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FACTORS RELATED TO SKELETAL AGE IN NORMAL SCHOOL-BOYS

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Abstract: *Several studies (Nicoletti et al. 1978, Benso et al. 1980, Vignolo et al. 1992) indicate that in italian normal children skeletal age is advanced by 0.3 to 0.7 years with respect to Tanner charts. In this note, we examine some factors which may affect bone maturation of a set of 681 normal school-boys aged from 6.5 to 12.5 years. Data have been collected between 1977 and 1978 in the framework of the PACT survey (Programma Antropometrico per la Citta di Torino) based on a random 2-stage sample of primary and secondary school-children in Turin. Instruments and techniques used to measure auxometric traits were those recommended by the Department of Growth and Development of London University. All left hand-wrist X-rays were rated by the same assessor according to the TW2 method. RUS bone age appears to be advanced by about 0.5 years in the whole period under study, while the advancement of carpus bone age is more prominent (0.6 years) in boys aged under 9. Bone age (20-bones) is delayed by 0.4 years in boys whose height is lower than the 25th centile of Tanner charts, and advanced by 1.2 years in boys whose height is above the 75th centile. The onset of puberty does not seem to affect bone maturation. In boys with BMI (body mass index) below 15.0 (25th centile) bone age is close to chronological age, while in boys with BMI above 17.5 (75th centile) bone age is advanced by 0.9 years (RUS) and 0.6 years (carpus). The correlation between BMI and bone age could explain in part the advancement of bone maturation of italian children, whose BMI values are slightly higher than those of the coeval boys participating in the Harpenden growth study (16.5 versus 16.1)*

Key words: *skeletal moturation, TW2 bone age, height, weight, BMI.*

Introduction

Several studies (Nicoletti, Cheli, Cocco, Salvi and Socci 1978, Benso, Corradetti, Fabio, Passone, Pastorin, Rota and Stasiowska 1980, Vignolo, Milani, Cerbello, Coroli, DiBattista. and Aicardi 1992) indicate that in the Italian normal children and adolescents skeletal age is. higher than chronological age by 0.3 to 0.7 years, on the average.

This finding is usually related to the difference in the mean age at the onset of puberty ,and at the age at peak height and weight velocity, between the Italian children and the subjects participating in the Harpenden study, from whom TW2 scoring method was derived (Tanner, Whitehouse, Marshall, Healy and Goldstein 1975, Tanner, Whitehouse, Cameron, Marshall, Healy and Goldstein 1983).

This note aims at assessing to what extent RUS (radius, ulna, short bones) and carpus maturation is related to some factors, such as sexual maturation, height growth and body mass index, in a set of normal boys.

Subjects and methods

In the framework of the *Programma Antropometrico per la cittá di Torino* (PACT survey, Benso et al. 1980) 681 normal boys aged from 6.5 to 12.5 years were included in a random 2-stage sample of primary school children and of the first class of secondary school children in Torino between 1977 and 1978 . In the first stage 10 % of classes were selected, and in the second stage 20% of the children were taken from each class selected.

Instruments and techniques used to measure auxometric traits were those recommended by the *Department of Growth and Development of London University* (Cameron 1986). Conventionally, a testicular volume equal to 4 ml or more was regarded as a sign of puberty. All left hand-wrist X-rays were rated by the same assessor according to the TW2: radius, ulna and short bones (RUS) and carpus (CAR) were analysed separately.

Results

The difference TW2-RUS age *minus* chronological age shows a range (-3.2 to +4.0 years) wider than the range of the difference TW2-CAR age *minus* chronological age (-2.9 to +3.3 years). Between 10 and 12 years, pubertal children show values of TW2-RUS age slightly higher than the prepubertal children of the same age, but no difference is apparent as regards. TW2-CAR (Figure 1, top). In prepubertal boys the advancement of bone age tends to decrease with increasing age, with the only exception of a peak at the age of about 11 years: this peak is steeper for RUS (+0.72±0.15 years, *mean±standard error*) than for carpus (+0.41±0.14). The difference TW2-RUS age *minus* TW2-CAR age ranges from -2.4 to +3.4 years. Before puberty, the difference in bone age between RUS and carpus increases rather regularly with age: from -0.25±0.10 to +0.45±0.14 years (Figure 2, left). The advancement of RUS maturation over carpus maturation is particularly apparent in pubertal boys 10 years old (0.64±0.18 years).

Boys whose height is above the 75th percentile of Tanner-Whitehouse norms (1976) show a remarkable advancement of bone age, for both RUS (from 1.19±0.28 to 1.70±0.18 years) and carpus (from 1.24±0.24 in boys aged 7 to 1.45±0.18 in boys aged 12). Boys with height below the 25th percentile show a slight delay of bone maturation, for both RUS (from -0.15±0.27 to -0.84±0.22) and carpus (from -0.22±0.17 to -1.32±0.12, if we omit the value at the age of 7 years). Boys whose height is within the interquartile range are in intermediate position also for bone maturation (Figure l, centre). In boys of the same age, differences in height growth do not seem to be correlated with differences in maturation between RUS and carpus (Figure 2, right). Height growth is related to RUS and carpus maturation to the same extent: we observe an average difference of 1.62±0.11 years between boys above the upper quartile of hSDS distribution and boys below the lower quartile (Table 1, top)

Table 1: Mean differences skeletal age minus chronological age and RUS minus CAR age (years) in PACT boys, classified by quartiles of height-SDS distribution (top) and Body Mass Index distribution.

Height SDS:	**<25th** N=152	**25th - 75th** N=346	**>75th percentile** N=183
TW2-RUS age	-0.39 + 0.08	+0.47 + 0.06	+1.23 + 0.08
TW2-CAR age	-0.53 + 0.08	+0.33 + 0.05	+1.09 + 0.07
RUS - CAR age	+0.14 + 0.06	+0.14 + 0.04	+0.14 + 0.06

Body Mass Index:	**< 15.0 kg/m²** N=162	**15.0-17.5 kg/m²** N=348	**l>7.5kg/m²** N=171
TW2-RUS age	+0.09 + 0.09	+0.46 + 0.06	+0.90 + 0.09
TW2-CAR age	+0.08 + 0.09	+0.33 + 0.06	+0.60 + 0.09
RUS - CAR age	+0.01 + 0.06	+0.13 + 0.04	+0.30 + 0.06

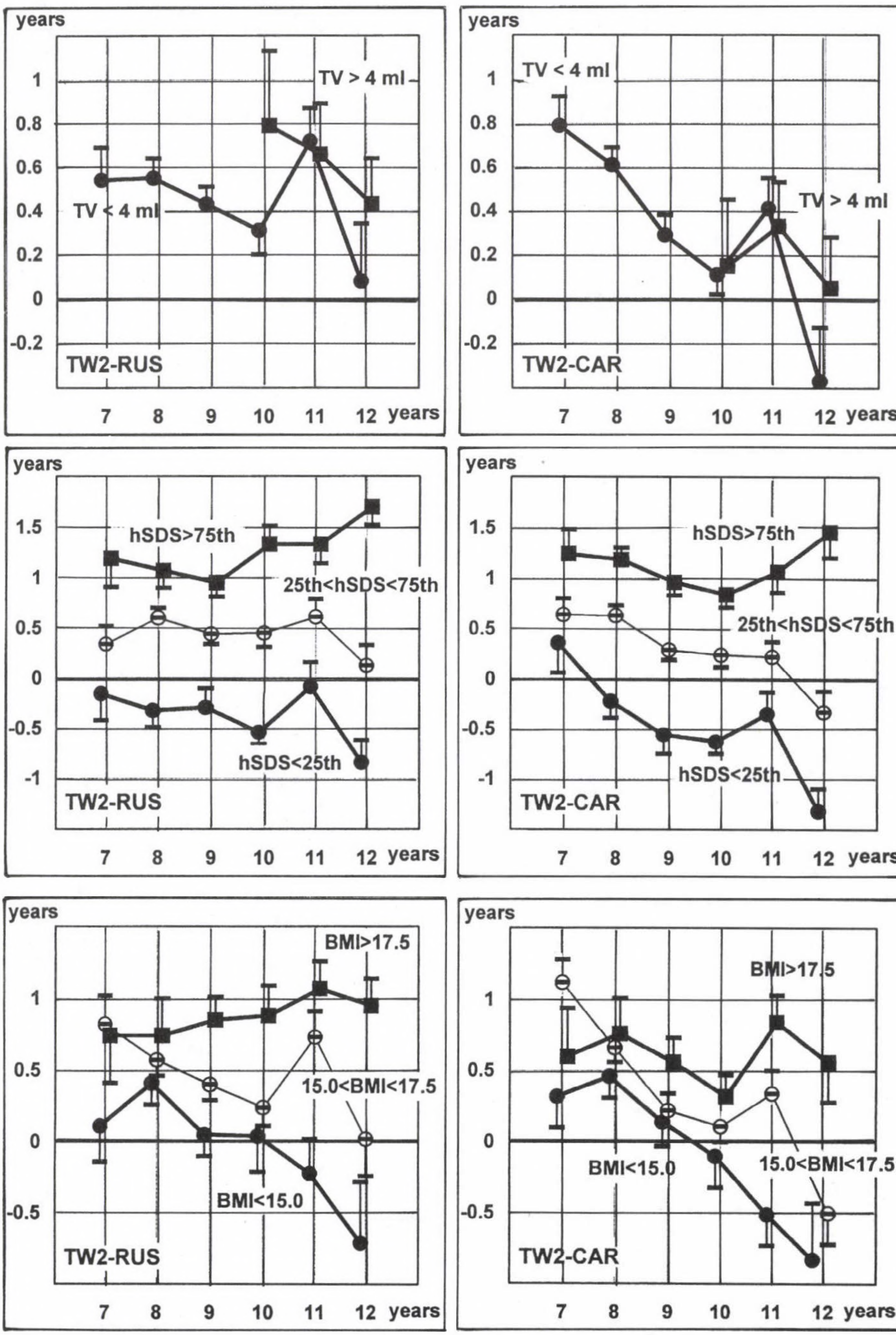

Fig. 1: Mean differences skeletal age minus chronological age (standard error) as a function of chronological age (years), in PACT boys classified by testicular volume (top), quartiles of height-SDS distribution (centre) and quartiles of Body Mass Index distribution (bottom).

Boys whose BMI is higher than 17.5 kg/m^2 (the *75th* percentile of BMI distribution in the PACT sample) show a consistent advancement of bone age, for both RUS (from 0.74±0.33 in boys aged 7 to 0.95±0.19 years in boys aged 12) and carpus (from 0.60±0.34 to 0.56±0.28). Boys with BMI lower than 15.0 kg/m^2 *(25th* percentile) show a delay of bone maturation only after 10.5 years of age. In boys 12 years old, delay values are -0.71±0.44 (RUS age) and -0.83±0.40 (CAR age). Generally, boys with BMI in the range 15.0-17.5 kg/m^2 are in intermediate position also for bone maturation (Figure 1, bottom). Bone maturation is related to BMI more for RUS than for carpus: between boys above the upper quartile and boys below the lower quartile we observe an average difference of 0.81±0.13 years for RUS age and of. 0.52±0.13 years for CAR age (Table 1, bottom). In this regard it should be noted that BMI is not completely independent of height-SDS: hSDS is -0.18±0.07 in boys below the lower quartile of BMI distribution and +0.44±0.08 in boys above the upper quartile. Nevertheless, this little difference in hSDS may account for only a part of the correlation between BMI and bone age: in particular, the difference between RUS age and CAR age appears to be related only to BMI.

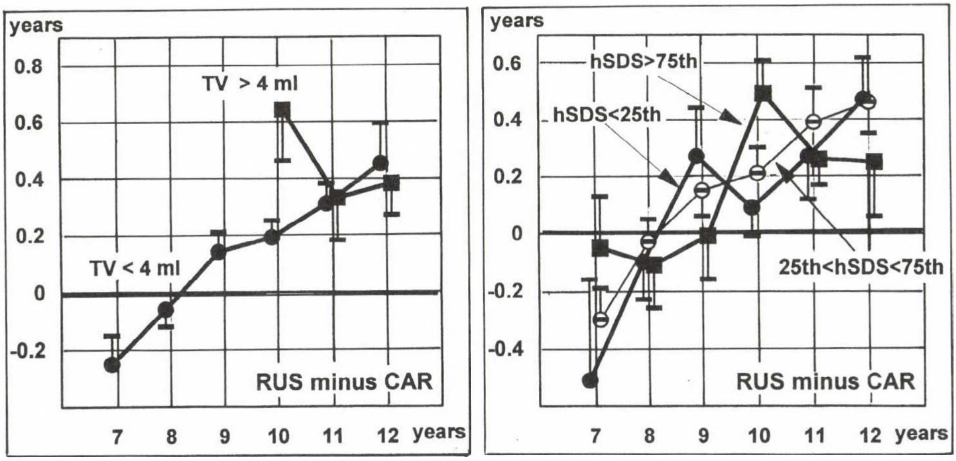

Fig. 2: Mean differences RUS minus CAR age (standard error) as a function of chronological age (years), in PACT boys classified by testicular volume (left) and quartiles of height-SDS distribution (right).

Comments

The above results cast further shadows on the belief that bone age may be considered *tout-court* a proxy of biological maturation. The first reason is that sexual maturation, which is the main marker of *tempo* of growth, is not strictly related to skeletal maturation: these two aspects of biological maturation are not necessarily synchronous (Benso, Vannelli, Pastorin, Angius and Milani 1986). The second reason is that a delay in bone maturation is often recorded in children whose height growth follows a low percentile. We must remember that a short child may be a case of growth delay as well as a short individual. In PACT sample, final height was known in 70 subjects: the advancement of skeletal age was

0.11±0.30 years (RUS) and 0.11±0.24 years (carpus) in subjects whose final height was below the *25th* percentile, whereas it was 0.94±0.32 years (RUS) and 0.74±0.40 years (carpus) in subjects whose final height was above the *75th* percentile! The third reason is that BMI is associated with bone maturation. Though boys with high BMI tend to be also more mature and slightly taller than slim boys, body weight was found to be related to bone age even in children of the same age, height and pubertal stage.

The above considerations not only should constitute a warning against a loose use of the.concept of skeletal maturation in clinical practice, but also should raise some doubts on the role of bone age in the prediction of adult height.

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