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Review Article

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Growth and Functional Development in 6 to 10 Years Old Soccer Players: Constraints and Possibilities

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ABSTRACT

Sport and more specifically football is an important asset in youth lives. It is widely considered that biological maturity influences physical performance. Relationships between body size and performance are partly confounded by age. In fact, age is positively associated to strength and motor performance, even when height and weight are controlled. Studies on young footballer have been started to consider the potential impact of variation on growth and biological maturity status upon sport-specific football skills. Some authors suggest that physical training should have a low priority until the late puberty and then the time could be devoted to other types of training such as focusing on technical aspects. However, the question remains that is this due to low trainability or inadequacies of training programs? A brief review of the literature was conducted with three specific exclusion criteria including the age of footballers, relation of age with performance, and studies on football. There are critical periods in the life of a young person, in which the effects of training can be maximized. Thus, a special attention should be paid to developing football skills by regarding the performance and full respect to youth development. Many papers have been published on functional capacities and dimensions in pre-adolescence and adolescence, but less information are available concerning the ages between 6 and 10. Hence, this paper aims to highlight some aspects of this age period and provide an understanding of important aspects of growth, development, and maturation is particularly important, as a youngster's football performance may depend heavily on gender and biological age and state.

Key Words: Adolescent, Football, Growth, Functional, Development.

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INTRODUCTION

The practice of football starts very early, around the age of five years old, in Portugal, although the inclusions in regulated championships only occur in the ages of 10 and 11 years old. It is a fact that early specialization compromises development over the years (1).

It is widely considered that biological maturity influences physical performance. Children can be advantaged/disadvantaged by being more or less mature than the counterparts of the same chronological age (2-6). There is evidence for a mid-growth spurt in childhood in stature and probably in other dimensions in many, but not all, children (7). As reported in another study (2), controversy exists during training do not appear to affect these young athletes' growth and development. In addition, their continued success in sport appears to be related to inherited traits.

Inter-individual differences at the moment and timing of the principal events of puberty and growth processes contribute to an enormous variability in morphology and functional capacities of children and youth (7). Therefore, directors and coaches tend to privilege and choose early matured boys, especially when related to aspects like size and height (8, 9). Much has been written regarding functional capacities and dimensions in pre-adolescence and adolescence, but there is less information concerning the ages between 6 and 10. The present paper aims to highlight some aspects of this age period.

Childhood and development

Studying the functional and structural characteristics of athletes has a long history in physical education and sport sciences (10). Childhood is a sensitive period in human life and interference with the growth process in the early years of life may bear long-term consequences for health in adulthood (4).

Childhood is usually divided in two phases including the early phase and the middle phase. The first one consists of what is usually called the years of "elementary school". It starts at about 5-6 years old and continues until 10-11 years old. The middle childhood is the period of arbitrariness because it is followed by adolescence, which could be very different from childhood. The end of adolescence is also very dependent on both external (social factors) and internal (timing of growth) factors and that is why it is difficult to determine when adulthood begins (9).

It is important to understand that growth, maturation, and development occur simultaneously and interact with each other. However they may not follow the same timeline (11). Maturity-associated variation in size, muscularity, and physical competence begins to manifest in the years preceding adolescence, about at 9-10 years old in girls and at 11-12 years old in boys (12). Therefore, one single system of maturity assessment may not be sufficient for a complete description of growth and performance among adolescents, since children of the same age may vary considerably in their degrees of biological maturity or maturity status (13). A child's maturity status will influence measures of growth and performance and the difference between children of contrasting maturity groups are primarily due to size differences (11).

Growth and timing of development

Nature versus nurture? In sport, as in other immensely varied aspects of human development, the answer resides within both realms. Growth refers to measurable changes in size, physique, body composition, and various systems of the body (3). Biological factors, such as body size and maturity

status, have been documented as predictors of athlete selection and performance in several sports (7). Although regular practice of football does not seem to increase height and body mass in children at the ages of 10 and 11 years old (14), variations in the size of young players (footballers in this particular case) should be recognized by coaches/trainers (15).

Relationships between body size and performance are partly confounded by age. In fact, age is positively related to strength and motor performance, even in the case that stature and weight are controlled. This positive relation suggests an important role of neuromuscular maturation and experience in performance on strength and motor tasks in children (7). Athletes in both sexes and in most sports have, on average, heights and weights that are equal or higher than the reference values for the general population of children and adolescents (6, 9, 16, 17), and distal-to-proximal growth occurs at this age (11).

Doing the "right" training at the "right" time by a child can maximize his/her future potentials in sport as an adult. The intensity and timing of the adolescent growth spurt are highly individual and variable, but identifying the spurt is useful for detecting early, moderately or lately matured girls and boys (5, 7, 18), and these tend to be more prevalent in elite groups.

Mean body weights and heights of young footballers fall within the bounds of 25th and 75th percentiles of United States reference data. The trend of the body size suggests, in general, appropriate weight for height during childhood and early adolescence (19). One of the most straightforward aspects for a coach to analyse is the relationship between height and weight. For example, a 10-year-old midfielder is on the 25th percentile for height and 75th for weight (18). For both boys and girls, the height velocity at age has a spurt of around 8 years and decreases until 10 years, whereas height grows systematically (20).

Studies do not suggest that training alters the biological maturity of the growing athlete, but the studies suggesting otherwise are cross-sectional. Longitudinal studies indicate that young athletes, on average, grow and mature in a similar manner compared with non-athletes (16). Another study referred that tennis players and swimmers were all tall for their age. However, footballers in that study were above and below 50th centile (2).

Therefore, these differences are due to biological maturity and can be of decisive importance. These characteristics may have a profound effect on the selection in a higher competitive level (19, 21). However, there are studies that present data in variation in body size, function, and sport-specific skills associated with maturity status in adolescent male young footballers (22), goal orientation (23), and elite youth academies (24).

On the other hand, another study (16) emphasizes that physique is an important contributor to the success in many sports and may be of particular importance in aesthetic sports. Physical activity has been shown to optimize growth in children (25), as they are expected to grow and increase in weight and height.

There is much variation among individual gain, on average, about 5-8 cm per year and about 2-3 kg per year between 6 and 10 years age. Although height and weight increase gradually during childhood, around 9-10 year old in girls and 11-12 year old in boys, the rate of growth in height increases more rapidly (9). The real studies that can assess maturity status are longitudinal ones (26). In fact, early matured children attain a greater percentage of their adult stature at each age than the middle and late matured children (5), so we can assume that there is specific age dynamics of somatotype development in young footballers (27).

Another study (28) examined the relationship between biological maturity status, body mass index, age, and perceptions of adult autonomy support in young footballers, aged 9 to 15 years old. They found that maturity status was unrelated to perceptions of autonomy support, and maturity status may have little or no social significance at these age ranges. The physical and functional demands associated with different sports and different standards of competition could also influence the nature of these relationships.

When observing individual growth patterns, it is acknowledgeable that all children exhibit patterns of growth more or less parallel to a particular centile (canalization). The apparent acceleration of height sometimes observed is likely a reflection of the earlier biological maturation of the studied subjects rather than an effect of the intensity of the training programme (16).

The multilateral development emphasis should be placed ahead when elaborating youth programs, because larger muscles are more developed than smaller ones. Another research (29) emphasizes that coaches should be careful in using body size as cut-points in sport and should be aware of individual differences. They should also be aware of expected developmental changes and how they influence performance (9, 11).

DISCUSSION

Functional capacities in childhood

Size, physique, and functional characteristics of young athletes typically reflect the demands of specific sports. Football is a sport that requires a high degree of both skill and athleticism (30). Young footballers classified as elite and non-elite, or as being high and low in football ability, for example, differ in body size and maturity (12).

During the growth spurt, first you stretch and then you fill them out. The body mass index (BMI) increases with age through childhood and adolescence, and into adulthood (5, 19). The overall size is of importance in strength tests, because strength is related to body size and especially fat-free mass (5).

Between the ages of 8 and 12 years old, a child is mature enough to learn skills (and knowledge). Learned the right skills at this time, the child will become a physically gifted adult. If they are wrongly taught, it would be a great deal to produce optimum performance. For many years, the use of resistance training to increase muscular strength and endurance in prepubescent and adolescent boys and girls was highly controversial. A comprehensive study on the mechanisms responsible for strength increase in prepubescent boys concluded that the likely determinants of the strength gain are as follows:

- Improved motor skill coordination
- Increased motor unit activation
- Other undetermined neurological adaptations

There are certain times when a pre-adolescent will quickly and optimally respond to a certain type of training more than others (See Table 1). For example, boys' window skill resides between the ages of 9 and 12 years old and between 8 and 11 years old for girls. The 8-year-old athlete coordination and muscle control continues to become finely-tuned; the young athletes will show off their skills in the sports field.

Performance in a variety of strength, speed, and power improves more or less proportionally to gains in body size, as with the improvement of balance and coordination in ages of 5 to 8 years old. In the transition to adolescence (8 to 12 years old), performance in motor skill (many are anaerobic), strength, and endurance (aerobic) tasks, on average, improves with age (7). The regular practice of football has a positive effect on the performance of motor

skill, speed, and agility of boys at the ages of 10 and 11 years old. The best performance of the practitioners of football was probably caused by regular practice of football, which also seems to provide acceleration of physical growth (6).

Table 1. Guidelines for Resistance Training in Children

Age(Years)	Considerations
6 years olds	Skill practice and development
7 years old	Introducing basic exercises with little or no weight: teach exercise techniques Speed training Practicing and developing the skills Developing the concept of a training session Progressing from bodyweight calisthenics, partner exercises and lightly resisted Keeping volume low
8-10 years old	Gradually increasing the number of exercises and training volume Learn to train Practicing and developing the skills Practicing the exercise technique in all lifts Keeping exercises simple Starting gradual, progressive loading of exercises, carefully monitoring toleration to the exercise stress

An important implication for youth football is that individual growth velocities should be taken into account. However, some authors indicate that they respond to resistance training with gains in strength, possibly due to changes in coordination of the nervous system (9, 29).

In this line of thought, another study (31) states that youth sport programs should focus on the control and regulation of mechanisms of speed training during childhood rather than on the metabolic and muscular mechanisms, which should be emphasized after puberty, despite the predominance of strengthening the musculature responsible for game posture (32). Some studies (33-35), when talking about speed, point out that the higher rates in the development of velocity (force velocity or short duration endurance), based on coordination activities, appears at the ages of 6-9 years old.

Obviously, muscular strength increases gradually during the early childhood and continues to improve with age during the middle childhood. Motor performance is partly related to muscular strength (7). On the other hand, absolute strength is probably less trainable in pre-pubertal than in pubertal and post-pubertal youth, with minimal or no muscular hypertrophy, despite the overall importance of strength training in pre-adolescence. Although at the ages of 8-10 years old child boys and girls could initiate explosive training in a structured and general way, muscular endurance emphasizes on general harmonious development of all muscle groups (36). Another discussion in literature concerns genre differences around muscle gain is whether sex differences exist in pre-pubertal years or not (29), they suggest that younger boys make greater relative gains in muscular strength, while older boys make greater gains in muscular endurance.

The cardiorespiratory system is developing and aerobic capacity is adequate for most activities (37). Despite this, children have a limited ability to perform anaerobic activities, indicating a lower glycolytic capacity. It is also known that until 12 years old and the onset of puberty, differences concerning V02 max are minimal (17, 31). In fact, changes in VO2 peak per body weight in children less than 10 years old with systematic training are generally small, with relatively low trainability that is enhanced with the transition into puberty/adolescence (29).

In a study on 35 boys and girls aged 10.9 to 12.8 years old who participated in a 12-week aerobic training program, the average change in VO2 peak per body weight was 6.5% (38). These findings suggest that correlation between physiological indices of adaptation to submaximal exercise is generally low between 8 and 11 years old (5). Therefore, it should be better to consider changes in submaximal work efficiency in response to training.

Some authors suggest that physical training should have a low priority until the late puberty and then a specific time could be devoted to other types of training such as focusing on technical aspects (39). However, this question remains that is this due to low trainability or inadequacies of training programs? And how can the sport retain or protect skilled smaller, late matured boys as they progress through adolescence? These results suggest differential responses to the type of training stimulus depending upon age.

It should be noticed that elite footballers spend a lot of time trying to improve physical capacities, including aerobic endurance and strength and the strength derivatives of speed and power (40). On average, boys excel in tasks that require power and speed, such as jumping, throwing, and running, whereas girls excel in tasks that require balance, such as hopping. Nevertheless, muscular endurance improves linearly with age from 5 to 13 or 14 years old in boys, followed by a spurt similar to that for static strength. The degrees of freedom of children in this age period permits motor learning in a considerable way, through spontaneous capacity of imitation (34). Lessons for training of youth players may be drawn from, on the one hand, observations on the demands of elite competition and, on the other hand, observations on training responses of young players (41).

Performance in Childhood

Under 12 years old, activities must be fun and not overly technical. Practices must be selected in a way that set the foundation for skill and physiological development. The former Easter European countries used to follow such a practice, known as being ‘physically literate’. Performance is understood as a complex multidimensional phenomenon that interrelates organic, motor, and cultural factors. These factors are modified in accordance to three processes of growth, maturation, and motor experience (42). Children are very responsive to systematic instructional and training programs for the development of motor skills. The concept of trainability refers to the responsiveness of individuals to a specific training regime and is related to critical periods and readiness as it refers to maturational presupposes (17, 29, 31, 42-44).

The main objective of this phase should be the overall development of physical capacities and fundamental movement skills in boys aged 6 to 9 years old and in girls aged 5 to 8 years old. The key points of this phase are as follows:

- Training programs, based on the school year, are structured and monitored
- Speed, power, and endurance are developed using fun and recreational games
- Participation in as many sports as possible
- ABC's of athletics
- Strength training with exercises which use the child's own body weight; medicine ball, and fitness ball exercises

The coach of young athletes also need to be mindful of growth spurts in a young athlete's life when they will be less coordinated, due to the way their body and limbs are rapidly growing. As it is often suggested, children and youngsters are more susceptible to the effects of training during the periods of rapid growth, with particular emphasis on pubertal period (5), with later implications on performance (19). As some authors argue, advanced biological maturity status constitutes an asset positively associated with the selection of process and success in several sports in the early adolescence (5, 19, 45, 46), as chronological age and sport specialization increase. It is also possible that late-matured boys are selectively dropped out of footballers as age and sport specialization increase (46).

When dealing with children aged 6 to 7 years old, they have acknowledged mature fundamental movements and are starting to make a transition generally to sport movements (7-10 years), predisposing the child to a new performance with age (5, 7, 47, 48). Concomitantly, performance in a variety of fundamental motor tasks also improves during the early childhood and improvement with age is linear for all tasks except balance test (5). So, to present maturity status of motor development in numerous abilities, it is important to possess all fundamental differentiated abilities (36). Indeed, another investigation (5) states that strength and motor performance of pre-adolescent children are influenced by the interrelationships among chronological age, skeletal age, and body size, so that it is difficult to partition the specific effects of maturity-associated variation on proficiency in tests of strength and motor performance.

A study concludes that increase in body size during growth and maturation is strongly correlated with increase in physiological performance measures (49). Sport training during growth depends on the morphological characteristics and stage of maturation (50). The latter argues that at the upper limit of middle childhood it may be difficult to partition learning effect from those associated with growth and maturation. An overall emphasis should be placed on general endurance training with big attention to the fundamentals and overall flexibility (37).

For 8-year-old individuals, this period of physical development continues to be one of the refinements. If the young athletes have athletic ability, this will be the time when his/her coordination, muscle control, and overall physical development become more accurate and precise. During the preschool years and extending into middle childhood, children develop basic competence in fundamental movement patterns such as running, jumping, skipping, etc. Football shows little variation in size by position, and

the late matured and skilled youngster often succeeds (19). Talent identification in football should be oriented to searching and developing aerobic capacity, anaerobic capacity, coordination, fatigue resistance, stress resistance, tactic intelligence, and group cohesion (42). It seems 3 vs. 3 small sided games provide not only the best opportunity for game-related activity but also the better physiological training stimulus for young players (41). Another study (32) states that in this particular age, dynamic and active mobility exercises are essential in children's sport repertoire, although it is known that the sporting trajectories through the youth program are intermittent (8).

They experience their first experience of youth sport programs at 5 to 6 years old, they have their first experience in youth sport (9, 29), developing the basic movement patterns but not all have yet mastered these basic movements. Coaches and teachers should therefore, guide, instruct, understand, and provide environments of positive learning as well as well-organized intentional programs (51), or such measures as single year age/playing groups to reduce the range of maturity-associated variation among youth players (15). As football is a team sport, players from the same team can differ considerably in physique due to their individual pace in development (26).

CONCLUSION

An understanding of important aspects of growth, development, and maturation is particularly important, as a youngster's football performance may depend greatly on gender and biological age and state. We know many factors are involved in successful athletic performance during childhood, and from a bio-cultural perspective, other characteristics play an important role in determining success. We must nurture our children so that their nature can be optimized in sport settings as in lifespan, and always be sharp at the particular characteristics of each child. Also, sport actors must be cautious in developing and implementing training regimes for the enhancement of functional characteristics and sport-specific skills in children and adolescents.

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رشد و نمو عملکردی در فوتبالیست‌های ۱۰- ۶ ساله: محدودیت‌ها و امکانات

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- بخش پژوهش، دانشکده تربیت‌بدنی و علوم ورزشی، دانشگاه کویمبرا، کویمبرا، پرتقال.

چکیده

ورزش‌ها و بطور خاص فوتبال در زندگی جوانان یک دارایی مهم محسوب می شود. بطور گسترده‌ای ملاحظه شده که بلوغ بیولوژیک بر اجرای بدنی اثر می‌گذارد. ارتباط میان اندازه بدن و اجرا بطور جزئی توسط سن مورد مداخله قرار می‌گیرد. در حقیقت، سن بطور مثبتی با قدرت و اجرای حرکتی همبسته است حتی زمانی که قد و وزن کنترل شوند. مطالعات بر روی فوتبالیست‌های جوان شروع شد تا تأثیر بالقوه تغییرات در سن و وضعیت بلوغ بیولوژیک به مجرد مهارت‌های ویژه فوتبال مورد ملاحظه قرار گیرد. برخی نویسندگان پیشنهاد می‌کنند که تمرین بدنی باید غلبه کمی تا اواخر دوران بلوغ داشته باشد، و از این پس می‌توان به انواع دیگر تمرین مانند تمرکز بر وجوه تکنیکی زمان اختصاص داد. با اینحال، این سؤال باقی است که آیا این مسأله در نتیجه قابلیت تمرینی پایین، یا عدم کفایت برنامه‌های تمرینی است؟ بدین منظور مروری کوتاه بر ادبیات پیشینه با سه معیار خاص خروج از مطالعه شامل سن فوتبالیست‌ها، ارتباط سن و اجرا، و مطالعات فوتبالی صورت گرفت. دوره‌های حیاتی در زندگی افراد جوان وجود دارد که در آن اثرات تمرین می‌تواند بیشینه شود. از این رو، توجه ویژه‌ای برای توسعه مهارت‌های فوتبال با عنایت به اجرا و توجه کامل به نمو جوانان باید نمود. مطالعات زیادی بر ابعاد و ظرفیت‌های عملکردی در دوره پیش- نوجوانی و نوجوانی صورت گرفتند، اما اطلاعات کمتری در رابطه با سنین ۶ تا ۱۰ سال موجود است. بنابراین، این مطالعه قصد دارد برخی وجوه این دوره سنی را روشن کند و درکی از وجوه مهم رشد، نمو، و بالیدگی را مهیا کند که بطور ویژه اهمیت دارد، بطوریکه اجرای فوتبال یک نونهال احتمالاً بستگی بسیار زیادی به جنسیت، و سن و وضعیت بیولوژیک داشته باشد.

واژگان کلیدی: نوجوان، فوتبال، رشد، نمو، عملکردی.

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