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Effect of Pubertal Maturation on the Development of Anaerobic Power (in College students 11-16 years of Algeria)

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Abstract

The aim of this long study was to examine the pattern of change of boy's anaerobic power during the different stages of puberty.

82 sedentary scholar boys aged from 11 to 16 years agreed to been followed for 2 years, in their schools. We proceed to measure the different anthropometric indicators. Stages of maturation were estimated according to Tanner's classification. The evaluation of the anaerobic process was done through the speed-force's test of Vandewalle. The results show that the majority of morphological indicators of the population developed very significantly from the first to the fourth stage of puberty. The transition from the second to the third stage of puberty seems decisive in the evolution of major morphological and physiological effort parameters. From stage 1 to stage 4 there has been a very significant development ($p<0.001$) of Anaerobic Maximal Power (Wanmax) and Maximum Force (Fo).

Among boys, the passage from the second to the third stage of puberty seems decisive in the evolution of principles morphological and physiological parameters of the effort.

Keywords: puberty stages, anaerobic power, scholar boys, anthropometric indicators.

Introduction

Childhood and adolescence as transitions to adulthood, have a number of important features that play a role in the possibilities of physical and mental effort.

The growth and maturation of speeds differ among children. A variety of factors can influence the growth and maturation as genetic inheritance, nutritional history and overall health. Regarding the effort capacity, it appears that puberty brings substantial changes and distinct physical potential in the same chronological age (GRODJINOVSKYA and BAR-OR, 1984; MURASE, 1981. Aires et al, 2010). In contrast to adults, children and adolescents have the so-called sensitive phases during which the optimal development of the main forms of effort can be made to varying degrees and at different times. Physiologically a pre-pubescent child is characterized by a relatively well developed aerobic metabolism compared to adults. Aerobic maximum opportunities and muscle oxidative enzyme activities deviation (Krebs cycle) are equal and even often superior to those of adults. Instead lactic anaerobic metabolism is commonly regarded as inefficient and immature pre-pubescent ages. The maximum power characterizes the energy sector and its measurement has long been a definite interest in monitoring and improving anaerobic physical skills in different sports. Furthermore anaerobic metabolism of children is relatively little studied; Yet the spontaneous physical activity in children is largely made up of short sprints where anaerobic metabolism is widely sought. Measuring the power of anaerobic metabolism becomes important in children since it is the ideal time to detect young talents and guide them towards explosive sports. The increase in lactic anaerobic power and alactic was found according to age (GRODJINOVSKYA and BAR-OR, 1984; MURASE 1981). Some recent research question this immaturity of anaerobic system during childhood (RATEL and Martin, 2012). The muscle glycolytic enzyme activities are always lower than those of adults. The anaerobic ability, unlike aerobic abilities seems closely related to muscle mass, as well as other factors such as muscle architecture, fiber composition, substrate availability, accumulation of metabolites (lactic acid), metabolic cycles and their activity levels (KEMPER, 1985; Tanner, 1962).

Intense and persistent efforts, with above maximum intensities (> VO2max), are frequently encountered in team sports and are mostly made spontaneously by the children. The adaptation and evaluation of workouts or physical education and sport for a better physical performance without harming the health of young practitioners is one of the major concerns of sports educators. To account for the effects of puberty and considering the significant changes that accompany adolescence we studied the maximum anaerobic power based on the five stages of pubertal Tanner staging (1962). These stages take into account the state of maturation of sex organs and development of body hair. The purpose of this study is to assess anaerobic power of Algerian schoolchildren non-athletes during their biological development.

Materials and methods

Eighty-two (82) sedentary college boys aged 11 to 16 years participated in the study after parental consent. The protocol was carried out within their school.

Protocol

Each subject was examined before being allowed to follow the following protocol which was used on three occasions over a period of two years:

The following anthropometric measurements were taken:

- Assessing the height using a fathom;
- Assessment of body weight using a balance type HB-LO5;
- Measurement of the perimeters of the body (maximum perimeters biceps, thigh, calf) using a tape measure;
- Measurement of four skinfolds (biceps, triceps, subscapular, supra-iliac) with a pair of skin folds (type Harpenden);
- The percentage of fat (% PF) was obtained by the method of four skinfolds in the words of Durnin and Rahaman (1967);
- We calculated lean body mass (LBM) :(LBM = mass -% PF / 100);

Anthropometric measurements were all carried out on the left side of the body by the same examiner.

Determination of pubertal stages according to Tanner staging (1962). These indices distinguish five maturation levels characterizing the sexual modifications undergone by the growth path in body:

- Stage 1: existence of pubic fuzz. Testicles, scrotum and penis size even in childhood;
- Stage 2: a few scattered hairs, long, straight or curly at the base of the penis. Increasing the volume of the
 scrotum and testicles. Volume penis little or no change;
- Stage 3: denser hair, thicker and curlier extending little above the pubic symphysis. Scrotum and testicles as
 well as increase penis length;
- Stage 4: adult appearance, but the hair region remains less extensive (no extension to the thighs). Penis

Enlargement and development of the glans. Testes and scrotum continue to grow. Dark color;

- Stage 5: hairiness has adult appearance location and quantity. Extension of the hair region thighs. Adult genitalia.

Evaluation anaerobic process by the test Force-speed Vandewalle (1989): for test-load speed, we used a cycle ergometer weight type Monark (894th model, Sweden). This was linked to a computer that calculates micro among other peak power output. The test is performed on a cycle ergometer whose wheel undergoes a braking force caused by tensioning a strap in proportion to the weight hanging on the end. A resistance of 4 kg is imposed on the first attempt and will grow from 2 in 2 for the following efforts up to 12 Kg. The subject makes the sprint 6 seconds maintaining the sitting position. Five events, with a different strength, are performed. The test is stopped when the speed reaches 90 revolutions / min. A passive recovery 3 to 5 minutes is required between levels. Fo values (maximum force), Vo (maximum speed) and Wanmax (Maximum Power), are directly on a graph.

Statistical analysis

The results were expressed by their average and standard deviations based on the pubertal classification. We conducted analyzes of variance (ANOVA) to study the evolution of the various parameters at different stages of biological maturation.

Results:

On the morphological parameters as shown in Table 1, we found a very significant change in all indices from first to fourth pubertal stage (S1 to S4) except for percent fat (% PF).

Pubertal Stages	AGE (an)	Height (cm)	Weight (kg)	Percentage of Fat (% P.F.)	Lean Body Mass (LBM) (kg)
S 1 (n= 13)	12.30	150.46	43.38	10.74	38.42
	± 0,6	*± 7,13*	*± 8,26*	*± 4,84*	*± 5,63*
S 2 (n= 32)	13.15	155.30	44.36	7.72	40.24
	± 0,7	*± 7,32*	*± 8,13*	*± 4,63*	*± 6,35*
S 3 (n= 23)	14.04	163.11	52.61	9.8718	46.49
	± 0,8	*± 6,91*	*± 9,19*	*± 7,84*	*± 6,80*
S 4 (n= 14)	14.99	168.00	56.31	8.72	50.93
	± 0,6	*± 5,7*	*± 6,88*	*± 2,55*	*± 5,87*

Table 1: Morphological clues as pubertal stages

In general it was found (Table 2) from stage 1 to stage 4 there has been a very significant change ($p < 0.001$) Anaerobic Max Power (Wanmax) and the Maximum Strength (Fo). The evolution of the Maximum speed (Vo) was less significant ($p < 0.05$) during the same interval.

Pubertal Stages	Wan max (watts)	Fo (kgf)	Vo (trs/mn)
S 1 (n= 13)	265.97	7.56	173.12
	± 64,03	*± 2,28*	*± 83,35*

S 2 (n= 32)	327.02	9.65	147.61
	± *100,55*	± *2,41*	± *20,35*
S 3 (n= 23)	448.61	10.92	172
	± *104,72*	± *2,38*	± *21,30*
S 4 (n= 14)	544.50	14.38	168.51
	± *116,46*	± *5,87*	± *20,88*

Table 2: The physiological indices according to pubertal stages

The most significant (Table 3) were identified from S2 to S4, especially between stages 2 and 3 for the indices of the Anaerobic Max Power (Wanmax) and Vo (P <0.001), and to a lesser degree Fo (P <0.05).

Pubertal Stages	**S1-S2**	**S2-S3**	**S3-S4**	**S1-S3**	**S2-S4**	**S1-S4**
	F P	F P	F P	F P	F P	F P
Wanmax	4.10 *	22.33 ***	7.58 **	19.66 ***	24.29 ***	25.88 ***
Fo	7.19 **	4.31 *	7.51 **	8.96 ***	10.29 ***	11.75 ***
Vo	2.76 ns	20.84 ***	0.27 ns	3.65 *	11.71 ***	2.92 *

Table 3: Evolution of physiological indices for all intervals of pubertal stages

Discussion

The results show that the majority of morphological indices of the study population evolved very significantly from the first to the fourth stage of puberty. These results are similar to those found by various authors (Åstrand 1976; Pineau, 1991. Weltman et al, 1986; ZAUNER, Maksud and MELICHNA 1989). This trend is more significant between stages 2 and 3, which is at the peak of growth often reported by several studies (BUCKLER, 1990; Kemper, 1985; Weltman et al, 1986;. Ortega et al. 2011).

As against this, notes the absence of a significant change in the percentage of fat (% PF) and its relative stability as reported by some researchers (Armstrong et al., 1995; HERTOGH, MICALLEF and Mercier, 1992). This can be explained by dietary habits in connection with the social conditions that do not favor the emergence of a morphotype with significant fatty layer.

One notes a very significant increase (p <0.001) of the maximal anaerobic power (Wanmax) particularly between stages 2 and 3 as observed in several studies (HERTOGH, MICALLEF and MERCIER, 1992; Lacour, 1992; Delgado, and ALLEMANDOU PERES, 1992 and 1993; VAN PRAAGH, 2007). As to the maximum force (F0) of the peak increase (p <0.001) is located between stages 3 and 4, that is, a little later than the Wanmax as has been noted by several authors (KEMPER, 1985; Pineau, 1991; BUCKLER, 1990).

Thus, these indices (Wanmax and Fo) can be faithful indicators for the sporty orientation, monitoring and evaluation of the effect of training during puberty (Van PRAAGH 2007; MAYLIST AMAS et al., 2002; VAN PRAAGH, DORE, 2002). Otherwise the very significant change (p <0.001) of the maximum speed (Vo) between stages 2 and 3 in parallel with the substantial increase of the Wanmax and Fo is indicative of severe muscle biochemical changes related to the metabolism anaerobic glycolysis described in the literature (HERMANSEN and OSEID 1971; DUCHE, BEDU and VAN PRAAGH, 2001; MELICHNA et al., 1983). In this sense several authors (Pineau, 1991. Weltman et al, 1986) showed that at this stage of sexual maturation, hormone secretion, particularly the increase in testosterone levels in males affects the great changes that appear in maximal strength and speed-strength and anaerobic capacity. The maturation may be a factor behind the increase in anaerobic power alactic (DUCHE et al., 2001). According VAN PRAAGH (1990) that power in young children is significantly lower than in adolescents and adults in absolute and relative terms. The growth of androgen production is almost simultaneous with that of the maximum force. Pubertal phase is a pivotal period corresponding to a sudden production of sex hormones with anabolic properties which allow the development of the musculature (Armstrong et al., 2000; Degache et al., 2010). Also suitable training in strength and speed especially in the pubertal stage is of paramount importance for the future development of the performance of adolescents (KEMPER and NPV of KOP, 1995; KHIAT and MEHDIOUI, 2000; MANNO 1990 ; AMAS et al, 2002).

Conclusion

It appears that genetic dispositions appear to be involved for a significant part in determining the physical performance requiring aerobic metabolism and / or anaerobic. The transition from the second to the third stage of puberty seems decisive in the evolution of the main morphological and physiological parameters of effort (TOMKINSON, 2007; ALMUZAINI, 2007). For ethical and methodological reasons there are few studies (in particular longitudinal) on anaerobic capacity of children and adolescents .In the future the use of the technique of nuclear magnetic resonance (NMR) should offer interesting opportunities investigation of stress metabolism in children.

Objective assessment of physical abilities depending on the biological maturation stage thus proves to be a key and essential element of the training process, present in all stages of its development to edit, correct, adjust, select and / or guide preparation of the young athlete in a manner best suited to its potential.

References:

1. Almuzainiks (2007): Muscle function in Saudi children and adolescents: relationship to Anthropometric characteristics during growth. *Pediatr Exerc Sci ; Vol. 19 (3), pp. 319-33.*
2. Amas M.T., Erron F.F., Noury-Desvaux B., Abraham P., Saumet J.L. (2002). Influence de la maturation et de l'entrainement sur la puissance maximale anaérobie alactique. Cinésiologie *n° 205- 41e année- p 109.*
3. Aires LB Andersen, D Mendonça, C Martins, G Silva, J Mota (2010): A 3-year longitudinal analysis of changes in fitness, physical activity, fatness and screen time Acta Pædiatrica n° 99, pp. 140–144.
4. Armstrong N., Kirby J., Mcmanus A.M. Et Welsman J.R. (1995). Aerobic fitness ofprebuscent children. *Ann. Hum. Biol. 22: 427-441.*
5. Armstrong N; Welsman J. R.; Williams C. A.; Kirby B. J.*(2000).* Longitudinal changes in young people's short-term power output**.***Medicine & Science in Sports &Exercise, 32(6):1140-1145.*
6. Astrand P.O. (1976): The children in sport and physical activity-physiology. *J.G. Albinson and G.M. Andrew (ed.). Child in sport and physical activity. Baltimore: University Park Press, pp. 19-33.*
7. Buckler J. (1990): A longitudinal study of adolescent growth. *Springer verlag, London, Berlin, 430 p.*
8. Degache F., Richard R., Edouard P., Oullion R., Calmels P. (2010): The relationship between muscle strength and physiological age: A cross-sectional study in boys aged from 11 to 15. *Annals of Physical and Rehabilitation Medicine, 53 : 180–188.*
9. Delgado A., Allemandou A. and Peres G. (1992) Evolution des qualities anaérobies et ages civil, statural et pondéral et stades pubertaires. *Sciences & Sports, 7 :37-38.*
10. Delgado A., Allemandou A. and Peres G. (1993) Changes in the characteristics of anaerobic exercise in upper limb during puberty in boys. *Eur. J. Appl. Physiol., 66 : 376-380.*
11. Duché P., Bedu M. et Van Praagh E. (2001) Explorations des performances anaérobies de l'enfant. Bilan de 30 ans de recherches. *STAPS, 54 : 109-130.*
12. Durnin J. and Rahaman M. (1967). The assessment of amount of fat in the human body from measurements of skinfold thickness. *Br. J. Nutr. 21: 681-689.*
13. Grodjinovskya A. and Bar-Or O. (1984) Influence of added physical education hours
14. Up on anaerobic capacity, adiposity, and grip strength in 12-13 years old children enrolled in sports class, *in Ilmarinen J. Valimaki I. (eds): Children and Sport. Berlin, Springer Verlag, pp. 162-169.*
15. Hermansen L. and Oseid S. (1971). Direct and indirect estimation of oxygen uptake in pre-pubertal boys. *ActaPaediatrica Scandinavia, 217: 18-23 (suppl.).*

16. Hertogh C., Micallef J.P. Et Mercier J. (1992) Puissance anaérobie maximale chez l'adolescent (étude transversale). *Sciences et Sports, 7 : 207-213.*

17. Khiat B. Et Mehdioui H. (2000). Incidence des paramètres physiologiques de l'effort sur l'orientation de l'entraînement selon l'âge pubertaire. *Sciences et Technologie du Sport, n°3 :34-40.*

18. Kemper H.C.G. (1985). Growth, health and fitness of teenagers.*Medicine and Sport Science, vol. 20, Ed. Hebblink: 202 p.*

19. Kemper H.C.G. et Van de KOP H. (1995). Entraînement de la puissance maximale aérobie chez les enfants pré-pubères et pubères. *Science et Sports, 10 : 29-38.*

20. Lacour J.R. (1992) Biologie de l'exercice musculaire. *Edition : Masson, 199 p.*

21. Maylist Amas et coll. (2002). Influence de la maturation et de l'entrainement sur la puissance maximale anaérobie alactique. *Cinésiologie n° 205- 41e année- p 109*

22. Manno R. (1990). Les bases de l'entraînement sportif. *Edition : Revue E.P.S., 223 p.*

23. Melichna J., Havlickova L., Mackova E., Spynarova S. And Novak J. (1983). The composition of the muscle fiber types in junior middle-distance runners.

24. Physician and Physical Education 6: 28-31.

25. Murase Y., Kobayashi K., Kamei S. And Matsui H. (1981): Longitudinal study of aerobic power in superior junior athletes.*Medicine and Science in Sports and Exercise,13: 180-84.*

26. Ortega F.B. et coll. (2011) Physical fitness levels among European adolescents: the

27. Pineau J.-C. (1991) Importance de la puberté sur les aptitudes physiques des garçons

28. scolaires. *Bull. et Mém. De la Soc. d'Anthrop. De Paris, t. 3, n°3-4 : 275-286.*

29. Ratel S., Martin V. (2012) Les exercices anaérobies lactiques chez les enfants :la fin d'une idée reçue ? *Science & Sports n°27, 195—200.*

30. Tanner J.M. (1962) Growth at adolescence (2nd)*ed. Oxford, Blackwell Scientific Publications.*

31. Tomkinson Gr. (2007). Global changes in anaerobic fitness test performance of children and adolescents (1958-2003). *Scand J Med SciSports , Oct; Vol. 17 (5), pp. 497-507.*

32. Van-Praagh E., (1990) Evolution du métabolisme aérobie et anaérobie au cours de la croissance, *revue S.T.A.P.S, p291-306*

33. Van-Praagh E, Doré E. (2002). Short-term muscle power during growth and maturation. Sports Med n°32:701–28.

34. Van-Praagh E. (2007). Physiologie du sport: enfant et adolescent. *De Boeck Supérieur, 288 pages.*

35. Vandewalle H. Et Friemel F. (1989). Tests d'évaluation de la puissance maximale des métabolismes aérobie et anaérobie. *Science et Sports, 4 : 265-279 .*

36. Weltman A., Janney C., Rians C.B. and al. (1986). The effects of hydraulic resistance strength training in pre-pubertal males. *Med. Sci. Sports Exerc. 18: 629-638.*

37. Zauner C.W., Maksud M.G. And Melichna J. (1989) Physiological considerations in training young athletes. *Sports Medicine 8 (1): 15-31.*