rome “IUSM”, Rome, Italy
[3] Unit of Physical Exercise Sciences, Department of Health Sciences, University of Rome “IUSM”, Rome, Italy

Corresponding author:

Professor Carlo Baldari
Unit of Sport Sciences, Department of Health Sciences,
University of Rome “IUSM” / Istituto Universitario di Scienze Motorie
Piazza Lauro De Bosis, 15
00194 Roma -Italy

e-mail: carlo.baldari@iusm.it
tel: +39 06 36733227
fax: +39 06 36733231

Key words Anthropometric characteristics, explosive leg power, standing long jump, steroid hormone,

ABSTRACT

Objective: There is growing interest in the implementation and assessment of strength and conditioning programs among young children. The purpose of this study was to examine the association between given anthropometric characteristics, pubertal development, salivary androgen hormones and explosive leg power in young soccer players.
Methods: Fifty-one (age range 10-14 yr) soccer players were investigated. The relations between age, pubertal developmental stages, testicular volume, weight, height, body fat, fat free mass, salivary DHEAS concentrations, salivary testosterone concentrations and lower limb explosive power were evaluated.
Results: Standing long jump length was positively correlated ($p<0.05$) with age (11.7 (1.2) yr; mean (SD), $r=0.66$), pubertal developmental stages (mode and range: 1 (1-4), $rho=0.64$), testicular volume (8.8 (5.2) ml, $r=0.58$), height (1.50 (0.10) m, $r=0.34$), weight (43.7 (9.1) kg, $r=0.34$), fat free mass (35.4 (7.2) kg, $r=0.67$), salivary DHEAS concentrations (4.4 (1.2) ng/ml, $r=0.38$) and negatively correlated with body fat (18.6 (7.0) kg; $r=-0.49$, $p<0.05$). There was no significant correlation between salivary testosterone concentrations (0.3 (0.1) ng/ml, $r=0.12$) and standing long jump.
Conclusions: Results of the present investigation demonstrated that age, pubertal developmental stages, testicular volume, weight, height, fat free mass, and salivary DHEAS concentrations were associated with standing long jump performance. In addition, salivary testosterone concentrations were not related to explosive leg power. Results of the present investigation suggest that the teacher/coach should evaluate long jump performance relative to the subject's given biological characteristics, and not simply established standards based on chronological age.

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INTRODUCTION

Talent identification can be useful for prediction of success in adult elite competition and for determination of appropriate development processes to achieve adult success and most efficient use of material resources [1]. Moreover if talented youngsters are provided with the best coaching and training from an early age, the probability that they will become elite players could increase. For this reasons there is growing interest in the implementation and assessment of strength and conditioning programs among young children [2, 3]. This interest is particularly true in professional sports in which a reliable identification of future elite performers at an early age represents for the teams an effective financial investment. Specific sports require physiological variables that are important to successful performance, such as mobility in artistic gymnastic, anaerobic capacity in sprinters, explosive leg power in long jump and high jump, etc. Obviously these parameters change during the growth and it would be of interest to assess the anthropometric characteristics and hormonal parameters that could influence specific performance.

Previous studies showed the effect of training on muscle strength in young male soccer players [4, 5, 6,]. Moreover, contribution of anthropometrics characteristic and maturity status to indicators of functional capacity and sport-specific skill were considered in a sample of adolescent soccer players (age 13-15) [7, 8]. Malina et al [7] showed that in young male soccer players aged 13-15 years the performances in the vertical jump improve with the increase of their sexual maturity. During the last years, the physiological and psychological issues surrounding physical performance in children and adolescents have been deeply assessed [9, 10, 5, 11, 12].

More recently the interest about the role of endocrine system status in influencing both athletic performances and the hormone response to exercise-related stress is increasing [9, 10, 13]. This new point of view is necessary since chronological age could not correspond with biological age and consequently a high inter-individual variability of certain parameters (pubertal stage, testosterone concentrations, salivary cortisol, etc.) could be found within the same class of athletes selected for chronological age. [10]. Within a chronological age group, boys who are advanced in sexual and skeletal maturity perform, on average, better in strength, power and speed tasks compared to boys who are later in sexual and skeletal maturity [7].

The acceleration of muscle strength during puberty, observed in boys, might be related to elevated levels of circulating androgen hormones in adolescents. In particular, most of the studies focused on the effect of testosterone on muscle size and strength [11, 14, 15]. Dehydroepiandrosterone (DHEA) is a steroid classified as a weak androgen, and is also a precursor of more potent sex hormones. It is found in the circulation in two forms, one unconjugated and the other conjugated as its sulphate ester DHEAS [16]. Few data are available about the effects of DHEA in sport [17, 18] and the relationship between DHEAS and growth [19]. No data are available about the relation between salivary androgen hormones and explosive performance in young male soccer players. For this reasons, the aim of this study was to examine the relationship of given anthropometric characteristics, pubertal development, and salivary androgen hormones to explosive leg power in young players.

METHODS

Subjects

Fifty-one soccer players from two successful clubs in the area of Rome were investigated. All participants and their parents gave their written informed consent according to protocol approved by the University Scientific Commission and by the University Ethical Committee. All participants were tested during the 2005-06 Italian competitive soccer season at the beginning of the annual training program. Measurements for each participant were undertaken according to three categories: anthropometric characteristics, pubertal development, and salivary androgen hormones. The procedures in each category are described in turn.

Experimental Approach to the Problem

The purpose of this study was to examine the association between given anthropometric characteristics, pubertal development, salivary androgen hormones and explosive leg power in young soccer players. For this purpose in the same testing session saliva samples were collected to determine DHEAS and testosterone concentrations and anthropometric characteristics were also assessed. Subsequently all subjects performed a standing long jump. One week before starting the experimental evaluations, all the subjects underwent a preliminary clinical screening assessment for detecting of the risk factors that might contraindicate participation in the study. Endocrine exclusion criteria were: precocious or delayed puberty, testis hypotrophy or absence, cryptorchidism, and any other clinically relevant endocrine diseases. All subjects also underwent a careful examination in order to avoid teeth, mouth, upper gastrointestinal and respiratory problems, interfering with salivary steroid evaluations.

Anthropometric characteristics

Skinfold thicknesses were assessed using a Harpenden calliper (St. Albans, UK) to the nearest 0.2 mm, on the right side of the body, with the subjects in standing position. Percentage of body fat was estimated using a two-skin-folds measurement method for children and youths [20]. Standing height was measured by a stadiometer (St. Albans, UK) to the nearest 0.1 cm and body mass was measured on a digital scale with an accuracy of 0.1 kg. Fat free mass was assessed as the difference between body mass and fat mass.

Pubertal development

Puberty was assessed according to the method of Tanner et al. [12] for pubic hair development (P1 to P5) and also by means of a Prader orchidometer (New York, USA) for testicular volume evaluation [21].

Androgen hormones

All subjects gave saliva samples by using a cotton swab and saliva collecting tube (Salivette, Sarstedt, **G**ermany). The sample was taken before a standing long jump. To reduce possible stress-related confounding factors, all the subjects and their respective parents were advised to avoid any relevant stressors starting 24 h before until the saliva collection. Contamination with food debris was avoided by rinsing the mouth with water and by delaying the collection for 15 min after rinsing to prevent sample dilution. In the same experimental day saliva collecting tubes were centrifuged at 2000 g for 10 min, then saliva samples were stored -40°C until they were assayed. All the saliva samples were analyzed for testosterone and DHEAS.

Standing long jump

The standing long jump assessed the explosive leg power. It was performed as a two-foot takeoff and landing. The takeoff was from behind a line on the floor, and the landing was in a pit of sand. The subjects jumped as far as they could and they were allowed the use of countermovement with the arms and legs. The distance from the takeoff to the point where the nearest heel touched the sand was measured in centimetres, and the best of two jumps was recorded.

Statistical analysis

Descriptive data for anthropometric characteristics, androgen hormones and standing long jump are reported as mean (SD), whereas data for pubertal development are reported as mode (range). Correlation results were analyzed with Pearson linear regression for comparisons of linear data (anthropometric characteristics, androgen hormones and standing long jump), or nonparametric Spearman rank correlation (correlation coefficient Rho corrected for ties, and tied *p*-value) for comparisons that included the ordinal pubertal development data. The level of significance was established at $P<0.05$ for all statistics. Statistics were performed using StatView (version 5.0.1 for Windows; SAS Institute Inc. Cary, NC, USA).

Results

The characteristics of the subjects are presented in Table 1.

Table 1 – Subject characteristics and their correlation with standing long jump.

	Mean (SD)	*r* value	Mode (range)	*rho* value
Age (yr)	11.7 (1.2)	0.66*		
Height (m)	1.5 (0.1)	0.67*		
Weight (kg)	43.7 (9.1)	0.34*		
Fat free mass (kg)	35.4 (7.2)	0.60*		
Body fat (%)	18.6 (7.0)	-0.49*		
Pubertal developmental stage (Tanner's stage)			1 (1–4)	0.64*
Testicular volume (ml)	8.8 (5.2)	0.58*		
Salivary DHEAS concentration (ng/ml)	4.4 (1.2)	0.38*		
Salivary testosterone concentration (ng/ml)	0.3 (0.1)	0.12		

Values are means (SD) or mode (range)
*$p < 0.05$, significant correlation vs standing long jump.

Standing long jump length was positively correlated ($p<0.05$) with age($r=0.66$), pubertal developmental stages ($rho=0.64$), testicular volume ($r=0.58$), height ($r=0.34$), weight ($r=0.34$), fat free mass ($r=0.67$), salivary DHEAS concentrations ($r=0.38$, fig 1) and negatively correlated with body fat ($p<0.05$). There was no significant correlation between salivary testosterone concentrations ($r=0.12$, fig 2) and standing long jump.

Discussion

In the present study we evaluated the possible relationship of anthropometric characteristics, pubertal development, and androgen hormones to explosive leg power in young male soccer players. We observed that except salivary testosterone concentrations all anthropometric characteristics and salivary DHEAS concentrations were correlated with standing long jump. It is not surprising that body fat is negatively correlated with standing long jump.

The adolescent grown spurt varies considerably in timing and duration among individuals and consequently it could be found a high inter-individual variability of certain parameters (pubertal stage, testosterone concentrations, salivary cortisol, etc.) within the same class of athletes selected for chronological age. This high inter-individual variability could determinate a high difference about the performance results.

Our results showed that boys who were advanced in biological maturity were generally better performers than their later maturing peers. This is in accordance with findings reported by Malina et al [7]. The authors reported that performances in the vertical jump favoured the more sexually mature players (stage 4 and 5) compared to pre-pubertal (stage 1) and early pubertal (stage2) players. Boys in mid-puberty (stage 3) tended to perform at an intermediate level. Then, one might expect adolescent boys in the later stages of puberty to perform better in strength and power tasks compared to boys in early or mid-puberty.

Biological maturity is strongly influenced by circulating androgen hormones. Muscle strength acceleration observed in boys during puberty might be related with elevated levels of circulating androgen hormones in adolescents. Our results showed a positive correlation between salivary DHEAS concentrations and explosive leg power. On the other hand, salivary testosterone concentrations were not correlated with standing long jump. DHEAS and testosterone hormones play a basic role during growth. DHEAS is a precursor of a numerous androgens (testosterone) and estrogens. A previous study showed that acute administration of DHEA increases serum androstenedione but not testosterone in healthy young men [18]. Nevertheless, testosterone induces an increase in muscle size and strength [22]. The different relationship between salivary DHEAS, salivary testosterone concentrations and standing long jump could be due to their different concentration in circulation during growth. In fact DHEAS concentrations in the fetus are high, but its secretion decreases rapidly during the first year of life. Moreover, it increases significantly from 6 to 7 years of age and reaches the maximum levels in women at about 24 years and in men at about 30 years of age [19, 23]. Plasma testosterone steadily declines after the age of 30 years in men [24]. Testosterone does not significantly increase between Tanner stage 1 and 2, but it significantly increases after stage 2 until stage 5 [25]. Pubertal stage mode of our subjects was 1 and consequently it could be possible that they had reached high DHEAS concentrations while high testosterone concentrations were not already reached. For this reasons salivary DHEAS concentrations were significantly correlated with standing long jump while salivary testosterone concentrations were not.

In summary, explosive performance in young male soccer players (Pubertal developmental stage mode and range were 1 and 1-4 respectively) was related to change in salivary DHEAS concentration and it was also influenced by age, pubertal developmental stage, testicular volume, height, weight, fat free mass, and body fat. On the contrary, standing long jump was not influenced by salivary testosterone concentrations. These results suggest that coach's realistic expectations and proper evaluations should be in accordance to the subject's given biological characteristics and not simply to established standards based on chronological age. We also suggest that physical education programs should be planned on the bases of biological age and classes of physical activity should be organized according to subjects' biological characteristics and not according to their chronological age.

Competing interest: none declared

Figure legends

Figure 1 Relationship between standing long jump and salivary DHEAS concentrations in young soccer players (n = 51).

Figure 2 Relationship between standing long jump and salivary testosterone concentrations in young soccer players (n = 51).

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Summary boxes:

What is already known on this topic

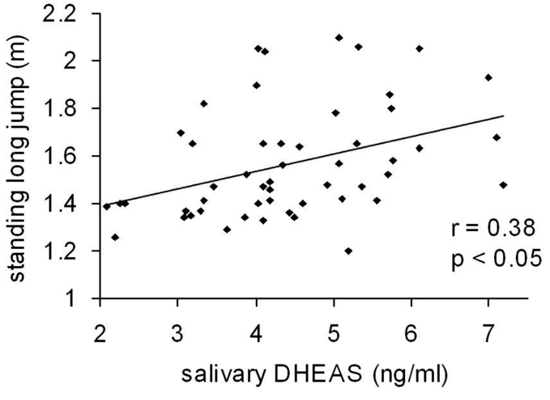
Chronological age could not correspond with biological age and consequently a high inter-individual variability of physiological parameters could be found within the same class of athletes selected for chronological age.

No data are available about the relation between salivary androgen hormones and explosive performance in young male soccer player.

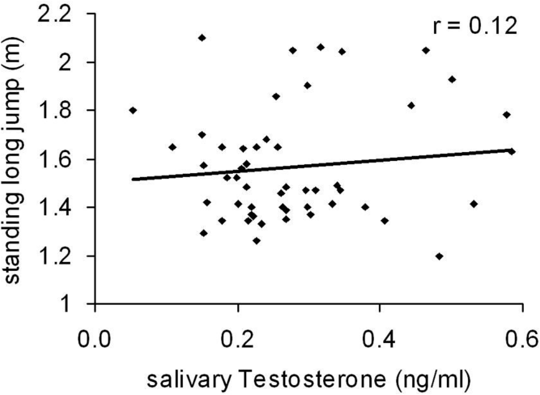
What this study adds

Salivary DHEAS concentrations were significantly correlated with standing long jump while salivary testosterone concentrations were not.

Coach's realistic expectations and proper evaluations should be in accordance to the subject's given biological characteristics and not simply to established standards based on chronological age.



2.2
2
1.8
1.6
1.4
1.2
1
standing long jump (m)
r = 0.38
p < 0.05
2
3
4
5
6
7
salivary DHEAS (ng/ml)


r = 0.12
standing long jump (m)
2.2
2
1.8
1.6
1.4
1.2
1
0.0
0.2
0.4
0.6
salivary Testosterone (ng/ml)

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Br J Sports Med published online February 28, 2008