Eur J Pediatr (1988) 147:242–244

European Journal of
Pediatrics

Growth and development in simple obesity

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Abstract. It is well known that fat children tend to be taller than their peers and to present a slight acceleration of skeletal and pubertal maturation. To verify this tendency and to examine some of the points that are still controversial, auxological data were studied concerning 303 subjects (141 males and 162 females, aged 6–16 years) affected by simple obesity. Subjects were seen to be taller than average by about 1 SD from 6 to 9 years of age, becoming close to or shorter than average at later ages. Height below the 10th percentile was common in 17% of males and 8% of females, due to hereditary shortness, growth delay or late puberty. Girls had early puberty and menarche; the rate of sexual maturation was variable in boys.

Key words: Simple obesity – Height – Bone development – Sexual maturation

Introduction

In spite of the great number of studies concerning growth and development in children and adolescents affected by simple obesity (SO), some controversial points still exist. According to most authors, SO subjects tend to be taller than their peers and to have faster bone maturation, with earlier puberty [2, 4, 14, 24] and early menarche in females [4, 7, 9, 11, 14]. However, there are also short children who are fat and sometimes skeletal and/or pubertal maturation is delayed in SO children [14, 16].

The aim of this paper is to study retrospectively data files of a large number of SO children and adolescents better for a understanding of their auxological behaviour during the childhood years.

Subjects and methods

The records of children and adolescents referred to the Auxology Centre of the "G. Gaslini" Institute for weight excess, between 1980 and 1985, were reviewed providing a series of 303 subjects (141 males and 162 females, aged 6–16 years). Subjects were considered obese if their weight was more than 20% over that expected according to height and sex and if family history, physical and laboratory tests allowed the diagnosis of SO. Patients with endocrine, metabolic or genetic disorders associated with obesity were excluded.

The following measurements and maturity ratings were determined in all subjects:

(1) Height and weight (with a Harpenden stadiometer and standardized scales) plotted on the growth charts of Tanner and Whitehouse [21];

(2) Subscapular and triceps skinfolds, measured with the Holtain skinfold caliper and referred to the standard of Tanner and Whitehouse [20];

(3) Bone age, assessed by Greulich and Pyle (GP) [13], and Tanner and Whitehouse (TW2-RUS) methods [22];

(4) Pubertal development evaluated according to the standards of Tanner and Whitehouse [21], adapted to the Italian population by Nicoletti et al. [18] because of the fairly consistent early maturation of Italian boys and girls compared with the British standard [1]. Girls were requested, with assistance from their parents, to give the date of their first menstruation (nearest month).

Data refer to the subjects' first visit and data processing was carried out using the growth evaluation computerized system (GECS) and dBase III software on an IBM Personal Computer System.

Results

Results are shown in Table 1 and Fig. 1–4. In Table 1, age distribution, mean values and standard deviations of the body mass index (BMI) (weight/height^2) and of subscapular and triceps skinfolds are given for 2-year age groupings. Cases were rather equally distributed within each age class. No remarkable variation of the mean BMI was found between the age groups for either sex, the values being above the 97th percentile in all cases, according to the charts provided by Rolland-Cachera et al. [19].

The mean values of the subscapular and triceps skinfolds for sex and age groups presented a flat and high levelled trend without a progressive increase during growth. When plotted on the Tanner and Whitehouse charts, they were above the 97th percentile, except for the subscapular skinfold in girls, which was on a slightly lower level after the age of 9–10 years. Adiposity assessed by BMI and by skinfold measurements gave highly correlated results ($P<.001$).

Individual height measurements were between the 10th and the 90th percentile in about 58% of boys and 63% of girls, over the 90th percentile in about 25% of boys and 29% of girls, and below the 10th percentile in 17% of males and 8% of females. Of this last group, all the girls and half of the boys

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Abbreviations: SO = simple obesity; BMI = body mass index; GP = Greulich and Pyle method; TW2-RUS = Tanner and Whitehouse method for skeletal age assessment (radius, ulna and short bones score); GECS = growth evaluation computerized system; G = genital development; B = breast development; PH = pubic hair development; M = menarche; SDS = standard deviation scores

Table 1. Age distribution of the subjects with means and SD of body mass index and of subscapular and triceps skinfolds, in 2-year groupings from age 6 through 16, for both sexes separately. ▨ Boys, □ girls

Chronological age (years)	*n*		Body mass index (weight/height^2)		Skinfold			
					Subscapular		Triceps	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
6–7	18	28	39.28 (5.25)	48.58 (14.9)	25.3 (8.1)	21.5 (7.5)	23.1 (7.2)	22.0 (6.9)
8–9	29	34	46.69 (6.94)	48.41 (17.4)	26.8 (10.2)	22.2 (9.4)	23.8 (6.3)	24.3 (7.3)
10–11	48	49	52.91 (10.2)	49.59 (16.1)	27.2 (11.4)	22.7 (8.8)	24.3 (7.9)	25.8 (8.1)
12–13	34	34	59.02 (15.8)	41.73 (20.3)	30.8 (9.2)	23.2 (7.3)	27.2 (8.3)	28.2 (6.5)
>14	12	17	55.29 (19.9)	40.19 (18.3)	29.1 (6.8)	24.6 (7.2)	27.3 (5.1)	29.3 (7.4)

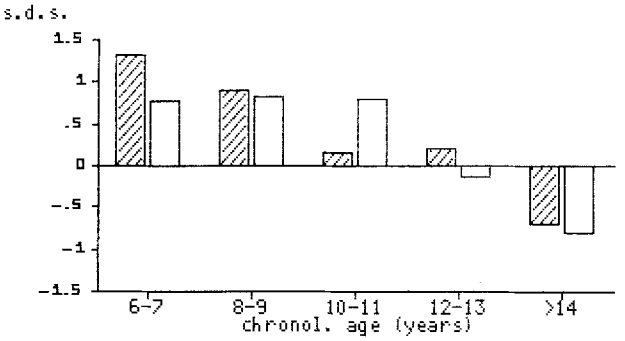

Fig. 1. Differences between the individual height and the mean expressed as standard deviation scores (s.d.s.) for age groups, in both sexes. ▨ Boys, □ girls

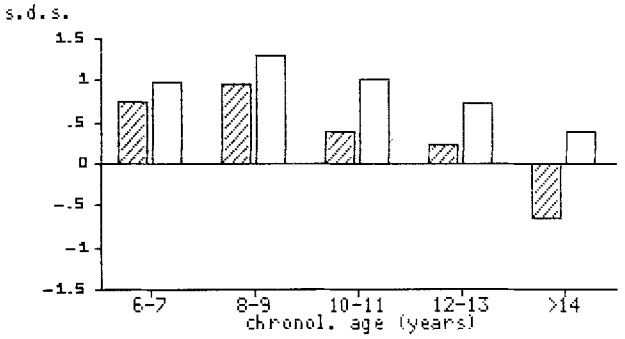

Fig. 2. Differences between the individual Greulich and Pyle bone age from chronological age, expressed as standard deviation scores (s.d.s.) for age groups in both sexes. ▨ Boys, □ girls

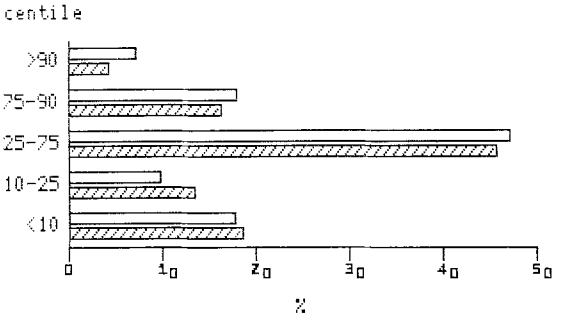

Fig. 3. Percentile distribution according to chronological age of the pubescent boys according to pubic hair *(PH)* and genital development *(G)* stages. ▨ G, □ PH

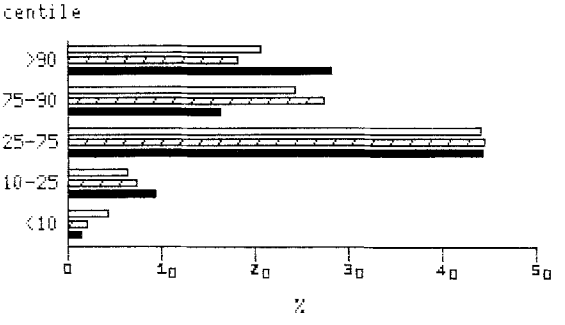

Fig. 4. Percentile distribution according to chronological age of the pubescent girls according to pubic hair *(PH)*, breast development *(B)* and menarche *(M)*. □ PH, ▨ B, ■ M

had mid-parent heights below the 10th percentile; the rest of the boys had retarded growth or late pubertal development.

The differences of the individual height from mean are expressed as standard deviation scores (SDS) within each age group. When considered as mean values, they were positive in both sexes for boys under 9 and girls under 12 years of age, tended to approach the average in the age groups from 12 to 13, and became negative for girls at 12–13 and for boys over 14 years (Fig. 1). The later reversing trend in boys may be linked to the later sexual development in males and seems to correspond in both sexes with the closing stages of puberty, taking place in boys at stage 3, as regards genital development, and in females at stage 4 for breast development. Mean statural differences from the mean values were: 0.59 SDS, at G2, −0.06 at G3, −0.31 at G4 in the boys and 0.38 at B2, 0.22 at B3, 0.08 at B4 and −0.42 at B5 respectively in the girls.

Figure 2 shows the differences of GP bone age from chronological age within each age class, as SDS. Mean values were positive in females in all age groups, indicating that bone development is earlier in girls, even if the mean difference tends to decrease at later ages. In boys they were close to +1 SD at earlier ages, only slightly positive from 10 to 13 years and became negative over 14 years of age.

The GP bone age/chronological age and height age/chronological age ratios were respectively:

(1) in males, 0.88 and 0.86 as regards the small group of subjects presenting growth delay and late puberty, 0.99 and 0.83 in boys with familial short stature, 1.075 and 1.085 in the remaining cases;

(2) in females, 1.058 and 0.859 in the familial short stature subgroup, 1.113 and 1.078 in the other subjects.

The assessments of skeletal age using the TW2-RUS system corresponded to the GP ratings, the absolute difference between methods never being greater than 7 months.

About 49% of the males and 52% of the females were pubescent. Of the girls 13.7% (ranging from 12.3 to 15.75 years) presented adult sexual maturation, while none of the boys had yet reached this stage. The percentile distribution for chronological age of boys according to pubic hair and genital staging and of girls according to pubic hair and breast development is shown in Figs. 3 and 4. Delayed puberty was observed in a fairly large group of boys under the 10th percentile, 19% of the pubescent subjects having delayed genital development and 16% delayed pubic hair.

Menarcheal age, as observed in 42.5% of the female group, ranged between the 25th and the 75th percentile in 45.4% of girls, was over the 75th in 44.2% and below the 25th in 10.4% (Fig. 4). The mean age of the first menstrual bleeding was 11.4 years (SD $\pm$ 1.2), about 1 year earlier than the mean value for the Italian population [1]. One hundred percent of the girls were menstruating by the age of 13 and 13.5 years.

Early adrenarche without any other sign of sexual development was observed in 11% of girls and 8% of boys, aged 6–8 years.

Discussion

Several studies have shown that fatness is growth promoting and it has been assumed that increased fat storage during the establishment of the obese state accelerates the height gain and development in the growing child [3, 7, 8, 11]. Although the main findings of the present series tend to confirm this tendency, some features seem to indicate a more variable trend in physical growth and sexual development of SO children and adolescents, this probably being due to the fact that SO is not a homogeneous condition either in terms of cause or clinical features [6].

The subjects under study were taller than average for their age by an amount equivalent to about 1 SD in childhood, but as they progressed into adolescence they became close to and then below average, a finding that has already been described in some longitudinal studies [3, 7, 11]. In a small group of subjects in our series, height was below the 10th percentile, this being linked to a familial shortness in stature or to a delay of growth and pubertal development, as observed in a group of males all over 12. The fairly high incidence of boys with delayed puberty possibly explains why skeletal age was slightly retarded in comparison with chronological age in older boys. In agreement with other studies [7, 10, 13, 23] earlier skeletal maturation was seen in younger males and in females.

Girls have an early puberty, but in boys sexual maturation is normal or even delayed. An acceleration of pubertal development has been described in males and in females [7, 12], but in boys a more remarkable variation in the rate of sexual maturation has been reported in various studies [3, 14–17]. A probable reason for this discrepancy is that among the SO boys referred to us, a relatively high number of subjects with associated delayed puberty may have been selected, because of greater concern about this condition than about obesity itself. A further reason, on the other hand, may be found in a possible dysfunction of the hypothalamo-pituitary-gonadal axis described in SO boys [5], this being a condition which could be related to the delay in sexual maturation in some pubescent males of this series.

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Received November 10, 1986 / Accepted October 9, 1987