

ON THE QUESTION OF SECULAR ACCELERATION IN JENA SCHOOL CHILDREN

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Abstract: The changes in the course of growing up and development in schoolchildren in Jena during the past hundred years followed up.

A statement may be made on the present level and the extent of acceleration on the basis of examinations carried out in 1975 on children from Jena (nearly 1100 boys and girls in each case) 7 to 15 years of age.

Hereby changes in body height, body weight and menarcheal age conditioned by acceleration since 11 years are especially examined.

The developmental differences between the schoolchildren of town and county at present will be examined.

It will be made a statement about growth and developmental trends of some body measures and proportions in children aged from 7—15 years.

Key words: Jena school children, body height, body weight, menarcheal age, secular changes.

Introduction

Anthropological investigations of schoolchildren have been carried out in Jena at more or less regular intervals from 1880 onwards. Therefore we have at our disposal the longest investigation series of school-age children ever made. Cross-sectional studies of schoolchildren were also initiated in various German towns (Leipzig, Stuttgart, Augsburg, Hamburg, a. o.) at the end of the past century. Unfortunately these series were mostly interrupted in the fifties or sixties of our century, and did not have the continuity of the studies made on schoolchildren from Jena.

The first surveys in Jena and elsewhere essentially aimed at providing the doctors with reference figures according to which an assessment of the particular individual developmental and nutritional condition of children was possible.

But the range of characteristics of the investigation was restricted to a few only (stature, weight; more seldom: width of chest). Although the mentioned characteristics give quite a good insight into the growth and development process changed by secular acceleration in children and adolescents, they do not permit any statements to be made on possibly occurring proportional shifts, earlier menarche or earlier onset of the 1st and in particular of the 2nd dentition. The range of characteristics for the respective investigation programmes has been continuously extended in Jena from 1964 onwards (Table 1).

Material and Methods

The results reported here are based on an investigation carried out by the Institute of Anthropology and Human Genetics of the Friedrich-Schiller University of Jena in 1975. In planning this investigation we felt that such a comprehensive survey (some 1100 boys and girls each aged between 7 and 15 years were covered) which at any rate involves a high effort both in terms of staff and time should not only include the clarification of a few individual questions, but also the treatment of extensive complexes of subjects, as far as possible. For this reason,

Table 1
Investigations of schoolchildren in Jena 1880—1980

Year of investigation	Number of probands	Number of characteristics			
		metric	morphological	physiological	functional
1880	1295	2 (+3)	—	—	—
1921	6186	8	—	—	—
1932/33	122—323 ♂* 104— 205 ♀*	3	—	—	—
1944	4868 (2259 ♂; 2609 ♀)	7	2	—	—
1954/55	2110 (1022 ♂; 1088 ♀)	5	—	1	—
1964	2517 (1269 ♂; 1248 ♀)	9	—	1	—
1975	2115 (1062 ♂; 1053 ♀)	50	29	1	—
1980	1057 (540 ♂; 517 ♀)	62	65	1	4

* for each semi-annual group

— the examination of children from the Jena countryside was included in the Jena investigation programme of 1975 to reveal possibly existing differences between town and countryside;

— the anthropological investigation programme was considerably expanded with regard to the individual parameters recorded as compared to former ones (to altogether 30 metric, morphological and physiological data);

— the anthropological investigation was linked with a relatively comprehensive one (50 characteristics) carried out by stomatologists (Department of Orthopedic Stomatology of the Stomatological Clinic and Polyclinic of the Friedrich-Schiller University of Jena) and being ancillary to the general objective.

The principal aim of the material evaluation was to find out the age- and sex-specific variability of the corresponding metric and morphological data in children. It is also intended to use the values obtained as a basis for the preparation of standard (norm) tables for our research area (Thuringia). The

clarification of the present state of acceleration both in case of the individual characteristics and in the proportions of the body and the influence of selected factors on the development of the body we regarded as another task. Moreover, questions of correlations of the characteristics which might play a role in the diagnosis of diseases will be of interest. Some remarks on the secular acceleration of selected dimensions of the body between 1880 and 1975 will be made in the following.

Results and Discussion

Body height

For boys the acceleration-conditioned increase in the height of body between 1880 and 1975 is about 14.4 cm on an average (the average of all semi-annual classes) (Table 2).

This means that the boys of 1975 aged between 7 and 14 are about 14.4 cm taller than the pupils of 1880 of the same age, on an average. We speak of

Table 2

Overall differences in body height and body weight in Jena schoolchildren aged between 7 and 14 years (1880/1975)

Age (years)	Boys		Girls	
	Body height (cm)	Body weight (kg)	Body height (cm)	Body weight (kg)
7	13.4	6.6	11.7	4.9
7.5	13.5	5.9	10.9	4.8
8	13.5	5.3	12.7	6.0
8.5	13.4	6.5	11.5	6.3
9	14.1	6.8	13.1	6.4
9.5	12.7	5.5	13.2	6.5
10	13.2	5.0	13.2	8.1
10.5	11.3	6.8	13.1	7.4
11	14.2	8.5	13.9	8.3
11.5	13.4	7.6	14.0	9.7
12	12.5	9.9	16.1	12.8
12.5	15.9	10.9	13.7	10.3
13	17.9	14.0	15.6	12.3
13.5	17.7	12.4	10.4	10.7
14	19.7	14.6	14.7	11.3
Overall difference	14.4 cm	8.4 kg	13.2 cm	8.4 kg

'about 14.4 cm' intentionally as the results published for 1880 to 1932/33 are based on an age classification of the boys under test (n minus 6 months) that differs from the one used for the subsequent studies ($n \pm 3$ months) and consequently an exact statement cannot be made. Starting from this overall period of time, the mean height of body increases by 1.5 cm on an average within 10 years in case of boys (minimum: 1.2 cm for those aged 10.5; maximum: 2.1 cm for those aged 14).

Considering the mean difference in body height calculated for all semi-annual classes together between 2 investigations in immediate succession (likewise converted to decades), this (Table 3) ranges between 0.6 cm (1932—1944) and 3.0 cm (1921—1932). The medium 2.8 cm increase in body height observed in the past eleven years (1964—1975) suggests an increased acceleration in Jena schoolchildren and among other things conforms with the result of the Brunswick longitudinal-section studies made by KURTH and MAY (1977).

The mean semi-annual increase in height of body (Table 4) ranges between 2.1 cm (1921) and 2.7 cm (1975) for boys — 2.44 cm on an average.

Table 3

Mean differences in body height in Jena schoolchildren aged between 7 and 14 years

Year of investigation	1880/1921 cm	1921/1932 cm	1932/1944 cm	1944/1954 cm	1954/1964 cm	1964/1975 cm
Boys	4.7 (1.2)	3.0	0.6	1.2	1.1	2.8
Girls	3.9 (1.0)	2.9	-0.6	2.4	1.0	2.7

Table 4

Mean semi-annual increases in body height and body weight in Jena schoolchildren aged between 7 and 14 years

Year of investigation	1880	1921	1932	1944	1954	1964	1975
Boys							
Body height	2,2 cm	2,1 cm	2,5 cm	2,4 cm	2,6 cm	2,6 cm	2,7 cm
Body weight	1,1 kg	1,2 kg	1,7 kg	1,4 kg	1,7 kg	1,7 kg	1,7 kg
Girls							
Body height	2,5 cm	2,5 cm	2,6 cm	2,6 cm	2,5 cm	2,6 cm	2,7 cm
Body weight	1,4 kg	1,6 kg	1,8 kg	1,6 kg	1,8 kg	1,9 kg	1,8 kg

Taking the last mentioned value and the overall body height difference between 1880 and 1975 (approximately 14.4 cm) as a basis for an assertion of the state of development of the body height, it can be stated that the boys of 1975 reach the values of body height of the pupils of the same age of 1880 roughly three years earlier on an average (14.4 : 2.44). The variation width of this developmental acceleration of the body height ranges between 2 years, 3 months (in case of 10.5-year-olds) and abt. 4 years (in case of 14-year-olds). To find out in which age stage of the infantile ontogenesis the obvious developmental advance in the past 95 years occurred, it is helpful to compare the mean values of the body height of 7-year-olds (as the youngest age class studied) and of the 14-year-olds (as the eldest age class studied) of 1880 and 1975 each. It can be seen that the mean differences in body height of the 7-year-olds of

the mentioned years of investigation are 13.4 cm and those of the 14-year-olds 19.7 cm (Table 2). This means that the differences already existing in the initial group (7 years) only increase by 6.3 cm (= 32%) in the span of age between 7 and 14 years, whereas 68% of the difference in body height are already reached below the age of 7.

This indicates that the secular increase in body height observed over the past 100 years must have essentially taken place before the 7th year of age (about two thirds according to our results) and is in accordance with the results obtained by other authors (OEHMISCH 1970, WALTER 1978, KNUSSMANN 1980).

The body heights of the *schoolgirls* of 1880 and 1975 calculated for all semi-annual classes differ by altogether 13.2 cm approximately on an average (Table 2), corresponding to an about 1.4 cm increase of the values of body height (minimum: 1.1 cm in case of 13.5-year-olds; maximum: 1.7 cm in case of 12-year-olds) within a 10-year interval. Considering the overall differences between 2 consecutive series (Table 3) on the other hand, these range between minus 0.6 cm (1932–1944) and plus 2.9 cm (1921–1932) at the respective time intervals.

The average semi-annual increase in body height (Table 4) ranges between 2.4 cm (1921) and 2.7 cm (1975) in girls from Jena — mean 2.56 cm. Using the last mentioned value and the overall mean difference of body height for schoolgirls of age 7–14 years between 1880 and 1975 (approximately 13.2 cm) as a basis to give information on the developmental acceleration, it can be said that the schoolgirls of 1975 are ahead of the girls of 1880 of the same age by 2 years, 7 months as to their development of body height (minimum: 2 years; maximum: abt. 3 years, 1 month).

The essential increase in body height due to acceleration in girls is found at the age below 7 years (abt. 80%), this is similar to what we have already noted for the boys. The remaining 20% of the overall difference are added up to the age of 14.

According to the investigation results of the body height it can be said that a further increase due to acceleration can be detected. This increase has still grown in intensity in our region, compared to most of the former studies of schoolchildren (Table 3 and 6).

Body weight

The increase in weight both for boys and girls between 1880 and 1975 amounts to about 8.4 kg on the total average (Table 2), this means about 0.9 kg converted to one decade.

A mean of 1.5 kg (minimum: 1.1 kg 1880; maximum: 1.7 kg 1932, 1954, 1964, 1975) was calculated from all 7 investigations made for the average semi-annual increase of body weight in *boys* (Table 4). Starting from the overall difference (8.4 kg) between 1880 and 1975 and the average semi-annual increase in weight (1.5 kg), this denotes that the boys of 1975 reach the values of body weight of pupils of the same age of 1880 about 2 years, 9 months earlier, on an average (minimum: 1 year, 7 months in case of 10-year-olds; maximum: 4 years, 8 months in case of 14-year-olds). Unlike the body height where the increase due to acceleration substantially takes place before the age of 7, the secular rise of the body weight is more intensely (about 55%) shifted to-

Table 5

Mean differences in body weight in Jena schoolchildren aged between 7 and 14 years

Year of investigation	1880/1921 kg	1921/1932 kg	1932/1944 kg	1944/1954 kg	1954/1964 kg	1964/1975 kg
Boys	2.2 (0.6)	2.3	-0.7	1.1	0.7	1.9
Girls	2.6 (0.7)	2.1	-1.3	2.4	0.7	1.0

Table 6

Acceleration of "Body weight- and Body height-age"

	Average differences		Acceleration of "Body weight- and Body height-age"	
	♂	♀	♂	♀
1. <i>Body height</i> 1880—1975	14.4 cm	13.2 cm	abt. 3 years, —	abt. 2 years, 7 months
1964—1975	2.8 cm	2.7 cm	abt. — 6 months	abt. — 6 months
2. <i>Body weight</i> 1880—1975	8.4 kg	8.4 kg	abt. 2 years, 10 months	abt. 2 years, 6 months
1964—1975	1.9 kg	1.0 kg	abt. — 7 months	abt. — 3 months

wards the age stages between 7 and 14 years (essentially between 11 and 14 years).

The mean semi-annual increase for the entire period of 95 years in *girls* is 1.69 kg (Table 4). According to this figure, in 1975 the schoolgirls reach the values of body weight of the 1880 girls of the same age earlier by roughly 2 years, 6 months, on an average (minimum: 1 year, 4 months in case of 7.5-year-olds; maximum: 3 years, 8 months in case of 12-year-olds).

The increase in body weight connected with the acceleration in the age classes between 7 and 14 is also stronger in the girls (about 57%) as compared to the period between 0 and 7 years (Table 5). In all it can be stated that the acceleration of the body weight increased in the past 11 years compared to most of the other time intervals. However, the body weight did not increase to the extent of that of the body height as it is expressed in the increase in body weight (kg) per centimetre of body height increase (boys: 1 cm: 0.7 kg; girls: 1 cm: 0.4 kg) (Table 6).

Chest breadth

Apart from the body height and body weight we also have at our disposal the means of the width of chest of Jena boys of age 7 to 14 years from 1880. Since the data of girls are incomplete (merely the 7 to 9.5-year-olds were examined in 1880), they will not be compared here with the values from 1975. For

that reason we restrict our statement to the mean chest widths of boys. This characteristic was recorded and evaluated in altogether 5 investigations of schoolboys from Jena between 1880 and 1975 (1880, 1921, 1932/33, 1954, and 1975).

The chest widths in *boys* calculated for all semi-annual classes of 1880 and 1975 differ by altogether 3.8 cm on an average, corresponding to a mean 0.4 cm increase of the width of chest values per decade. On the one hand this means (starting from the above mentioned total differences) that the secular acceleration does not make itself felt as strongly as this happens for body height and weight. On the other hand, also the relative differences, for example 6.0% for the width of chest in the male sex (between 1880 and 1975) are clearly below the percentage increases for body height (11.2%) and weight (31.0%).

The average semi-annual differences amount to 1.06 cm of all studies. Taking this figure and the total difference (3.8 cm) as a basis, this means that the 1975 boys on an average reach the values of chest width of the 1880 boys of the same age earlier by about 1 year, 9 months. What is striking in our results is that the means of 1975 are below those of 1954 in the majority of age classes, that is to say the width of chest declined both in boys (mean: -0.4 cm) and girls (mean: -0.8 cm) in the past 20 years.

This fact and the proof that the width of chest is not subjected to secular acceleration to the same degree as the other discussed dimensions of the body are suggesting that children and adolescents nowadays are slimmer than those of former times.

We hope to be able to make a contribution to the influence of acceleration on various dimensions of the body and the related proportional shifts by the evaluation of other characteristics. This could close part of the gap in our knowledge because according to KNUSSMANN (1980) it is still unclear today whether and to what extent all dimensions of the body undergo secular acceleration.

Menarche

As this characteristic was not included in former studies of schoolchildren in Jena, only the results of the 1954 investigation for the occurrence of menarche are available for comparison. While the mean menarcheal age was still 15.49 years (WINTER 1962) in Germany at the beginning of this century, GRIMM (1966) could indicate a mean menarcheal age of 14.5 years for his studies made in Halle between 1947 and 1948. The investigations carried out in Jena in 1954 revealed a mean menarcheal age of 13 years, 6.5 months. A mean menarcheal age of 12 years, 8 months was calculated for the 1975 questioning of girls. The mean menarcheal age of 12 years, 3 months indicated by RICHTER (1976) for Görlitz is not yet reached by our data, but this among other things may be attributable to the different recording of this characteristic. While RICHTER undertakes longitudinal-section studies — i.e. questioning of the girls being possible immediately after the occurrence of menarche — the retrospective method we used is liable to certain error sources (e.g. girls whose answers were not precise).

The earlier menarcheal age is substantially due also to a decline of the portion of late menstruating girls (also cf. WINTER 1962, a. o.).

Summary

To summarize it is noted again that acceleration of growth and development goes on in our region. The investigation results of body height and (with restrictions) body weight permit the conclusion that the intensity of increase due to acceleration has still grown compared to most of the former investigations of schoolchildren undertaken in our region of research (Thuringia). The described development of the width of chest can possibly be interpreted in this direction, but this requires the inclusion of other characteristics to confirm it.

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