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On Growth of Children: Effect of Some Socioeconomic and Genetic Factors

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In 8195 boys and girls (2.00 to 7.99 years of age) height, per capita family income and mid-parent height were recorded. Children who lived in good socioeconomic conditions, as measured by per capita family income, achieved greater mean height than those in poorer ones. The greater proportion of variation is explained by mid-parental height and not by income. Apparently there seems to be a relationship between the height percentiles of individuals and the categories of the studied socioeconomic variable.

Physical development of children depends on the action of a diverse set of social conditions and on the significant effect of heredity [8]. It is obvious that if an individual or a population lives in an optimum environment, genes will have the opportunity to express their maximum potential [16, 20, 21]. This explains the great importance of investigating the existing relationship between physical development and socioeconomic conditions.

In a developed socialist country, the classical differentiation criteria of society lose their meaning mainly because its organization is based on collective ownership of the means of production and a set of variables becomes relevant due to the fact that they show the differences that are still present in the population as a result of characteristics of the actual work [4]. These differences can be expressed, for example, in the educational level or the family income.

The purpose of this research was to obtain information on the relationship between height of children, as a sensible indicator of growth [10, 7], and per capita family income, which was selected as one of the variables that reflect the effect of social conditions on physical development [14, 15]. Included was also the mean height of both parents, frequently used to account for the effect of some hereditary factors on growth [1, 11, 17].

Materials and Methods

Data for 4163 boys and 4032 girls, from 2.00 to 7.99 years of age were studied (Table I). These 8195 children belonged to the 1972 Cuban National Growth and Development Study [7]. The chosen variables were height, per capita family income and mid-parent height. Decimal age was used [18] and height was measured by using procedures recommended by the International Biological Program [19].

Monthly per capita family income was classified in four categories: $\leq$ \$ 25.00;

TABLE I

Distribution of children by age and sex

Age (in years)	Number of children Boys	Girls	Total
2+	719	644	1363
3+	875	890	1765
4+	635	619	1254
5+	639	624	1263
6+	648	611	1259
7+	647	644	1291
Total	4163	4032	8195

TABLE II

Mean height of children by monthly per capita family income

Age (in years)	$25.00 number	$\bar{X}$	S.D	$25.00—$49.99 number	$\bar{X}$	S.D	$50.00—$74.99 number	$\bar{X}$	S.D	$75.00 number	$\bar{X}$	S.D
					Boys							
2+	554	89.9	0.20	54	91.0	0.23	52	92.1	0.50	59	91.5	0.54
3+	716	95.9	0.24	64	97.5	0.26	55	99.0	0.40	40	97.5	0.65
4+	516	102.2	0.30	48	104.1	0.37	42	106.3	0.70	29	104.8	0.72
5+	551	108.8	0.33	38	110.9	0.38	22	111.1	0.69	28	110.4	0.81
6+	561	113.3	0.35	32	116.6	0.39	35	118.3	0.65	20	115.6	0.77
7+	551	119.7	0.32	33	121.8	0.41	36	122.9	1.10	27	121.6	0.91
					Girls							
2+	501	89.8	0.21	56	90.4	0.28	46	90.9	0.45	41	91.0	0.63
3+	734	95.2	0.25	56	96.9	0.24	51	97.4	0.45	49	96.9	0.49
4+	513	101.5	0.30	44	103.8	0.34	32	104.8	0.72	30	102.4	0.79
5+	521	107,4	0.32	40	110.4	0.40	42	111.9	0.82	21	109.8	0.88
6+	525	113.8	0.35	30	116.1	0.34	33	118.7	0.70	23	115.9	0.84
7+	549	118.6	0.33	50	120.9	0.39	25	123.3	0.81	20	122.6	1.02

$ 25.00—49.99; $ 50.00—74.99; and $\geq$ $\geq$ 75.00. Mean and standard deviation of height were calculated by sex and age for each income category. These results are shown in the Tables and Figures. The variation on the standard deviation units of height was compared with the variation in mid-parent height, after adjusting for age and income category.

A covariance analysis [13] was carried out by sex and 1-year age categories in order to obtain information about the effect of income on the variation of height in children. Mid-parent height was the concomitant variable.

Pearson's χ^2 test was used to measure independence between height and income category using, as one group, children at or below the 10th percentile and, as another one, those at or above the 90th percentile of the Cuban national growth curves [7]. The contingency coefficient was calculated to measure the strength of the association.

Results and Discussion

Table II shows the mean and standard deviation of height by age and income. Figure 1 shows the mean height of boys. The trend is apparently following the increasing income categories. The only exception was seen in the highest category ($\geq$ \$ 75.00) where the values moved irregularly around the curve of an intermediate category, \$ 25.00 – 49.99. The results obtained for girls were similar and are shown in Figure 2.

Standard deviations for both sexes fell within the expected range when compared to those of the Cuban population [7]. As expected, these values increased as the number of subjects in a category decreased.

It was characteristic that children in low income categories showed low height values, while children in higher income categories had a tendency towards a greater height. Other studies showed similar results: the mean size of children in good socioeconomic conditions is greater than the mean size of those in worse socioeconomic situations [2, 3, 5, 12].

Figures 3 and 4 show the variations in the height of children and mid-pa-

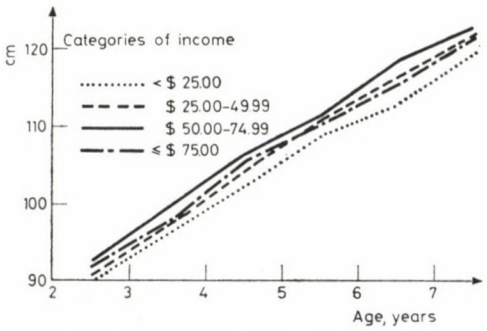

Fig. 1. Mean height of boys

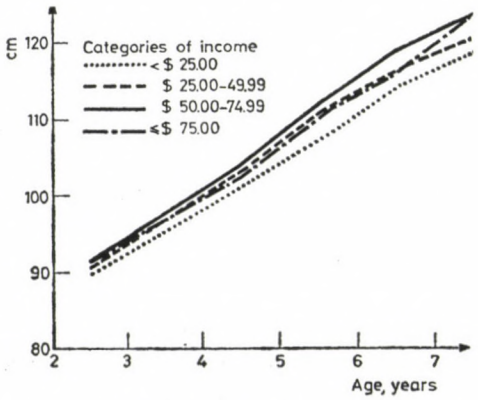

Fig. 2. Mean height of girls

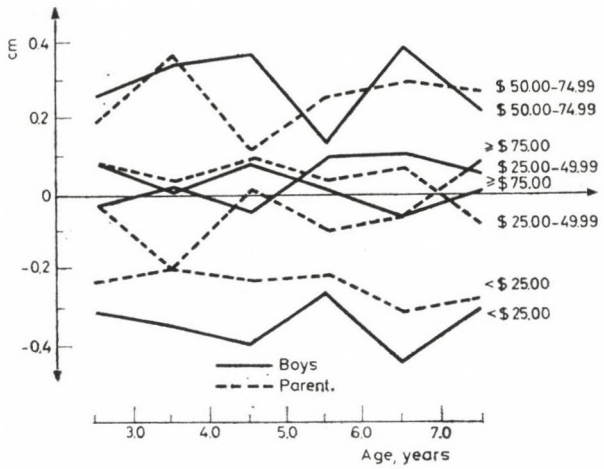

FIG. 3. Standardized deviations from the mean. Height of boys and mid-parent height

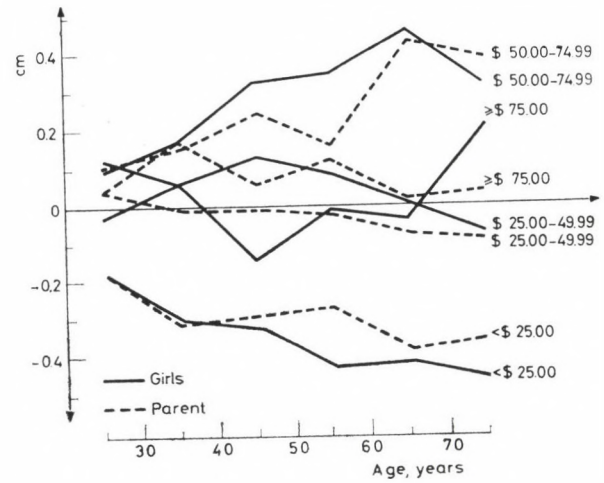

FIG. 4. Standardized deviations from the mean. Height of girls and mid-parent height

rent height by age and sex. For all children the height standard deviations had values that fell within the approximate distance of ± 0.4 cm.

The income categories with the largest differences were $ 25.00 and $ 50.00—74.99. In boys the standard deviations varied from — 0.3 to 0.4 cm, while among girls the interval was narrower after the age of 4 years. The corresponding deviations for mid-parent height were distributed in a narrower range.

What could be the probable cause for the narrower range of the standard deviations of mean parent height when compared to those of their offspring, especially the male ones? Some elements of which we do not have enough information may distort or

limit any analysis. For example, the parents of these children could belong to different generations; there is no information about their height when they were of the same age as their offspring at the time of measurement. Would the variation in their height have been similar to that of their children today ? Will the variation in the adult height of these children be different from that of their parents ? Furthermore, in our population the correlation between the height of spouses was unknown and this factor has been reported to influence the correlation of child stature with mid-parent height [9, 11]. A possible explanation of the phenomenon might be that during the preschool ages the child is specially sensitive to the environment [6]. Due to this higher sensitivity, the variations among these children could remain in a higher range that those corresponding to their parents, even though the former are growing in a qualitatively better environment than the latter on account of the improved conditions. The fact that girls deviate more from their parents than do boys is another expression of the different susceptibility to the environment depending on biological factors such as age and sex.

Table III shows the covariance analysis. The interaction with the covariate (mid-parent height) in 3-year old boys and in 4 and 7-year-old girls (values in boxes) are evident.

TABLE III

Result of covariance analysis

Age (in years)	$R^2 \times 100$	
	Income adjusted by mid-parent height	Mid-parent height adjusted by income
	Boys	
2+	1.32*	8.23**
3+	3.45 **	4.49**
4+	3.73**	10.43**
5+	0.76	17.77**
6+	3.79**	16.41**
7+	1.94**	16.04**
	Girls	
2+	1.04	6.31**
3+	1.43**	3.04**
4+	4.49 **	2.72**
5+	4.69**	15.16**
6+	2.09**	19.22**
7+	3.17 **	17.29**

* $p < 0.05$
** $p < 0.01$

In all other cases $p > 0.05$

The results are presented without having a plausible explanation for these irregularities.

The proportion of variation in the height of children explained by mid-parent height is larger than the one explained by income. Furthermore, the determination coefficient for mid-parent height is always significant, when income is adjusted for. When income is analysed adjusting for mid-parent height, the determination coefficient is significant for almost all ages.

These results confirm the effects that variables with a strong genetic component (such as mid-parent height) and those reflecting socioeconomic conditions (such as income) can have upon an anthropometric dimension such as height.

Table IV shows the percentage of children falling in the 10th percentile or below and in the 90th or over of the Cuban national growth curves, arranged by income category. As income increases, the percentage of children in the 10th percentile or below decreases, while the opposite happens with those in the 90th percentile or over, with the exception of the highest income category, $\geq \$ 75.00$.

Table V shows values for the tested hypothesis and they are rejected. There is a relationship between height in the two extreme percentiles and the categories of the socioeconomic vari-

TABLE IV

Percentage of children by income categories. Height $\leq$ 10th percentile or $\geq$ 90th percentile

Percentile	Income categories							
	<$25.00		$25.00— 49.99		$50.00—$74.99		≥$75.00	
	N	per cent	N	per cent	N	per cent	N	per cent
				Boys				
≤10	195	10.2	67	4.3	6	1.6	17	5.6
≥90	155	8.1	240	15.4	84	22.3	60	19.8
				Girls				
≤10	227	12.5	66	4.3	7	2.0	18	6.2
≥90	157	8.6	238	15.2	73	20.4	57	19.6

TABLE V

Chi-square (χ^2) and contingency coefficient (C) values

Variables	χ^2	D.F.	C
	Boys		
Monthly per capita family income	127.4**	2	0.37
	Girls		
Monthly per capita family income	142.6**	3	0.38

**$p < 0.01$

able in study. The contingency coefficients in Table V reach high values.

The results of this paper confirm that social and biological factors cannot be dealt with separately. New questions arise and old ones remain unanswered. Providing explanations is not an easy task, but this is precisely the incentive to continue the examination of these factors.

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