THE NORMAL CHILD: ITS PHYSICAL GROWTH AND MENTAL DEVELOPMENT

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FOR purposes of psycho-educational analysis it should be recognized that a child has five parallel or interrelated ages: a chronological age in years, months and days, denotive of the temporal span of life; a physiological age denotive of stages of physical growth and maturity; a mental age denotive of the ripening of certain instincts, capacities and mental traits; a pedagogical age denotive of the rate and position in school progress; and a moral age denotive of fairly well-defined nodes of development in moral judgment and religious awakenings. In a normal child these ages balance each other.

This paper presents the results of a study of the physical growth (physiological age) and the pedagogical age (school standing) of a group of boys and girls from six to eighteen years of age when observed consecutively. The chief value of the study lies in the fact that it is the first attempt to follow for any considerable length of time the same group of individuals through the elementary and high schools, either in physical growth, school standing or the relation of the two.

The scope of the investigation includes, first, a series of norms based on the height, weight and age distributions: the average and average deviations of individual yearly and half-yearly increments of growth in height, weight and lung capacity; and individual curves in height, weight and lung capacity with health notes, and weight, height and vital indices. The second part of the paper deals with the school standing of the same individuals in marks, grades and ages; the third with the relation or correlation of physical growth to mental development as shown in school progress. The data comprise 43,840 measurements on approximately 1,000 boys and 1,000 girls, and 21,683 final quarterly term marks for 135 of these same boys and girls from the Horace Mann School at Teachers' College, New York, the University of Chicago Elementary and High Schools and the Francis W. Parker School in Chicago.

That these boys and girls form a select group and that school-medical inspection, directed play and physical training are important educational agencies are shown by the fact that on the average these children are taller, heavier and have better lung capacity than any other group in a series of 112 groups extending from Quetelet's first study in 1836 to 1914, and comprising over one million individuals.
The base line divisions represent periods of one year; the vertical divisions represent 8 centimeters in height and 10 pounds in weight. The degree of pitch of the line shows the relative amounts of increase of absolute increments for the same individual. The broken line shows Boas's norm.

In reply to the question how tall or how heavy is the normal child within this group, and how much lung capacity has this child, the distribution tables give the following medians in inches, pounds and cubic centimeters, respectively.

<table>
<thead>
<tr>
<th></th>
<th>8 yrs.</th>
<th>10 yrs.</th>
<th>12 yrs.</th>
<th>14 yrs.</th>
<th>16 yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height: Boys</strong></td>
<td>50.3</td>
<td>53.5</td>
<td>57.1</td>
<td>60.9</td>
<td>65.7</td>
</tr>
<tr>
<td></td>
<td>49.2</td>
<td>53.0</td>
<td>57.4</td>
<td>61.8</td>
<td>62.9</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td>49.2</td>
<td>53.0</td>
<td>57.4</td>
<td>61.8</td>
<td>62.9</td>
</tr>
<tr>
<td><strong>Weight: Boys</strong></td>
<td>57.2</td>
<td>67.2</td>
<td>76.8</td>
<td>96.1</td>
<td>111.8</td>
</tr>
<tr>
<td></td>
<td>51.3</td>
<td>65.5</td>
<td>75.4</td>
<td>102.8</td>
<td>108.8</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td>51.3</td>
<td>65.5</td>
<td>75.4</td>
<td>102.8</td>
<td>108.8</td>
</tr>
<tr>
<td><strong>Lung capacity: Boys</strong></td>
<td>85.6</td>
<td>110.6</td>
<td>134.0</td>
<td>162.5</td>
<td>212.6</td>
</tr>
<tr>
<td></td>
<td>81.8</td>
<td>100.9</td>
<td>128.9</td>
<td>150.2</td>
<td>176.2</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td>81.8</td>
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</tr>
</tbody>
</table>

For the boys and girls below the median or normal height, the period for accelerated growth in height, weight and lung capacity is later than for those above and the growth continues longer. This is true of the schools individually and collectively for yearly and half yearly increments, and for the per cent. of gain over the initial measurements. In conclusion, the nodes of acceleration or cessation are different for tall children and heavy children than for short and light children.

In answer to the question, "What relation does the growth of any one age or period have to subsequent ones?” it can be said that the per cent. of gain from year to year shows that each child remains practically
within its percentile group. Aside from the height and weight curves in 1890 for Dr. Weiner's four boys, no long series of curves have been available in scientific literature. Taking at random 170 individuals and plotting their curves for height, weight and lung capacity, we have 510 such curves for comparison.

In carrying out comparisons graphically among forms so dissimilar in absolute size as those of height, body weight and lung capacity, it was thought best to use the following units. In the height and weight curves the same base line division of 20 millimeters equals 12 months in age, while for the ordinates or vertical lines 40 millimeters equal 20 centimeters in height and 10 millimeters represent 20 pounds in weight. In the lung capacity charts a base line division of 15 millimeters is used for 12 months in age, and in the vertical or ordinates 10 millimeters represent 20 cubic inches in lung capacity. The original charts have been reduced in size and the millimeter lines taken out. The black lines represent distances of 20 millimeters on the height and weight charts and 15 and 10 millimeters on the lung capacity charts. The same Arabic numerals in a chart refer to the same individual.

Short children do not become tall, neither do tall children become short, under normal conditions. The per cent. of increase in height increments over the initial heights for a given chronological age from 6 to 18 is so comparatively uniform for each normal individual that the growth curves enable us to prophesy with considerable accuracy how tall a child of normal growth should be at any subsequent age within the
LUNG CAPACITY CURVES. BOYS.

The base line divisions represent periods of one year; the vertical divisions represent 20 cubic inches in lung capacity. The degree of pitch of the line shows the relative amounts of increase of absolute increments for the same individual.

interim, provided his relation to any given median or norm be known.

The second significant point to notice is the relative shifting of the period of adolescent acceleration from 12½ for the tallest boy (No. 2) to 16 years for a short boy. For the tallest girl maximum height was attained at 14½ and for the shortest girl at 17 years, 3 months.

A period of marked retardation before adolescence is usually marked by a period of rapid acceleration during adolescence. If the increment of growth before adolescence is uniform, this uniformity tends to persist throughout adolescence. Where there is unusually rapid growth from 7 to the beginning of adolescence, there is frequently a decrease during adolescence. Marked arrests with these children usually occur during adolescence and persist throughout the period.

As a rule the weight and height are relatively proportionate to each other. Aside from irregular periodic fluctuations in height, each child retains relatively its position throughout childhood in regard to weight.
One of the most useful and practical indices of growth is the weight-height coefficient, which expresses the comparative solidity or robustness of the individual, and therefore, other things being equal, his general nutrition.

The lowest ratio in this group of boys is .15 at six years, and the highest .40 at 17½ years of age. There is little or no apparent difference, as a rule, between the tall boys and the short boys, except that the acceleration begins earlier for tall individuals. For example, if we take 0.33 as representing a given physiological stage of development, it will be noted that the time shifts chronologically in a fairly uniform manner between 7 and 8 years of age with No. 1, to 14½ years for No. 14.

It will be noted in the boys' lung capacity curves that No. 9 in the first chart, who is relatively heavier than the others for his height, also has more lung capacity. This is significant since the other boys hold approximately their relative places for height, weight and lung capacity.

The boys have greater lung capacity than the girls, on an average, for all periods except at about 13 and 13½ years of age. The develop-
ment in lung capacity for girls about comes to a standstill or decreases after 15 years of age; for boys the period is some time after 17 or 18. Marked arrests in height and weight are uniformly accompanied by arrest in growth of lung capacity. The boys and girls above and below median height differ in their periods of accelerated growth in lung capacity in a manner similar to the differences in height and weight.

In general it may be stated that there is more marked relationship between disease or physical defects and growth in weight than growth in height. Diseases seem to inhibit growth more during the late period of childhood than earlier. Accelerated growth and resistance to disease go hand in hand. The inception and removal of adenoid growth materially affect physical development.

Selecting the individual growth curves of the girls whose physiological changes have been recorded day by day during the periods of maturation, it is evident that the taller girls mature early.

Height and weight, therefore, offer excellent objective criteria for teachers and parents for determining the advent of menstruation as a factor in pubescent development and the onset of maturity. If the girl is tall, healthy and well nourished, this physical stage may be reached as early as 11 years in a normal girl; if tall, but underweight, it may be delayed; if very short and markedly light, it may be delayed until 16 years of age.

These conditions have wide educational application both in physical training and school work. They emphasize the fact that the smaller child should be treated as a younger individual, who has not the physical development and the accompanying mental disturbances and experiences which would seem to be indicated by her chronological age in years, and which, too often, has been used as a basis of classification, training and social activities.

It must be recognized, since we are investigating the school standing or pedagogical age, and since promotions are based on marks, school records must be taken at their face value, because they represent school practise and because they offer tangible criteria of the efficiency of the individual and of the school.

If we accept progress through school when measured by marks, age and grade distribution in highly specialized schools, as criteria of mental development or at least indicative of nodes of mental maturation, we have in this section of our discussion 135 individual pedagogical curves based on 21,682 final term marks in the common school subjects, music and deportment. The average school mark for the Horace Mann boys is 81.9 per cent., for the girls 85.9 per cent., for the Francis W. Parker boys it is 77.7 per cent., and for the girls, 80.9 per cent.

Some of the main facts are: Girls maintain a higher school standing than boys; there are also more repeaters among the boys; and fewer
cases of skipping a grade. In the fourth and fifth grades the boys and girls are approximately the same age, but in the last year in high school the boys are older on the average.

Expressing these tables in school standing in graphic form where 20 millimeters in the horizontal equals one year in age and 30 millimeters in the vertical equals one school grade, the two variables, age and school grade, may be expressed in the form of a continuous line. A third variable, or the average mark for each grade, may also be expressed, assuming the first 6 millimeters in the vertical within a grade to represent a standing between 50 and 60 per cent., the second 6 millimeters, between 60 and 70 per cent.; the third, between 70 and 80 per cent.; the fourth, between 80 and 90 per cent.; and the fifth, between 90 and 100 per cent. Thus it will be noted in the chart that the uppermost curve represents the most precocious child and the lowest curve the most retarded from standpoint of age and grade. No. 6 is the most precocious from the standpoint of age until he reaches 16½ years, and No. 11 the most retarded throughout his school life. On the contrary, comparing the average marks within the grade, No. 11 has higher marks than No. 6, as may be seen by noting the height of the circles in each grade.

Pupils who are relatively poor in the first few grades are relatively poor in the upper grades; that is, poor marks in the early school course are indicative of low standing throughout the school course. Boys and girls of normal school age or under maintain a better school standing, both as to grades and marks, than those over age for grade. The age of entrance after six or seven years determines the age for completing the elementary and high school. With very few exceptions these children progress through the elementary school at the rate of one grade per year, regardless of the chronological age at entrance.

What is the relationship between these two? Accepting the pedagogical age as a fair equivalent of mental development, the first noteworthy fact of general significance is that among these children those of normal school age or younger maintain a better school standing both as to grade and mark than those age for grade. These are the physiologically accelerated or normal pupils. Those above median weight complete the last grade of the elementary school at 12 years, 9½ months of age with an average of 84.35, and those below average or of retarded physiological development complete the elementary school work at 13 years, 7½ months of age with an average of 81.72 per cent. Checking the individuals whose curves have been plotted for age, height, weight, lung capacity, school grade and school mark, and giving the results graphically, it may be seen that the majority of children above median height are in or above normal grade and above the average in marks. Of those below median height the majority of children are below or in normal grade and below average mark.
SCHOOL STANDING CURVES, BOYS.

The base line divisions represent one year in age, while five of the vertical divisions equal one school grade. The average mark for each grade may be determined by assuming that the first division of the grade represents a standing between 50 and 60 per cent., 2d between 60 and 70 per cent., 3d between 70 and 80 per cent., 4th between 80 and 90 per cent., and 5th between 90 and 100 per cent. The degree of pitch of the line shows the relative amounts of increase of absolute increments for the same individual.

The main educational corollaries which logically follow from this study would require that our school systems, public and private, be graded on the physiological age and the accompanying stage of mental maturity of boys and girls in place of the chronological age, as is now
done. This would require that tall healthy children of accelerated physiological age be encouraged to proceed through school as rapidly as possible within the limits of thoroughness, and that the small light children of retarded physiological development be kept below or in the normal grade doing supplementary work, since these short light pupils are immature in mental development, although in many instances precocious in brightness. It also follows from the study that rapid healthy growth favors good mental development, and therefore the healthy growing child should have plenty of physical and mental exercise.