

HEIGHT, WEIGHT and SKELETAL MATURITY IN ASTHMATIC CHILDREN (*)

by

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1. Introduction

Since Cohen and Abram (1948) demonstrated for the first time that children, suffering from allergic asthma, usually have a stature below normal, several studies have been reported on growth and maturation of asthmatic children in relation to genetical, etiological and environmental factors.

Blodgett, Burgin, Iezzoni, Gribetz and Talbot (1956) showed a retardation of bone age, as well as height, in asthmatic children.

It has furthermore been suggested by some authors that treatment of the allergy, resulting in an improvement of the asthmatic symptoms, is followed by a period of accelerated growth or catch-up growth (Welsh, 1951).

Nevertheless, there still remains a lot of doubt about the degree to which growth and maturation are impaired in asthmatic patients and about the possibility of recovering a certain growth delay (Falliers, Szentivanyi, McBride and Bukantz, 1961 ; Van Metre and Pinkerton, 1959).

In this paper we present results of a cross-sectional study on height, weight, and skeletal maturity of asthmatic children.

2. Subjects and Methods

The study was carried out on a sample of 354 asthmatic boys and girls attending a residential institute (Zeepreventorium, De Haan, Belgium) for treatment of their asthma.

(*) Communication présentée le 25 février 1974.

All subjects were of Belgian ancestry and belonged to a variety of socio-economic classes of which the distribution did not differ significantly from the distribution for the whole Belgian population.

The ages ranged from 3 to 20 years. The subjects composing the sample were selected only by their medical diagnosis. Indeed, the study was limited to those individuals with a positive allergy test who suffered from asthma, asthma + eczema or asthmatic bronchitis. For convenience in this study we shall simply term them all asthmatic.

All the data presented here were recorded at the time of arrival of each patient in the institute and were therefore treated cross-sectionally (Tanner, 1962). Standing height was measured by the method of Martin and Saller (1957) (see also Twiesselmann, 1952). Weight was measured in light underwear with a high precision medical balance to the nearest 0.1 kg.

Mean values of these somatometric measurements were calculated for age classes of one year and were compared with Belgian standards of height and weight for age (Twiesselmann, 1969). These standards are based on a population of 14,299 individuals studied cross-sectionally. The midpoint of each age group is the half-year.

Bone age has been determined from radiographic pictures of the left hand and wrist using the method of Greulich and Pyle (1959). For girls, bone age has been compared to chronological age since appropriate female Belgian norms are not yet available. For boys, bone age has been compared with a sample of 714 normal Belgian boys (Verlinden, 1974 ; unpublished data) as well as to chronological age. These male reference data are based on a random sample of Belgian boys aged 6 to 14 years. In each age group were included all children who were up to 6 months older or 6 months younger than the age assigned to the group. Thus the midpoint of each age group is the year.

All films, separated for sex, were read by the same examiner, who did not know the ages of the children. His reliability of skeletal age assessments has been determined previously from two separate and independent ratings of a set of 30 radiographic films. The correlation coefficient between these two ratings was 0.969 ; values of coefficients of reliability in bone age assessments mentioned by other authors are in good agreement with our value (Borms, 1971). Correlation of the examiner's ratings with those effected on the same set of radiographs by a second examiner gave a coefficient of objectivity equal to 0.967 (Verlinden, 1974).

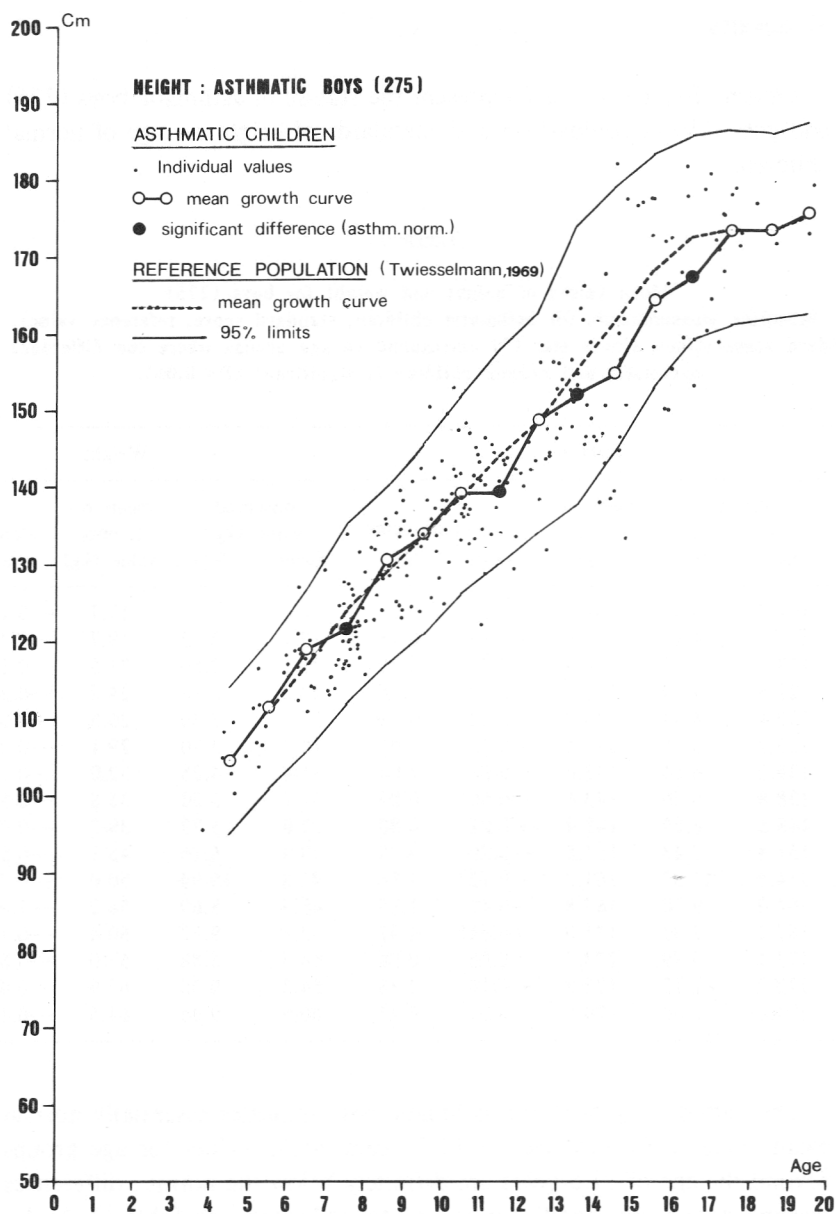


FIG. 1. — Mean growth curve and individual measurements for height of asthmatic boys in comparison to the mean reference growth curve and the 95% limits.

3. Results

Stature. Figures 1 and 2 represent the stature of asthmatic boys (275) and girls (79) in comparison with standards of height for age of normal children.

TABLE 1

Mean values of height and weight for boys (275)
(absolute measurements for asthmatic children, standard score, reference value)
The standard score values with a star (*) correspond to age groups where the difference between asthmatic and normal children is significant ($P < 0.05$).

Age classes	No of cases	Height					Weight				
		observed value (cm)		mean reference value	Standard score		observed value (kg)		mean reference value (kg)	standard score	
		mean	S.D.		mean	S.D.	mean	S.D.		mean	S.D.
4 +	5	104.7	3.02	104.6	-0.15	0.67	17.8	2.36	17.7	-0.12	1.05
5 +	9	111.6	4.84	110.9	+0.13	0.74	19.1	2.22	19.7	-0.20	0.98
6 +	17	119.1	5.10	116.9	+0.43	0.85	21.1	2.50	21.5	-0.12	0.70
7 +	38	121.5	4.79	123.7	-0.37*	0.78	23.2	3.18	24.2	-0.26	0.79
8 +	29	130.4	4.58	128.9	+0.20	0.79	27.1	3.36	26.5	+0.08	0.82
9 +	28	133.7	6.25	133.4	-0.02	1.03	28.0	3.70	29.1	-0.27	0.72
10 +	34	139.2	6.54	138.6	+0.08	1.08	31.4	4.28	32.0	-0.11	0.87
11 +	18	138.8	5.26	143.6	-0.60*	0.80	31.9	3.30	35.8	-0.51*	0.58
12 +	18	148.5	6.59	148.4	-0.07	0.80	37.0	5.79	39.2	-0.37	0.70
13 +	20	151.8	7.43	155.5	-0.39	0.95	39.3	6.16	45.1	-0.59*	0.77
14 +	23	154.6	12.37	161.3	-0.72*	1.36	42.8	10.94	50.0	-0.72*	1.08
15 +	11	164.0	9.70	167.8	-0.47	1.36	46.5	8.69	56.2	-1.03*	1.01
16 +	13	167.2	9.31	171.9	-0.64*	1.37	53.1	9.72	60.4	-0.78*	1.12
17 +	6	173.1	3.79	173.3	+0.00	0.58	54.4	5.88	63.0	-0.88*	0.61
18 +	3	173.2	2.13	173.5	-0.10	0.36	54.3	0.20	63.9	+0.66*	2.58
19 +	2	175.0	3.00	174.5	+0.07	0.47	60.5	0.05	64.6	-0.46	0.01

The pattern of growth for asthmatic boys indicates essentially normal mean values before the age of 11.5 years. Mean values for age groups beyond the age of 11.5 years are definitely below the norms; differences become statistically significant at the ages indicated (see Table 1). At the age of 16 years, the mean height for asthmatic boys is still below the mean normal value. However, the mean stature for asthmatic boys in age classes beyond the age of 16 years closely resembles the reference values.

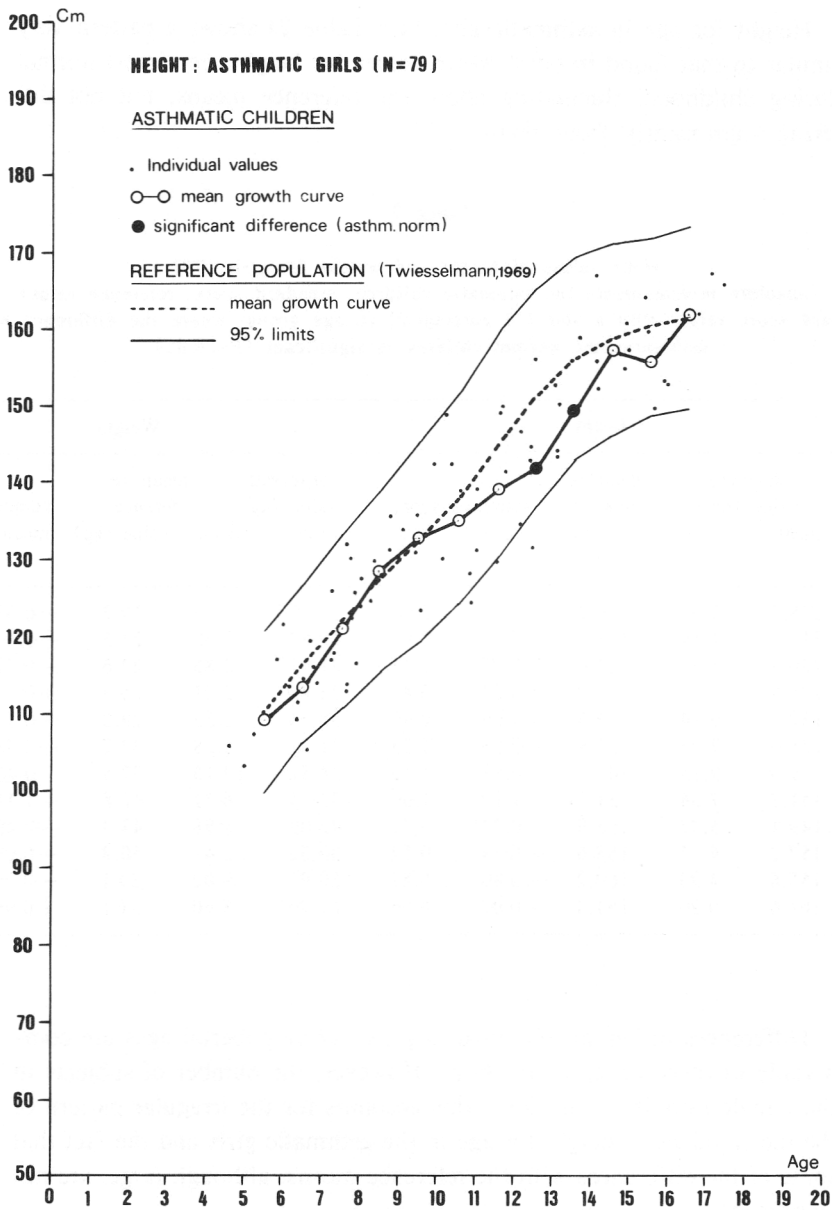


FIG. 2. — Mean growth curve and individual measurements for height of asthmatic girls in comparison to the mean reference growth curve and the 95% limits.

Height for age in asthmatic girls (see Table 2) shows a pattern very similar to that found in boys. Mean values for height are almost normal during childhood, fluctuating about the reference means, but not differing significantly from them.

TABLE 2

Mean values of height and weight for girls (79)
(absolute measurements for asthmatic children, standard score, reference value)
The standard score values with a star (*) correspond to age groups where the difference between
asthmatic and normal children is significant ($P < 0.05$)

Age clas- ses	No of ca- ses	Height					Weight				
		observed value (cm) mean	S.D.	mean re- ference value (cm)	standard mean	score S.D.	observed value (kg) mean	S.D.	mean re- ference value (kg)	standard mean	score S.D.
5 +	3	108.9	5.67	110.2	-0.09	0.68	18.20	1.72	19.2	-0.33	0.40
6 +	9	113.4	4.59	116.4	-0.55	0.99	19.82	2.38	21.5	-0.50	0.84
7 +	10	120.9	6.37	122.0	-0.27	1.13	21.91	2.85	23.6	-0.52	0.73
8 +	10	128.4	3.26	127.2	+0.24	0.41	24.44	2.01	26.3	-0.37	0.40
9 +	5	132.7	6.14	132.3	+0.09	0.90	28.34	2.55	29.0	-0.11	0.44
10 +	9	135.0	7.26	137.6	-0.53	1.23	31.32	5.58	32.7	-0.28	0.96
11 +	5	139.0	9.15	145.1	-0.83	1.15	34.52	13.15	37.5	-0.40	1.59
12 +	7	141.7	7.36	151.1	-1.12*	1.00	32.54	6.71	42.8	-1.11*	0.80
13 +	5	149.1	5.81	155.9	-0.74*	0.73	42.09	8.98	47.3	-0.45	1.02
14 +	6	157.2	4.77	158.6	-0.19	0.77	50.22	3.41	50.3	-0.00	0.40
15 +	6	155.6	4.93	160.2	-0.80	0.87	50.92	9.02	53.1	-0.29	1.17
16 +	2	161.6	0.20	161.3	+0.07	0.06	61.20	8.60	54.1	+0.96	1.13

Differences in height, observed in girls during pubertal ages are comparable to those observed for boys. However, the number of subjects in the female sample is very low: this accounts for the irregular pattern of the mean values of height for age in the asthmatic girls and the fact that some of the differences with the reference means, although large, are not significant.

Weight. Figures 3 and 4 represent mean values of weight for age for the same group of asthmatic boys and girls.

Weight, as well as stature, is almost normal in the prepubertal period

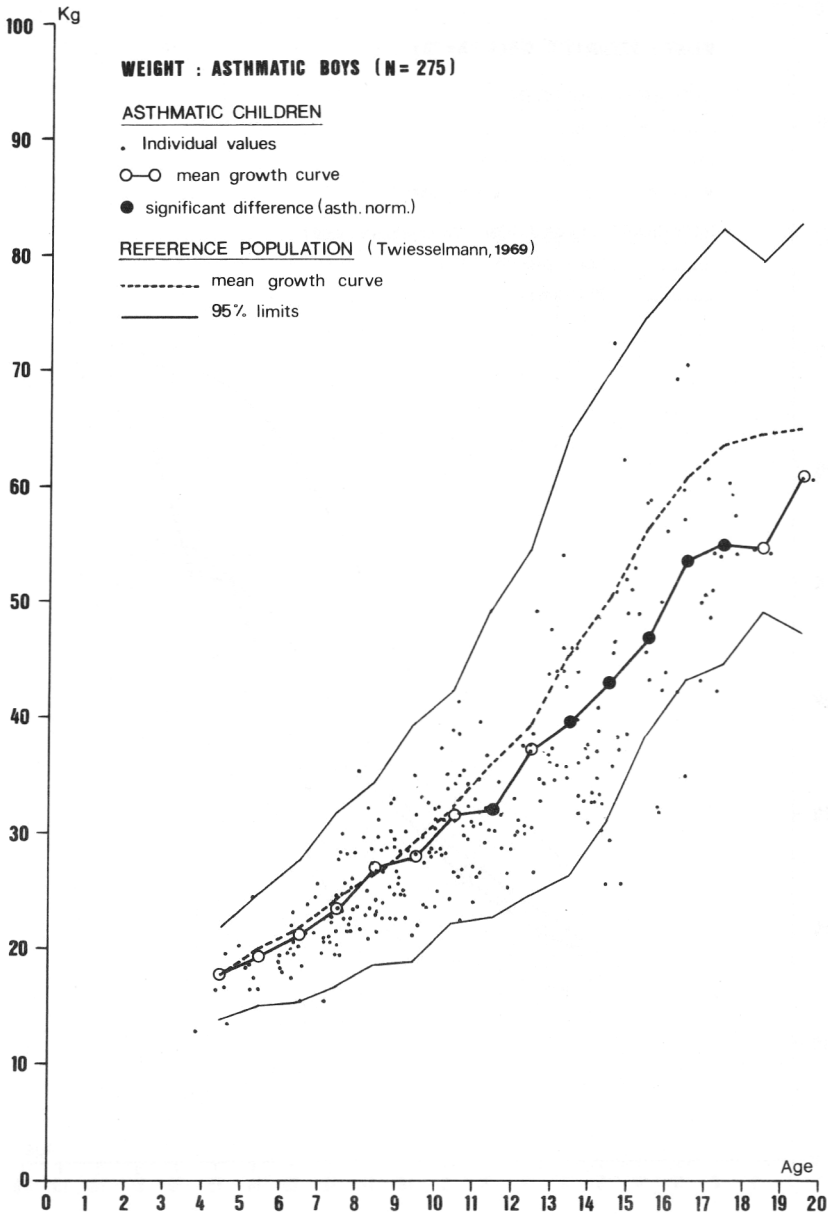


FIG. 3. — Mean growth curve and individual measurements for weight of asthmatic boys in comparison to the mean reference growth curve and the 95% limits.

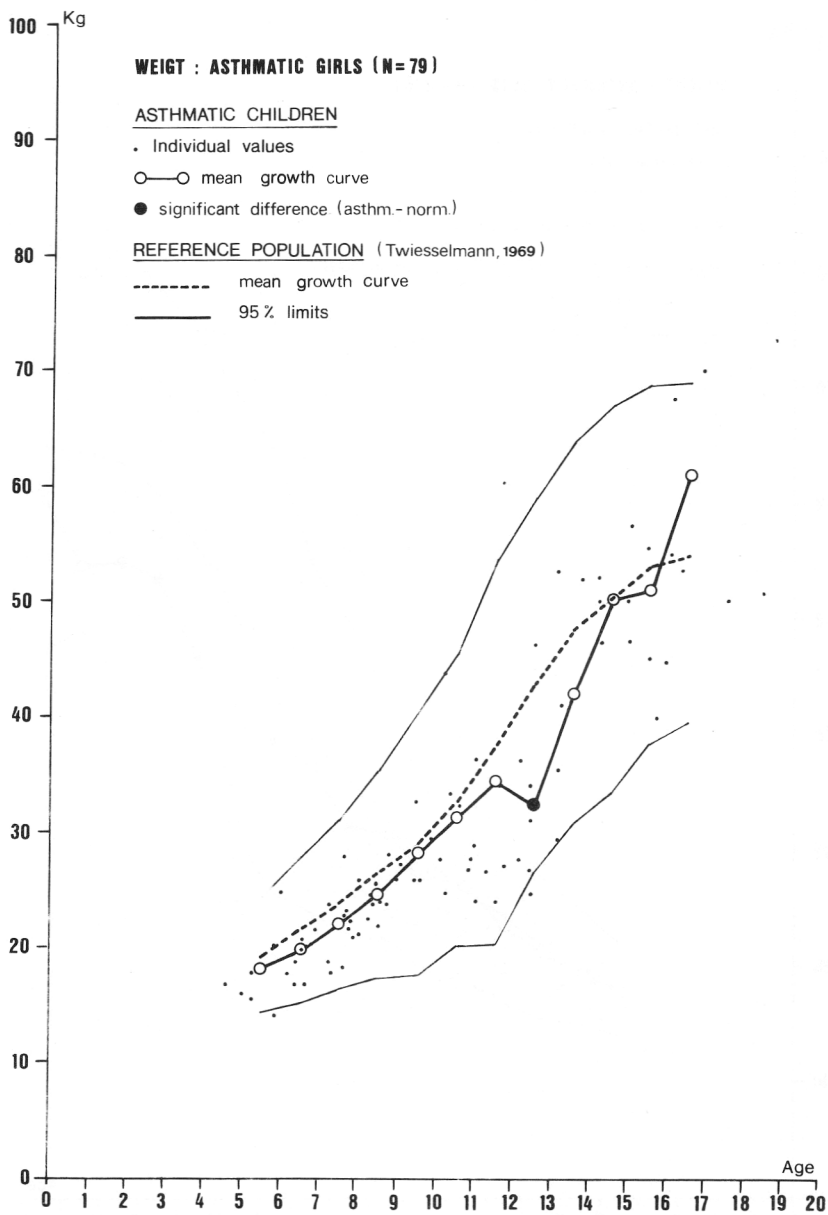


FIG. 4. — Mean growth curve and individual measurements for weight of asthmatic girls in comparison to the mean reference growth curve and the 95 % limits.

BOYS

N = 160

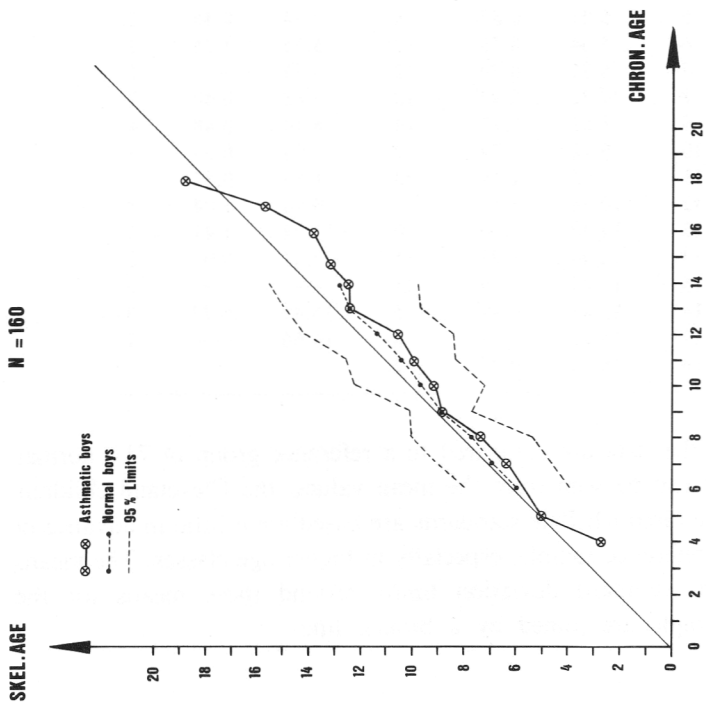


FIG. 5.— Mean values of skeletal age for age classes of one year in relation to chronological age: asthmatic boys. Mean values and two standard deviation limits of skeletal age for 714 normal Belgian boys. Diagonal line corresponds to the mean values of Cleveland children in which skeletal age equals chronological age (Greulich and Pyle, 1959).

GIRLS

N = 44

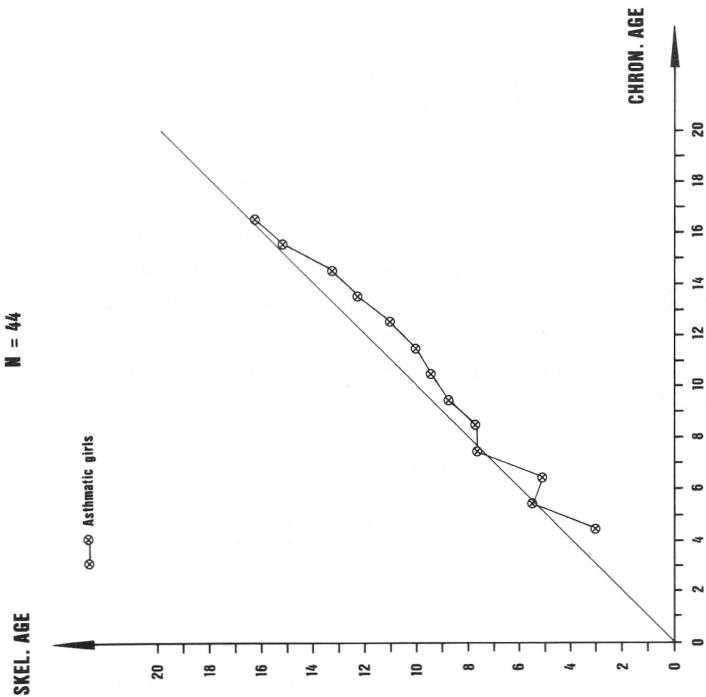


FIG. 6.— Mean values of skeletal age for age classes of one year in relation to chronological age: asthmatic girls. Diagonal line corresponds to the mean values of Cleveland children (Greulich and Pyle, 1959).

in both sexes, but is significantly below the norms, during the period in which puberty normally takes place.

Standard scores for height and weight (Tables 1, 2) show that deficiency is somewhat greater for weight than for height.

Bone age. The results of bone age assessments of 204 children (160 boys, 44 girls) are presented in figures 5 and 6 where bone age is plotted against chronological age. Mean values of bone age have been calculated for age classes of one year with the mid-point of each age group on the year (Table 3). These mean values are indicated by the black dots in figures 5 and 6.

TABLE 3

**Mean values of skeletal age (Greulich and Pyle, 1959)
for asthmatic boys (160) and girls (44).**

Age classes	Boys			Girls		
	skeletal age mean	S.D.	No of cases	skeletal age mean	S.D.	No of cases
4	2.66	0.58	2			
5	5.01	0.83	6	3.54	0.46	2
6	5.64	0.75	7	5.75	1.25	2
7	6.31	0.70	12	5.74	—	1
8	7.32	0.92	18	7.68	0.40	7
9	8.82	0.77	14	8.14	0.48	4
10	9.12	1.29	19	10.04	0.55	4
11	9.95	1.14	20	8.86	0.81	7
12	10.56	1.11	11	10.90	1.04	8
13	12.40	1.00	10	11.94	1.41	3
14	12.44	1.23	15	13.31	0.01	2
15	13.41	1.69	11	—	—	0
16	13.81	0.99	5	15.41	0.77	3
17	15.72	1.37	8	16.66	—	1
18	18.75	0.25	2			

For boys the data are compared to a reference group of 714 normal children. As can be seen from the mean values, the Cleveland children on which the Greulich Pyle standards are based are a little in advance of the Belgian reference sample, especially in higher age classes. The means and the two standard deviation limits around these means for the reference sample are joined by a broken line.

The skeletal age of the asthmatic boys does not differ greatly from that of the Belgian reference groups. No significant difference (at 5%) was observed by comparing the means for each age class. Nevertheless bone age reached its lowest values during the period of puberty.

For girls bone age was plotted against chronological age in the same way as for boys. No reference sample was available, so that we only could compare the mean bone age for asthmatic girls to chronological age.

4. Discussion

Children suffering from asthma have significantly lower height and weight but not significantly retarded skeletal maturity during the period that puberty normally takes place.

Chronic asthma in children may be associated with inhibition of growth and skeletal maturity (Cohen *et al.*, 1940, 1948; Welsh, 1951; Blodgett *et al.*, 1956; Falliers *et al.*, 1961, 1963; Prader, Tanner and von Harnack, 1963; Smith, 1963; Snyder, Collip and Greene, 1967; Kerrebijn and De Kroon, Post and Huijser, 1969; Henocq and Menibus, 1972).

The statement of Cohen *et al.* (1948) and Spock (1965) that asthmatic children have an increased incidence of a slender body build, is confirmed in our study by the observation that the mean standard score for weight is lower than that for height. It seems that the impairment of height development in asthmatic patients is of a rather temporary nature. Indeed, statistically significant differences between the mean values of height for age in asthmatic boys and girls and the standards of height for age, appear only at about the same time that puberty normally occurs. Before and beyond this period height and weight are essentially normal.

Since the sample is a cross-sectional one, it is not possible to find out whether the observed reduction in stature is due to an increased difference in growth timing or to a weakened growth-spurt. Nevertheless, the stature attained by asthmatic children aged 17.5 years or more equals normal adult stature. Late adolescent growth in height could be a way of compensating growth retardation (Frisancho, Garn and Ascoli, 1970).

The observed lower mean values of bone age during the period of reduced height may be an indication that despite his retardation in height, an asthmatic child retains the ability to reach his genetically potential stature and that this adult stature will not be radically altered.

ACKNOWLEDGEMENTS

We are indebted to Professor F. ALEXANDER, Director of the "Zeepreventorium" De Haan, for his helpful criticism and to the various technicians of that institution for their valuable assistance.

RÉSUMÉ

La taille, le poids et la maturation osseuse de 354 enfants asthmatiques (275 garçons, 79 filles) ont été étudiés lors d'une enquête transversale. L'âge varie de 3 à 20 ans.

Les valeurs moyennes de la taille, du poids et de l'âge osseux de ces enfants asthmatiques sont quasi normales durant l'enfance.

Des valeurs significativement inférieures pour la taille et le poids apparaissent au moment où normalement la puberté s'installe, mais les valeurs de jeunes adultes sont essentiellement normales. L'âge osseux de ces enfants asthmatiques n'est jamais retardé de façon significative, cependant les valeurs moyennes les plus basses se situent au moment de la puberté.

SAMENVATTING

De gestalte, het gewicht en de skeletale maturiteit van 354 astma-kinderen (275 jongens en 79 meisjes) werden bestudeerd in een transversaal onderzoek. De leeftijden varieerden van 3 tot 20 jaar.

De gemiddelde waarden voor gestalte, gewicht en beenderleeftijd werden normaal bevonden gedurende de kinderjaren. De gemiddelde waarden voor gestalte en gewicht waren significant vertraagd vanaf het tijdstip waarop de puberteit normaal intreedt, maar quasi normaal bij jonge volwassenen. De beenderleeftijd in deze astma-kinderen was niet significant vertraagd maar de laagste gemiddelde waarden komen voor rondom de pubertaire leeftijd.

SUMMARY

Height, weight and skeletal maturity of 354 asthmatic children (275 boys, 79 girls) have been studied cross-sectionally. The ages ranged from 3 to 20 years.

Mean values of height, weight and bone age of these asthmatic children differ little from normal during childhood. Significantly lower values of height and weight for age appear at the time that puberty normally begins but young adult values are quite normal. Bone age in these asthmatic children is never significantly retarded, the lowest mean values appearing yet at the time of puberty.

Keywords

GROWTH, SKELETAL MATURITY, ASTHMA, BONE AGE.

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