

THE INFLUENCE OF PHYSIOLOGICAL AGE UPON SCHOLARSHIP.*

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The term *physiological age* refers to the stage of development in contradistinction to age in years and months, which is the usual method of designating age.

Various evidences of physiological age are tooth appearance, pubescence, change of voice, menstruation, menopause, etc.

Pubescence is an evidence of sexual ripening and the beginning of adolescence. Pubescence in the male is the feature studied in this work. For the purpose, three physiological groups are distinguished, corresponding to three successive stages of development: (1) prepubescent, (2) pubescent, (3) postpubescent. The percentage of prepubescent, pubescent and postpubescent population in each age group, taken in half years, is given in Table I. This table, which is based on 4,800 records, shows that each chronological age group contains subgroups based upon physiological age.

TABLE I.

AGE IN HALF YEARS	PHYSIOLOGICAL GROUPS.		
	PREPUBESCENT.	PUBESCENT.	POSTPUBESCENT.
12.75	69%	25%	6%
13.25	55	26	18
13.75	41	28	31
14.25	26	28	46
14.75	16	24	60
15.25	9	10	70
15.75	5	10	85
16.25	2	4	93
16.75	1	4	95
17.25	0	2	98
17.75	0	0	100

It gives, also, the relative size of these subgroups. These facts have been disregarded hitherto, and the chronological age group treated as if it were homogeneous.

*Syllabus of a paper delivered before the first congress of the National School Hygiene Association of America, held in Washington, D. C., May 6 and 7, 1907.

It is also apparent that each physiological age group contains individuals who vary much among themselves as to their real physiological age. For instance, the prepubescent are fifty-five per cent of the total number at the age of 13.25 years. Some of these, fourteen per cent of all at that age, will become pubescent within a half year; others, one per cent of all, will not become pubescent until 16.75 years of age. This one per cent is, therefore, three years younger physiologically than the fourteen per cent.

In a similar manner, the individuals in the postpubescent groups vary as to the number of years elapsed since they have passed through their pubescence.

From the above table, the expected number of years required to reach pubescence, with the variability of each age, was calculated for each alternate half-year group. The result is shown in Table II. In a similar manner the average number of years that have elapsed since pubescence has been calculated for each of the half-year groups represented in Table III.

TABLE II.

EXPECTED NUMBER OF YEARS REQUIRED FOR PREPUBESCENTS TO REACH PUBESCENCE.

<i>Half Year Age Group.</i>	<i>Average in Years.</i>	<i>Variability.</i>
12.75	1.37	± .95
13.75	.97	.79
14.75	.78	.59
15.75	.55	.40

TABLE III.

NUMBER OF YEARS ELAPSED SINCE POSTPUBESCENTS' PUBESCENCE.

<i>Half Year Age Group.</i>	<i>Average in Years.</i>	<i>Variability.</i>
17.75	3.28	±1.25
16.75	2.43	1.14
15.75	1.64	.98
14.75	1.13	.72
13.75	.70	.61

American born children of German born parents appear to be later in attaining pubescence than American born children of American born parents. This was demonstrated in percentages for each year.

Weight and Pubescence.—Postpubescent average twenty-four per cent to thirty-three per cent heavier than prepubescent of the same age.

TABLE IV.

AGE IN HALF YEARS	WEIGHT IN KILOGRAMS.		
	PREPUBESCENT.	PUBESCENT.	POSTPUBESCENT.
12.75	35.2	36.6	(50.8)
13.25	35.0	37.2	44.3
13.75	35.4	37.9	43.8
14.25	35.2	38.6	45.4
14.75	36.8	39.0	47.2
15.25	37.9	38.8	47.7
15.75	36.7	41.8	49.3
16.25	(40)	38.3	51.6
16.75	(46.5)	(41.5)	53.5

From Table IV it is evident that any statistics which do not include a reference to physiological age are faulty and incomplete in so far as weight and allied features are concerned. Practically all of our statistical work must be revised in the light of this evidence or disregarded completely.

Height and Pubescence.—Postpubescents average as much as eleven per cent taller than prepubescent of the same age.

TABLE V.

AGE IN HALF YEARS	HEIGHT IN CENTIMETERS.		
	PREPUBESCENT.	PUBESCENT.	POSTPUBESCENT.
12.75	144.0	147.5	150.5
13.25	144.2	148.7	153.9
13.75	145.7	150.4	155.9
14.25	146.6	150.6	157.9
14.75	147.3	151.7	158.9
15.25	149.8	151.5	160.7
15.75	149.8	153.1	162.6
16.25	151.0	152.4	164.6
16.75	(153)	(151.4)	165.4

Table V shows the different average heights of these three physiological age groups for each half year. The error of previous statistical work is clear, and the necessity of recognizing the basis of physiological age in grouping statistical and other records is thoroughly demonstrated.

Strength and Pubescence.—The strength of the muscles of the forearm which flex the fingers was registered by the ordinary grip dynamometer. It showed that the postpubescents averaged about thirty-three per cent stronger than the prepubescent.

TABLE VI.

AGE IN HALF YEARS	STRENGTH IN KILOGRAMS		
	PREPUBESCENT.	PUBESCENT.	POSTPUBESCENT.
12.75	25.6	28.2	(32.5)
13.25	26.3	28.1	33.6
13.75	27.6	30.4	35.2
14.25	27.3	30.2	37.8
14.75	29.4	30.8	38.3
15.25	29.6	31.1	40.1
15.75	32.5	30.4	42.9
16.25	31.7	29.6	43.8
16.75	(27.5)	33.2	48.3

The variabilities of all these sub-groups have been determined. The prepubescent are least variable, the postpubescent most. There is a very slight increase in the variability of weight and strength in each physiological age as the age in years increase. This is not the case with respect to height. The variabilities at the age of 14.75 are typical:

TABLE VII.

	<i>Prepubescent.</i>	<i>Pubescent.</i>	<i>Postpubescent.</i>
Weight (kilograms)	± 5.18	± 5.83	± 8.09
Height (centimeters)	± 5.96	± 6.37	± 7.51
Strength (kilograms)	± 4.96	± 5.66	± 8.46

Pubescence and Scholarship.—Success in school should not be taken to imply success in other lines.

Pubescence and School Grade. (First Method).—The higher the grade the fewer prepubescent, age for age; hence postpubescent are better in scholarship than prepubescent, and the more advanced a group is in pubescence the better will be the scholarship. This can be expressed by a scale of percentages in which zero means all prepubescent and one hundred all postpubescent. The members of the age group 14.75 are distributed over different school terms (High School) as follows:

TABLE VIII.

First term	57.1 per cent.
Second term	62.7 " "
Third term	69.6 " "
Fourth and fifth terms	83.3 " "

This is typical of all the age groups studied. Since, therefore, the higher the grade the higher the percentage of pubescence, we should expect to find that the higher the grade the greater would

be the weight, height and strength, which it has been proven are related to pubescence. This is true. Greater height, weight and strength are related to better scholarship because they are all effects of the same cause,—earlier pubescence.*

It is next in order to determine whether there is any correlation between scholarship on the one hand, and weight, height and strength on the other, excepting that which is due to their common relationship to physiological age. To do this it is only necessary to compare the average for weight, etc., of the same *chronological age* and the same *physiological age* groups which differ only in school term. Thirty-one pairs of averages have been compared.

Weight.—The average increase in weight per term is .95 kilograms, taking the 14.75 age group as typical. But the average increase is only .07 kilograms when those of this age and of the same physiological age are taken. Hence .88 kilograms of this is due to correlation with pubescence and only .07 kilogram due to correlation with other factors. Several other factors are to be considered in this connection. We have not taken into consideration the fact that postpubescents vary among themselves as to the time elapsed since pubescence; hence the older postpubescents are in the higher classes and would therefore be heavier. It is possible that if this factor were to be eliminated there would appear a minus instead of a plus relation between scholarship and weight (irrespective of pubescence).

Height.—There is an average movement of plus .66 centimeter in height per term including pubescence, and of plus .36 centimeter per term eliminating pubescence as a factor; this latter is the only part that can possibly be due to other factors than pubescence and, as explained above, may also be due to this factor.

Strength.—There is an average movement of plus 1.34 kilograms in strength, including pubescence, and of plus .36 kilogram in strength excluding this factor.

Conclusion.—By far the greatest part of the correlation of weight, height and strength with scholarship is due to the fact that they are all correlated in common with the pubescence factor.

Scholarship and Pubescence. (Second Method.)—We can determine what influence physiological age may have on success in scholarship by observing the rate of success and failure of each chronological age and physiological age group. Postpubescents

*It was found by Smedley (Forty-sixth Annual Report of the Board of Education, Chicago, Ill., 1899-1900) that the higher the term the greater the height, weight and strength. He failed to observe pubescence or any other sign of physiological age.

are thus found to be more successful, eighteen per cent failing to pass into the next term as against twenty-seven per cent of failure for the prepubescents, at thirteen years of age. At fourteen years the percentages of failure are twenty-four and thirty-four respectively; at fifteen years, twenty-nine and thirty-six. (These figures are taken from first year students in a High School.)

Conclusions.—Earlier pubescence favors good scholarship; later pubescence, poorer scholarship. This should be taken into consideration by all those who have the care of the pubescent.

Growth Rates.—Rapidity of growth depends upon physiological age and not upon age in years. Prepubescents of every age grow slowly in weight and height and strength. The acceleration begins as the stage of pubescence is reached and continues a variable time into postpubescence. There is absolutely no such thing as a prepubescent "spurt." The first year of postpubescence is the year of greatest acceleration in all growths, regardless of its chronological relation. To give any figures of growth rates for a chronological age is absurd.

Rapidity of Development.—Children are much more apt to begin pubescence and complete it during the five warmer months of the year than during the seven colder months.

Teeth as Evidence of Physiological Age.—About one thousand elementary school boys from ten to fifteen years of age were examined as to weight, height and presence or absence of permanent canines and second molars. Those with a full set of permanent canines averaged from five to seventeen pounds heavier and from one-half an inch to three inches taller than those with none. The molar grouping showed a somewhat stronger correlation. Tooth appearance had but a slight relation to actual age.

Menstruation as Evidence of Physiological Age.—A preliminary study of weight, height and strength demonstrated that menstruees are taller, heavier and stronger than non-menstruees. Weight showed the greatest correlation.

General Conclusion.—In future all of our thought concerning the years nine to seventeen must be released from the idea of chronological age. Statistics for groups or individuals respecting weight, height, strength, scholarship, mental or physical endurance, medical or social conditions, that are not referred to physiological age are inconsequential and misleading.