

INDICES OF PHYSICAL DEVELOPMENT IN CHILDREN

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At the beginning of the war, the London County Council issued a report by Sir Frederick Menzies, their late School Medical Officer, on the average heights and weights of London elementary school children in 1938. The report is based on the measurements of about 100,000 children, and is probably the most important contribution to the anthropometry of childhood that has appeared in this country for many years.

A quarter of a century ago, the writer, adopting the weight/height ratio as the simplest and perhaps the most reliable criterion of physical development, published certain formulae containing standardizing factors, whereby the weight/height ratios of school children of all ages and of both sexes could be reduced to a common denominator and so made comparable (Tuxford, 1939). By this means, comparisons of physique could be made, not only as between different children or those belonging to different districts, but also, in the case of the individual child, as between different dates, the resulting changes in the index affording some indication of the condition of the child's nutritional processes during the intervening period. The formulae, which were based on the physique of the average English child of 1909-10, have now been readjusted in order to render them applicable to these latest measurements of London children; new standardizing factors have been found and are set out below, together with the indices obtained by their use from the London measurements.

These factors are the most accurate that could be discovered, and the search for them demonstrated the one serious defect in the published tables, namely, the fact that they do not refer to a homogeneous school population. The measurements of a considerable number of children, who were transferred to secondary schools at the age of 11, are omitted from the tables, and it is reasonable to infer, as is suggested in the report, that they included a larger than average proportion of well-developed children, and that the figures for the later years of school life are, consequently, below the true mean measurements of London children of those ages. The average London boy of 10 years of age has, thus, the expectation of a somewhat better physique in 2 years' time than is implied in the measurements in the tables for age 12.

As a result of these omissions, the boys' weight/height ratios, when plotted out, do not form the harmonic curves required by the formulae; indeed, the English ratios for the later ages, from 9 to 14, are practically identical with part of a well-known geometric series—that of the vibration-ratios of consecutive intervals in the tempered 12-note scale. It was, therefore, impossible to find entirely satisfactory standardizing factors for these ratios, and the factors adopted are those which give the best set of indices, taken as a whole. Some other factors, however, $\frac{325\text{—months}}{46}$ and $\frac{325\text{—months}}{258}$ for instance, yield results up to 11 years of age, with metric and English measures respectively, which are as good as those of the girls, after which age the indices deteriorate badly.

The girls' ratios, on the other hand, form very regular harmonic curves throughout, though usually such curves have an upward bulge at about the age of 12 (owing to quickened development at the onset of puberty) which is accompanied for a year or two by indices higher than normal. The bulge is absent, and indices are, consequently, very near the normal at all ages.

Girls start school life with an average physique inferior to that of boys, and finish it with one considerably superior. They grow more quickly throughout the period, and, in 1910, the age at which they overtook the boys was $11\frac{1}{2}$. The improvement in the physical development of both boys and girls in London, since that date, has been such that they now have the weight/height ratios of children who were then $1-1\frac{1}{2}$ years older, with the result that equality of physique, as between the sexes, now occurs a year earlier, at about the age of $10\frac{1}{2}$.

Similar changes have, no doubt, been taking place throughout the country, and the better development of the modern child is obvious to those who can recall the build of the average elementary school child of the last generation. The improvement has been

London elementary school children, 1938

Age	Boys				Girls			
	Wt. (kg.) Ht. (cm.)		Wt. (lb.) Ht. (in.)		Wt. (kg.) Ht. (cm.)		Wt. (lb.) Ht. (in.)	
	× $\frac{335-\text{age in months}}{48}$		× $\frac{336-\text{age in months}}{270}$		× $\frac{308-\text{age in months}}{42}$		× $\frac{308-\text{age in months}}{235}$	
	Wt./ht. ratio	Index	Wt./ht. ratio	Index	Wt./ht. ratio	Index	Wt./ht. ratio	Index
5	0.1733	0.993	0.9706	0.992	0.1704	1.006	0.9542	1.007
6	0.1819	0.997	1.0185	0.996	0.1781	1.001	0.9975	1.002
7	0.1913	1.000	1.0714	1.000	0.1872	0.998	1.0484	0.999
8	0.2016	1.004	1.1291	1.004	0.1979	0.999	1.1081	1.000
9	0.2129	1.007	1.1924	1.007	0.2098	0.999	1.1749	1.000
10	0.2251	1.008	1.2606	1.008	0.2235	1.000	1.2518	1.001
11	0.2384	1.008	1.3349	1.009	0.2390	1.002	1.3384	1.002
12	0.2524	1.004	1.4136	1.005	0.2568	1.003	1.4380	1.004
13	0.2677	0.998	1.4989	0.999	0.2767	1.001	1.5496	1.002
14	0.2837	0.987	1.5888	0.989	0.2994	0.998	1.6764	0.999

so considerable that it is now evident that the standardizing factors of 30 years ago have, to-day, lost their applicability; they give very discrepant results when applied to the new London measurements, and it is advisable that their use should be abandoned, at any rate in respect of English children. One may, perhaps, suggest that, in the continued absence of any standard measurements of English children, the L.C.C. averages might well be adopted as temporary national standards for purposes of comparison; the physical development of children could then be ascertained by means of the new formulae. The physique of London children has, during the present century, been above the average for the country generally; it should, therefore, be borne in mind that, in most districts, a majority of the indices obtained by this method will, in some degree, be subnormal.

The rates of growth of these London children are of interest. The yearly proportional increments of weight decrease uniformly, in the case of boys, from 0.108 in the sixth to 0.090 in the fourteenth year, whereas, in the case of girls, they increase, also uniformly, from 0.100 to 0.122 during the same period. The difference between the sexes in this respect is the chief factor in the more rapid development of the girls, and is probably not peculiar to London. If the mean of these two diverse rates of growth be obtained

by combining the figures for the two sexes, the average London child is found to put on flesh by an almost constant yearly increment, ranging between 0.104 and 0.106 and averaging 0.105, i.e. by $10\frac{1}{2}\%$ per annum. With a somewhat larger margin of error, the rate of increase for each sex separately may also be expressed as the average increment, i.e. as 9.9 and 11.1 % per annum for boys and girls respectively.

The annual proportional increments of height decrease, during the same years, from 0.056 to 0.028 for boys, and from 0.052 to 0.037 for girls; these figures vary too widely (those for boys diminishing by one-half) to be represented, with any degree of accuracy, by average yearly proportional increments. The girls, however, gain height by the uniform yearly addition of 5.48 cm. to their stature throughout their school life; the boys' heights were calculated by a different method, and the added centimetres, in their case, vary between 5.9 and 4.1 and average 5.1 per annum.

On the whole, the figures in these London tables show that changes in the size, mass and shape of children (as indicated by their height, weight and weight/height ratio) take place, during the years of their school life, at rates which are, respectively and approximately, those of series in arithmetical, geometrical and harmonical progression.

REFERENCE

- TUXFORD, A. W. (1939). The estimation of physique and nutrition in children. *J. Hyg., Camb.*, **39**, 203-16.

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