A STATISTICAL STUDY OF THE PHYSIQUE OF ELEMENTARY SCHOOL CHILDREN WITH SPECIAL REFERENCE TO THEIR MENTALITY.

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(With 8 Graphs.)

Introductory.

Comparatively few specialised investigations of the physical development of school children seem to have been made in this country. The most comprehensive British investigation is that made by Arthur Greenwood. This enquiry, based on the published annual reports of the various Educational Authorities, as well as those that preceded it, did not touch the main problem of the present study; viz. the relation between physique and mentality. Miss E. M. Elderton, a year later, made a careful biometric study of the school population of Glasgow.

The question of the physical growth of children, in relation to educability, is of fundamental importance.

Many observers have made vague statements that mentality does depend on physique, but no one in this country appears to have made a definite special and systematic study to see how closely the two are related.

Much money is being spent on elementary education, and such questions as the following are constantly being asked: "Is the nation getting the best return?" "Are the children receiving the benefit they ought to derive from such an expenditure?"

To these may be added another, the answer to which is made the subject of study. "Is it possible that we have concentrated too much attention on the child's mental side, to the neglect of the physical side, and have we, in consequence, overlooked an important factor, namely, nutrition?"

General Considerations.

The present study, broadly divided into two main sections, the first dealing with physical growth, and the second with physique and mentality, is confined to children attending the elementary schools of Barry, South Wales, who were born during the years 1902–9. Observations and records made in the course of the ordinary school medical routine examinations as required by the Regulations of the Board of Education, have been used. Also, the investigator knew the district and conditions thoroughly, and had taught in its schools for many years. All the medical cards for the children born between 1902–9 were examined, and a selection of records made on certain lines.

The number of routine medical examinations has varied. For most years three was the number, one on entry into school, between the age of 4 and 7 years, the second or intermediate between 8 and 9 years, and the third, or leavers, generally between 12 and 13 years, conducted before the child left the elementary school. This change in the number of routine examinations will explain why so many children fall into age groups other than 4–5, 5–6, 6–7, the general ages of entry into the Infants' School, and 8–9.

The cards dealt with were those upon which there were proofs of at least three examinations, one before 7, and one between 12 and 13 years, with one in the intermediate ages. Such a selection would to a certain extent permit the assumption to be made that each child had been in attendance at the same school for at least five years. Unfortunately the section of the medical history card "regularity of attendance" was never filled in, with the result that in estimating the value of any conclusion that may be submitted later, it will not be possible to trace the effect of absence.

From each card selected, three sets of records were taken, one for each routine examination:

1. Age (in years and months).
2. Weight (kilograms, to nearest hectogram).
3. Standing height (centimetres).
4. School standard.

The children were measured without superfluous clothing, and without boots, in stockinged feet.

Observations on individual children were spread over the year so that favourable and unfavourable conditions for growth were evenly distributed. In much previous work dealing with the mental attainments of children, the teacher's estimate has been used. In this study the school standard has been taken. The classification of Infants into school standards is somewhat arbitrary, but in the Senior School is more definite. The following may be taken as the general and normal distribution of classes according to age:

Type of school	Infant			Elementary						
Age	4	5	6	7	8	9	10	11	12	13
Standard	3rd class	2nd class	1st class	1	2	3	4	5	6	7

These two main divisions will be referred to hereafter as Infant and Senior. Insufficient records were obtained for the ages 11–12 years, and 13–14 years.

Practically all the work previously done on the physique of children has been based on measurements taken in "cross section" at different age periods. By this is meant that an observer selects an area, records observations of weights and heights of the children of all ages, covering a comparatively short interval of time. Calculations are then made of the mean weights and heights, and the final results are put forward as representing the growth of the average child. Among objections raised against this procedure is the fact that many included in the early ages die before the later ages are reached, hence the older

the age groups the more select are the occupants of those groups. There is need for records of consecutive measurements made on the same group of individuals.

In the present study we can trace the growth of various groups of children at three different school ages, and see if there is any sound reason for the objections to the "cross section" method.

The mentally and physically defective (*i.e.* cripples—not fit for ordinary school) are catered for in a special school. Neither class is included in this study.

SCOPE OF PRESENT INVESTIGATION.

The first part, based on a statistical study of the weights and heights of 2021 boys and 1893 girls, deals with the following matters:

1. A series of comparisons of mean weights and heights at different ages were made for the two sexes for the purpose (*a*) of discovering such differences as might exist at various ages between boys and girls with respect to weight, height and the relation of weight to height; (*b*) of observing the rates of growth in these respects during the period 3–13 years, omitting the period 11–12 years; (*c*) of comparing these results with those of previous investigators who adopted the "cross section" method, to see if they differ in any fundamental respect.

2. The degree of variation in weight and height at each age for each sex was calculated.

3. Conclusions arrived at as a result of comparisons made between data of this study and those of other investigators, particularly American.

In the second part I include:

1. A discussion on the relationship between the weight and height, and mentality (as indicated by school standard), of boys and girls between the ages of 12 and 13 years.

2. A classification of these children according to age groups at the earlier routine medical examinations for weight and height and school standard, to see if there be any close relationship between weight and height, and mentality, at the earlier ages.

3. The calculation of the percentage distribution of children of the same age in various standards to find where the retardation of mental growth begins to show itself most prominently.

4. A discussion of the question whether children who entered school very early have gained any advantage at the age of 12–13 years over those who entered later.

5. Conclusions.

METHOD.

The records of the children between 12 and 13 years were classified first. These were then separated into various groups according to the ages at the

earlier routine examinations. The ages did not coincide for all children, hence many different groups of ages were obtained, as follows:

Entrance examination	Intermediate	Leavers
4–5	8–9	12–13
4–5	9–10	12–13
5–6	8–9	12–13
5–6	9–10	12–13 etc.

For each trio of ages, one group of boys and one group of girls, and in all eight groups for each sex, were obtained. The children who entered school between 3 and 4 years when divided into groups gave very small numbers, hence they have been omitted from this classification.

The groups in which 11–12 years formed one examination were very small, and they were omitted in obtaining the results for the whole range of ages in Table II. This explains why the numbers in the first two examinations are unequal, and both less than the number between 12 and 13 years. The numbers omitted, distributed fairly evenly over the earlier ages, were small, and consequently there has been no appreciable difference made in mean weights and heights at the various ages. Hence the assumption can be made that the same children are considered in the three routine examinations.

The numbers at some ages were small, and any cards showing records of four examinations were used to augment the weak groups. This would make all groups comparable and the range of ages more complete. The following records were used for this purpose.

Age	Boys	Girls
3–4	38	28
6–7	172	159
10–11	166	220

The addition of these records makes very little difference to the mean weights and heights computed for the smaller classes. These records have been omitted when the comparison of the growth of the various groups of children at three different school periods is made.

Table I. *Distribution according to sex and age at the time of examination of* 3914 *Barry school children.*

Age	Number: Boys	Number: Girls	Medical examination
3 and under 4	145	131	Entrant
4 „ 5	664	600	„
5 „ 6	282	346	„
6 „ 7	363	324	„
7 „ 8	467	388	„
8 „ 9	861	820	Intermediate
9 „ 10	692	669	„
10 „ 11	324	333	„
11 „ 12	—	—	—
12 „ 13	2021	1893	Leaver
Total for all ages	5819	5504	—

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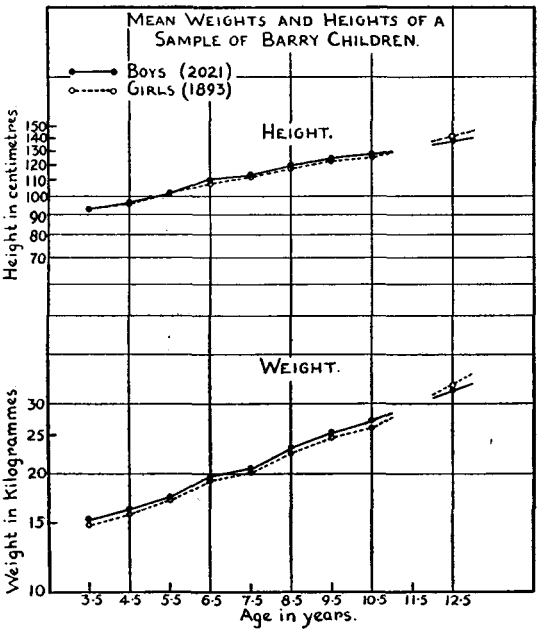
The distributions are similar for both sexes. Only one group, 3–4 years, is on the small side. These records were kept mainly to see how these children benefited as compared with other groups of children because of their longer time at school.

PART I. PHYSICAL GROWTH.

I. MEAN WEIGHT AND HEIGHT.

The basis for the first series of comparisons is given in Table II of mean (arithmetic average) weights and heights (Graph I).



Graph I.

There are differences between the means for boys and girls at any given age period, and though they are not great they are significant. The boys are both heavier and taller than the girls up to $10\frac{1}{2}$ years, but at $12\frac{1}{2}$ the reverse is true. The excess is most pronounced between 6 and 7, and 10 and 11 years, and this point will receive attention later.

The differences in the ratios for the sexes occur at the same ages approximately as the differences in weights and heights considered separately.

These results correspond in a general way to those of similar studies of other groups of children, the most notable exception being those of Baldwin (U.S.A.) who found that ratios $\frac{\text{Mean weight}}{\text{Mean height}}$ for girls were higher than those for boys at all ages 7–14 years.

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Table II. *Mean weights and heights of sample of Barry children, at each age, compared for boys and girls, and comparison of these means, showing the excess in favour of either sex at different ages.*

Average age	Boys			Girls			Excess in the mean: Boys over girls		Excess in the mean: Girls over boys	
	No.	Mean	P.E.	No.	Mean	P.E.		P.E.		P.E.
				Weights (kilogrammes)						
3½	145	15·18	·089	131	14·89	·105	·29	·138	—	—
4½	664	16·09	·042	600	15·89	·044	·20	·061	—	—
5½	282	17·47	·081	346	17·06	·078	·41	·112	—	—
6½	363	19·89	·078	324	19·20	·087	·79	·117	—	—
7½	467	20·57	·071	388	20·10	·074	·47	·103	—	—
8½	861	23·24	·063	820	22·62	·063	·62	·090	—	—
9½	692	25·44	·078	669	24·82	·081	·62	·112	—	—
10½	324	27·19	·126	333	26·13	·124	1·06	·177	—	—
11½	—	—	—	—	—	—	—	—	—	—
12½	2021	32·72	·062	1893	33·30	·083	—	—	·58	·103
				Heights (centimetres)						
3½	145	93·24	·260	131	92·28	·266	·96	·372	—	—
4½	664	96·90	·124	600	96·31	·130	·69	·180	—	—
5½	282	102·22	·240	346	101·71	·197	·51	·309	—	—
6½	363	110·36	·197	324	109·43	·206	·93	·285	—	—
7½	467	113·25	·152	388	112·76	·173	·49	·230	—	—
8½	861	120·14	·132	820	119·68	·130	·46	·185	—	—
9½	692	125·00	·148	669	124·35	·159	·65	·217	—	—
10½	324	128·46	·237	333	127·37	·232	1·09	·332	—	—
11½	—	—	—	—	—	—	—	—	—	—
12½	2021	138·71	·099	1893	140·57	·114	—	—	1·86	·151

Table III. *Ratios of mean weight (kilogrammes) to mean height (centimetres) at each age of sample of Barry children compared for boys and girls, and comparison of ratios showing the excess of either sex at different ages.*

Average age	Mean weight / Mean height: Boys	Mean weight / Mean height: Girls	Excess in mean weight / mean height: Boys over girls	Excess in mean weight / mean height: Girls over boys
3½	·163	·161	·002	—
4½	·166	·165	·001	—
5½	·171	·168	·003	—
6½	·180	·175	·005	—
7½	·182	·178	·004	—
8½	·193	·189	·004	—
9½	·204	·200	·004	—
10½	·212	·205	·007	—
11½	—	—	—	—
12½	·236	·238	—	·002

Rate of increase in weight and height.

The logarithmic histogram has been preferred to the ordinary methods of graphical representation to give a more satisfactory idea of the rate of growth. Such a graph shows directly the proportional changes, which are frequently of more importance than actual increases.

The means in Table II have been plotted in Graph I. The slopes of the four lines are comparable.

In neither case is the graph a straight line, for there are definite changes of slope indicating that the rates of increase in weight and height vary at

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different ages for boys and girls. The height curves show a slight concavity. For the age groups under consideration there is a general similarity between the curves for mean weights for the two sexes from the ages $3\frac{1}{2}$ years to $10\frac{1}{2}$ years, in each case the girls being lighter than the boys, but at $12\frac{1}{2}$ years the girls are heavier than the boys. From the mean height curves we learn that not only are girls from $3\frac{1}{2}$ years to $10\frac{1}{2}$ years lighter than the boys, but that they are shorter also. At $12\frac{1}{2}$ years girls are taller and heavier than boys. This merely confirms the findings of other investigators.

The rate of increase for weight for both sexes gradually increases from the age of $3\frac{1}{2}$ to $6\frac{1}{2}$ years and then there is an apparent slackening in growth between $6\frac{1}{2}$ and $7\frac{1}{2}$ years. From the latter age onward the earlier rate of increase for weight is regained, and for boys is fairly evenly maintained until $12\frac{1}{2}$ years, except for a slight retardation between $9\frac{1}{2}$ and $10\frac{1}{2}$ years; whilst at $9\frac{1}{2}$ years for girls the rate of increase is retarded, and followed at $10\frac{1}{2}$ years by a pronounced acceleration. The graph showing mean heights has a corresponding falling off in the rate of increase between the ages of $6\frac{1}{2}$ and $7\frac{1}{2}$ years, which is regained at the latter age, and maintained until the age of $9\frac{1}{2}$ years for both sexes. Between the ages of $9\frac{1}{2}$ and $10\frac{1}{2}$ years there is a slight retardation in height growth, again followed by an acceleration, which is, as for weight, more pronounced in the case of girls.

There is a general similarity in the rates of increase for weight and height for boys and girls at all the ages considered except between the ages of $10\frac{1}{2}$ and $12\frac{1}{2}$ years.

The slackening in the rate of growth of both weight and height between $6\frac{1}{2}$ years and $7\frac{1}{2}$ years is interesting. There are at least two influences, one physiological and the other environmental, simultaneously at work, which might be responsible, but the data do not allow a conclusion to be drawn as to which is the more important. The former is associated with the development of the permanent dentition. The latter is a change in school life. Terman thinks that the slight retardation in growth between the ages of 6 and 7 years noted in the case of American children is partly due to entrance into school. American children enter school a year or so later than British children—usually between 6 and 7 years.

In the case of the Barry children 7 is the normal age of transfer from the Infants' to the Senior Department, and this change is invariably accompanied by what must appear to the children to be great changes, especially of environment. This means a change in the kind of discipline, a passing from the free kindergarten atmosphere in which great initiative scope is allowed, to one of a more severe and rigid type, in which less scope is permitted for self-expression. There is a lengthening of the school day, and the work assumes a more serious aspect. There exists, in reality, a wide gap between these types of schools. The question naturally arises, "Does the influence of this change affect the growth in weight and height?" The data are consistent with an affirmative answer.

A comparison of the weights and heights of children for a few years before entry into school, were they available, with similar statistics for the first year or two after entry, would prove very interesting. It appears that for American children attending school between the ages of 6 and 7 years there is a difference in the rate of growth from that of the following ages, but there is no indication whether this rate differs materially from that between the ages of 4 and 6 years. Again, American children do not appear to experience a similar break at the age of 7 years.

A German investigator Dr Schmid-Monnard endeavoured to ascertain the influence of school life on the body. He did this by comparing the growth attained in the seventh year by children in school with that attained in the same year by children who had not entered school. Attempts made to get a copy of his work in the original failed, and consequently the results have been quoted from Terman, page 388. Unfortunately there is no indication given as to whether the two samples of children under observation were homogeneous in respect of racial or social class. In spite of this omission the results have been deemed of sufficient interest to be reproduced. They are claimed to "indicate that school entrance brings a shock to the nervous system of the young child severe enough to retard growth."

	Growth in weight (kilogrammes)		Growth in height (centimetres)	
	Boys	Girls	Boys	Girls
Pupils *not* in school	2·2	1·9	7·4	5·6
Pupils at school	1·5	1·6	4·2	4·5
Difference in favour of former	0·7	0·3	3·2	1·1

This explanation of the possible effect on growth of altered school environment following transfer from one school department to another does not appear to have been pointed out previously, and may prove to be of importance. The transition from one school grade to a higher should be made easy so that the possibility of a set-back might be minimised. The work and conditions of the lowest standard of the Senior school should not differ too greatly from those of the upper Infants' classes.

This possible effect on growth of marked changes in environment would be expected to show itself in the case of boys and girls leaving school for industry. Consequently an effort was made to find records of weight and height for children taken for periods before and after such a transfer.

Apparently there are no such records available for this country. The taking of such records on the same individuals before and after entering industry would be certainly worth while, and a comparison drawn between such figures and those obtained on a group of children who followed occupations offering less drastic environmental changes would be very instructive.

The acceleration after the age of $7\frac{1}{2}$ years may be partly explained as a rebound from the preceding retardation. There again the influences are twofold in character, one physiological, improved chewing surface due to second

dentition, and the other environmental, due to familiarity with the new work, surroundings and general school conditions.

Another point brought out by the graphs is a retardation in the case of girls, between $6\frac{1}{2}$ and $10\frac{1}{2}$ years, more noticeable in weight.

The variations in the rate of increase are expressed numerically in Table IV.

Table IV. *Percentages of annual increase in mean weight and mean height of sample of Barry children, compared for boys and girls.*

	Percentage increase in			
	Weight		Height	
Age period	Boys	Girls	Boys	Girls
$3\frac{1}{2}$ to $4\frac{1}{2}$	6·0	6·7	3·9	4·3
$4\frac{1}{2}$ to $5\frac{1}{2}$	9·1	7·4	5·5	5·5
$5\frac{1}{2}$ to $6\frac{1}{2}$	13·9	12·6	7·9	7·6
$6\frac{1}{2}$ to $7\frac{1}{2}$	3·4	4·7	2·6	3·0
$7\frac{1}{2}$ to $8\frac{1}{2}$	12·9	12·6	6·0	6·1
$8\frac{1}{2}$ to $9\frac{1}{2}$	9·5	9·7	4·0	3·9
$9\frac{1}{2}$ to $10\frac{1}{2}$	6·9	5·2	2·8	2·4
$10\frac{1}{2}$ to $12\frac{1}{2}$	20·3	27·5	8·0	10·4

These figures again show very clearly the retardation of growth in weight and height previously noted between the ages of $6\frac{1}{2}$ and $7\frac{1}{2}$ years, and also between the ages of $9\frac{1}{2}$ and $10\frac{1}{2}$ years, and the rebound between $7\frac{1}{2}$ and $8\frac{1}{2}$ years. The last row of figures indicates the percentage increment covering two years, viz. $10\frac{1}{2}$ to $12\frac{1}{2}$ years, and is for both weight and height larger for the girls than for the boys. There is a relatively faster increase in weight than in height, which suggests that the $\frac{\text{mean weight}}{\text{mean height}}$ ratio increases as the children get older.

Mean weights and heights of the same children examined at three school ages (Barry data).

When the children at the age of $12\frac{1}{2}$ years were classified into groups according to the ages of the earlier routine examinations eight separate groups of boys, and an equal number of groups of girls, were obtained. These were generally numerically large. The results are submitted in Table V. There is very little variation at the earlier ages between group and group, and all groups have practically the same mean at the age of $12\frac{1}{2}$ years.

All the groups under consideration seem to have reached the age of $12\frac{1}{2}$ years with practically the same mean weights and mean heights, allowing the conclusion to be drawn, that the series of mean weights and heights calculated by using the weighted average can fairly accurately represent the growth of the same individuals, as if taken throughout all the school ages. That is, the Barry figures based on the triplicate records of the same children approximate closely to the ideal case, in which the same individuals are studied at all ages.

From Table V other series of weighted averages have been computed in order to give the means for the same children at two different ages, one of which was the $12\frac{1}{2}$ years period. These are presented in Table VI.

Table V. *Mean weights and mean heights of various groups of boys and girls measured at three different ages.*

Boys.

Average age			Mean weights (kilogrammes)						
12½	32·7	32·4	32·9	31·8	32·6	32·4	32·7	33·0	32·72
11½	—	—	—	—	—	—	—	—	—
10½	—	—	—	—	—	—	—	26·7	27·19
9½	—	24·6	—	24·6	—	25·66	25·96	—	25·40
8½	23·17	—	23·34	—	23·1	—	—	—	23·24
7½	—	—	—	—	—	—	20·5	20·8	20·57
6½	—	—	—	—	19·4	19·9	—	—	19·89
5½	—	—	17·45	17·5	—	—	—	—	17·47
4½	16·13	16·0	—	—	—	—	—	—	16·09
No. under observation	518	146	219	63	68	123	309	158	All boys
			Mean heights (centimetres)						
12½	138·9	138·1	139·3	137·8	138·3	138·1	138·5	138·5	138·7
11½	—	—	—	—	—	—	—	—	—
10½	—	—	—	—	—	—	—	127·6	128·46
9½	—	123·4	—	123·3	—	125·5	126·7	—	125·0
8½	120	—	120·3	—	119·9	—	—	—	120·1
7½	—	—	—	—	—	—	113·1	113·5	113·25
6½	—	—	—	—	108·7	110·9	—	—	110·4
5½	—	—	102·2	102·1	—	—	—	—	102·2
4½	96·9	97·0	—	—	—	—	—	—	96·9

Girls.

			Mean weights (kilogrammes)						
12½	33·9	33·4	33·1	31·4	32·8	32·8	33·0	33·6	33·3
11½	—	—	—	—	—	—	—	—	—
10½	—	—	—	—	—	—	—	25·75	26·1
9½	—	24·45	—	23·8	—	25·0	25·4	—	24·8
8½	22·65	—	22·5	—	22·5	—	—	—	22·6
7½	—	—	—	—	—	—	20·1	20·12	20·1
6½	—	—	—	—	18·5	19·3	—	—	19·2
5½	—	—	17·04	17·1	—	—	—	—	17·06
4½	15·9	16·0	—	—	—	—	—	—	15·9
No. under observation	457	143	250	96	70	95	275	113	All girls
			Mean heights (centimetres)						
12½	141·1	140·6	140·6	138·4	139·5	140·0	140·6	140·5	140·6
11½	—	—	—	—	—	—	—	—	—
10½	—	—	—	—	—	—	—	127·0	127·4
9½	—	122·8	—	122·5	—	124·9	125·8	—	124·35
8½	119·8	—	119·6	—	118·7	—	—	—	119·7
7½	—	—	—	—	—	—	112·7	113·0	112·76
6½	—	—	—	—	107·0	109·7	—	—	109·4
5½	—	—	101·8	101·9	—	—	—	—	101·7
4½	96·3	96·24	—	—	—	—	—	—	96·3

In the cases where the numbers of children observed differ from those given in Table II for corresponding ages, the means are practically unaltered, with the exception of those at 3½ years, where the numbers were comparatively small, and not truly representative, as most likely the bulk of the entries into school between the ages of three and four would be nearer the four years than the three. Hence the assumption that the average age of the number in any particular age group could be taken as the mid-point of the interval would not hold between the ages of 3 and 4.

Here again, the means for all groups of boys and girls at the age of 12½

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years are in very close agreement, lending support to the view that the records of these children as given in Table II may be taken as approximating closely to the records of growth of the same individuals.

Table VI. *Mean weights and mean heights for separate groups of boys and girls between* 12 *and* 13 *years and at an earlier age.*

Average age at examination	No. of observations	Mean weight (kilogrammes)	Mean height (centimetres)	At 12½ years: Mean weight (kilogrammes)	At 12½ years: Mean height (centimetres)
		Boys			
3½	107	14·58	92·92	33·27	139·84
4½	664	16·09	96·93	32·63	138·74
5½	282	17·47	102·21	32·64	138·94
6½	191	19·89	110·20	32·46	138·20
7½	467	20·57	113·25	32·81	138·54
8½	861	23·24	120·15	32·75	139·00
9½	692	25·46	125·00	32·60	138·50
		Girls			
3½	103	14·74	92·10	33·71	140·71
4½	600	15·89	96·31	33·80	140·97
5½	346	17·06	101·71	32·61	138·95
6½	165	19·00	108·56	32·80	139·81
7½	388	20·10	112·76	33·17	140·61
8½	820	22·62	119·68	33·60	140·70
9½	669	24·82	124·35	32·85	140·10

Comparison of the measurements of the present study with periodic measurements made on a single group of individuals.

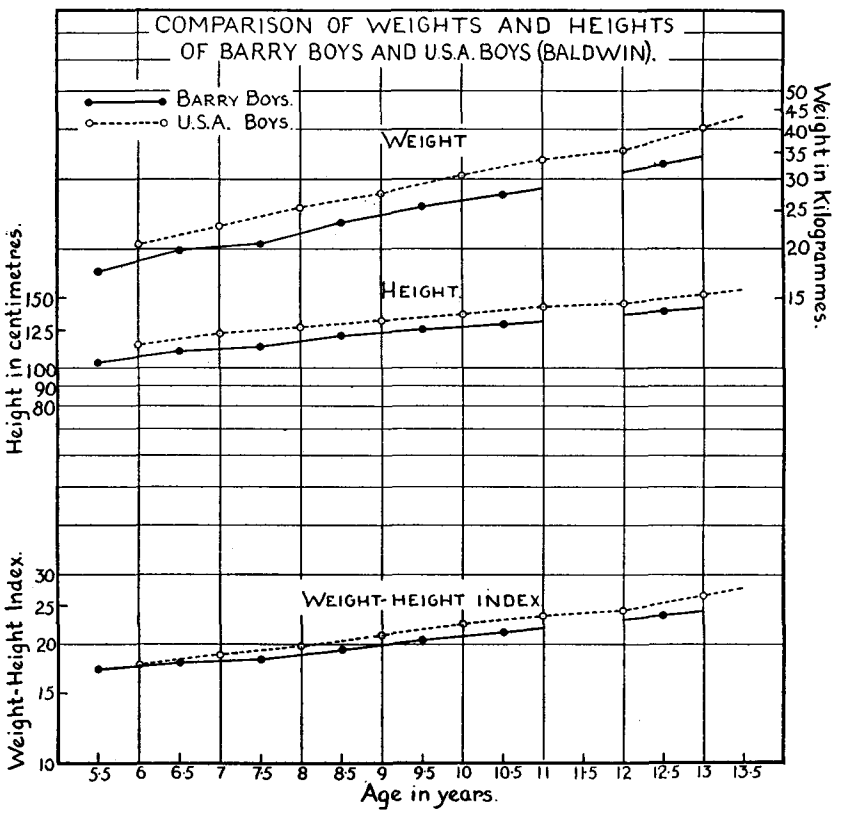
Many observers have objected to weight and height standards based on measurements of children taken in cross section, at different age periods. Consequently the measurements of the present study were compared with records taken by Dr Bird T. Baldwin, Director of Research in Child Welfare, University of Iowa, U.S.A. This investigator has conducted much anthropometric research on the same individuals at all ages from birth to 18 years.

The U.S.A. figures in Table VII, shown graphically in Graphs II and III, are based on the semi-annual measurements of an average of 125 boys and 125 girls from the Horace Mann School, Teachers' College, Columbia University, New York, for a period of 8 years or more. The American records were taken with shoes and ordinary clothing.

Apart from differences noted later, the curves are similar in general trend. The pairs of curves representing height are fairly straight and parallel, the differences noted at the later ages of 10½ years and 12½ years being the same as those at the earlier ages. In regard to weight the differences at the later ages are common at the earlier ages in the case of boys, but not of girls. The Barry data do not give any definite information as to what happens to children of either sex between the ages of 11 and 12 years. This should be borne in mind when comparisons are made. The portions of the graphs between these ages merely indicate the general trend.

Table VII. *Mean weights, mean heights, and ratios* $\frac{\text{mean weight}}{\text{mean height}}$, *of sample of Barry children compared with corresponding measurements made periodically on a single group of U.S.A. children by Dr B. T. Baldwin.*

	Weight (kilos.)				Height (cm.)				$\frac{\text{Weight (kilos.)}}{\text{Height (cm.)}}$			
	Boys		Girls		Boys		Girls		Boys		Girls	
Age group	Barry	Baldwin	Barry	Baldwin	Barry	Baldwin	Barry	Baldwin	Barry	Baldwin	Barry	Baldwin
5·5	17·47	—	17·06	—	102·2	—	101·7	—	0·171	—	0·168	—
6·0	—	20·50	—	19·32	—	115·3	—	112·5	—	0·178	—	0·172
6·5	19·89	—	19·21	—	110·4	—	109·4	—	0·180	—	0·176	—
7·0	—	22·95	—	21·77	—	121·4	—	118·9	—	0·189	—	0·183
7·5	20·58	—	20·10	—	113·3	—	112·8	—	0·182	—	0·178	—
8·0	—	25·08	—	24·40	—	126·5	—	124·7	—	0·198	—	0·196
8·5	23·24	—	22·62	—	120·2	—	119·7	—	0·193	—	0·189	—
9·0	—	27·53	—	27·08	—	130·8	—	129·8	—	0·210	—	0·209
9·5	25·45	—	24·83	—	125·0	—	124·4	—	0·204	—	0·200	—
10·0	—	30·48	—	30·48	—	135·9	—	134·9	—	0·224	—	0·226
10·5	27·22	—	26·13	—	128·5	—	127·4	—	0·212	—	0·205	—
11·0	—	33·16	—	33·61	—	140·5	—	140·5	—	0·236	—	0·239
11·5	—	—	—	—	—	—	—	—	—	—	—	—
12·0	—	35·24	—	38·06	—	144·5	—	146·3	—	0·244	—	0·260
12·5	32·72	—	33·30	—	138·7	—	140·6	—	0·236	—	0·237	—
13·0	—	40·10	—	43·64	—	150·6	—	152·7	—	0·266	—	0·286



Graph II.

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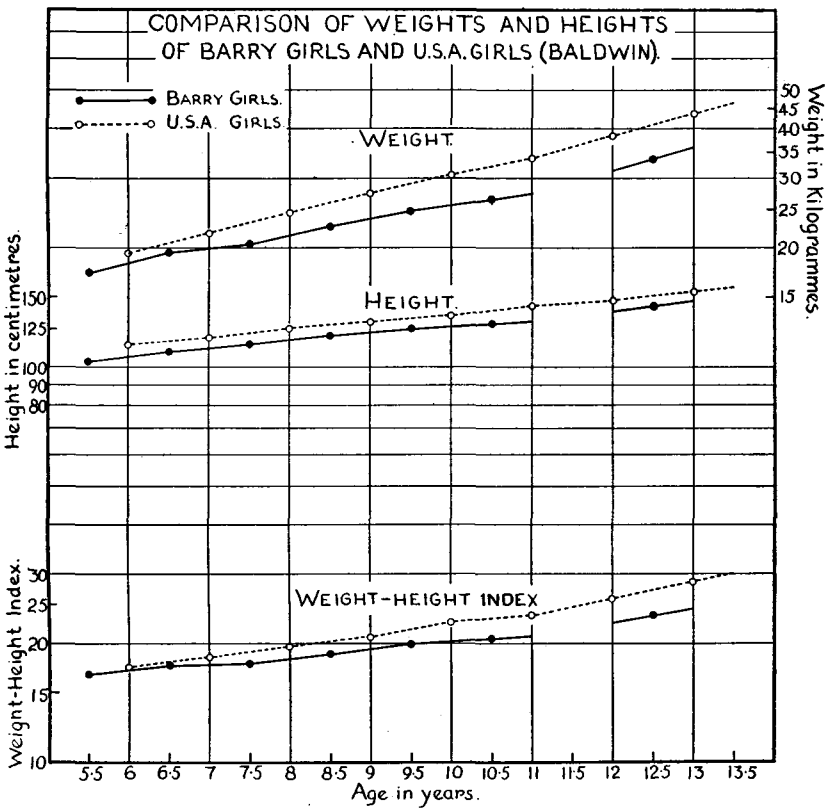
The American graphs show more uniformity, that is, they approximate in all cases more closely to straight lines, suggesting that the growth of American children is more regular. The retardation between the ages of $6\frac{1}{2}$ and $7\frac{1}{2}$ noted in the Barry children, partially explained as being probably due to transfer from the Infants' to the Senior Department, is less distinct in the American data. Again, the falling off in the rate of increase in weight, noticeable in the Barry children between the ages of $9\frac{1}{2}$ and $10\frac{1}{2}$ years, has no corresponding retardation in the New York children at that age, but appears a little later.



Graph III.

The slackening in the rate of increase in weight in the New York boys between $10\frac{1}{2}$ and $11\frac{1}{2}$ years does not appear in the Barry boys.

In all cases the American figures are higher than the Barry ones, and the differences in weight and height cannot be explained solely by the fact that in one case measurements were taken with boots worn. The upward trend is apparent in all cases, but the Barry graphs are more uneven. These facts seem to suggest that the American children at all ages and for both sexes are not only heavier and taller than the Barry children, but that they are also heavier per unit height, the difference being more pronounced as we proceed along

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the age scale. If, therefore, we had American and Barry children of the same height and age, we should most probably find the former the heavier. Comparisons made on measurements of children homogeneous with respect to race, stock and geographical distribution, would probably yield more definite conclusions, but the above comparison shows no valid reasons for the objections to growth statistics based on measurements taken in cross section, for the curves are similar.

The latter method adopted by previous investigators appears to be reliable, and therefore justified.

The differences observed above can only be explained by the fact that both samples of children are not being influenced by similar factors.

II. Differences in weight and heights of children of the same sex and age.

Up to the present we have only compared mean weights and mean heights. There is now need to see how the range of weights and heights is affected. The arithmetic mean does not show the dispersion, or variation, of the weights and heights about the mean. Do the observations crowd around the mean in a dense mass, or are they widely scattered?

All the observed frequencies at particular ages were obtained as percentages; these percentages at each weight or height were plotted vertically, and the weights and heights were plotted horizontally. In all cases the curves were of the same general trend as the frequency curves met with in other biometric work of this character. The curve opened out and became flatter as the ages increased. That is, as age increased the greater the dispersion; children of a given age differed more widely in weight and height as they grew older. The dispersion became more marked at the age of puberty, and was greater for girls than for boys at $12\frac{1}{2}$ years. As these results are brought out equally well by more precise statistical methods the graphs have not been reproduced.

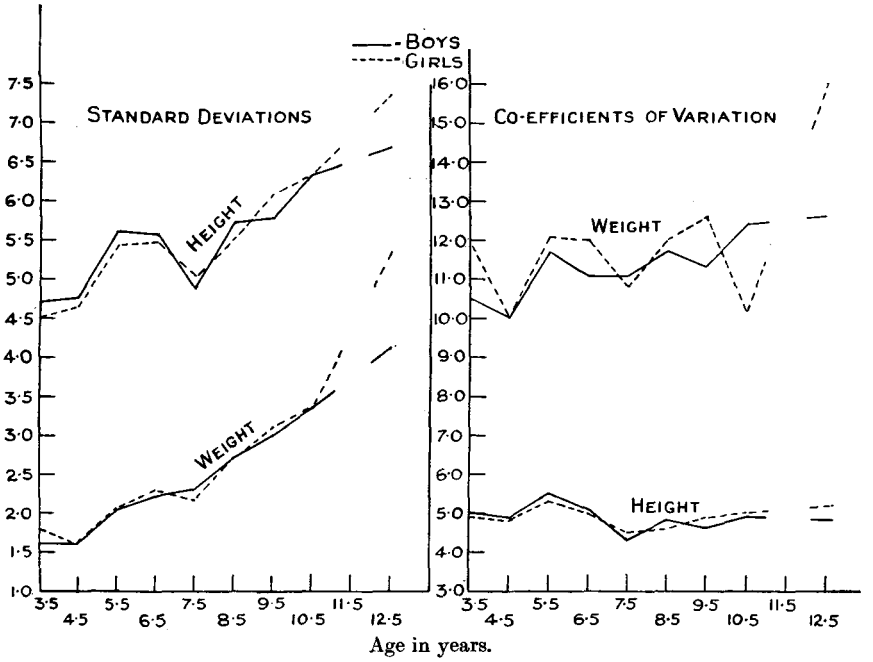
Two constants, viz. the Standard Deviation (σ) and the Coefficient of Variation (V) have been used for comparing the differences in weight and height. The Standard Deviations and corresponding Coefficients of Variation are given in Table VIII (and shown in Graph IV).

For standard deviations the lines keep close together for boys and for girls, and have a general upward trend indicating that with increasing age we get greater dispersion about the mean, both for weight and height, and the most pronounced differences in dispersion between the sexes occur at $12\frac{1}{2}$ years. What has been observed previously about the period $6\frac{1}{2}$–$7\frac{1}{2}$ years is again well brought out in these diagrams.

The coefficients of variation for weights are larger in all cases than those for heights. There are marked differences in the values of this constant for weights at various ages for the same sex, and for the same age, when the sexes are compared. The differences between the sexes are most prominent at $9\frac{1}{2}$

Table VIII. *Variation in weights and heights of boys and girls of the same age as expressed in standard deviations, and the corresponding coefficients of variation.*

Average age	Standard deviations: Boys S.D.	Standard deviations: Boys P.E.	Standard deviations: Girls S.D.	Standard deviations: Girls P.E.	Coefficients of variation: Boys C.V.	Coefficients of variation: Boys P.E.	Coefficients of variation: Girls C.V.	Coefficients of variation: Girls P.E.
			Weights (kilogrammes)					
3½	1·587	±·063	1·783	±·075	10·46	±·419	11·90	±·503
4½	1·605	±·029	1·582	±·037	9·974	±·186	9·957	±·196
5½	2·036	±·058	2·059	±·055	11·66	±·335	12·07	±·313
6½	2·212	±·055	2·307	±·061	11·12	±·283	12·01	±·406
7½	2·287	±·050	2·174	±·053	11·12	±·250	10·81	±·265
8½	2·716	±·044	2·703	±·045	11·69	±·192	11·95	±·202
9½	2·865	±·052	3·125	±·057	11·27	±·207	12·59	±·236
10½	3·362	±·089	3·350	±·088	12·37	±·332	10·06	±·266
11½	—	—	—	—	—	—	—	—
12½	4·129	±·044	5·344	±·059	12·59	±·136	16·04	±·180
			Heights (centimetres)					
3½	4·704	±·186	4·518	±·189	5·046	±·200	4·897	±·205
4½	4·738	±·088	4·658	±·091	4·890	±·091	4·838	±·094
5½	5·610	±·159	5·432	±·140	5·489	±·156	5·343	±·137
6½	5·584	±·140	5·474	±·145	5·060	±·127	5·001	±·133
7½	4·872	±·107	5·028	±·121	4·302	±·095	4·458	±·108
8½	5·722	±·094	5·504	±·092	4·763	±·078	4·599	±·077
9½	5·772	±·120	6·090	±·112	4·618	±·085	4·898	±·090
10½	6·328	±·168	6·312	±·165	4·926	±·131	4·956	±·129
11½	—	—	—	—	—	—	—	—
12½	6·590	±·070	7·358	±·081	4·750	±·050	5·234	±·057



Graph IV. Standard deviations and coefficients of variation of heights and weights of Barry boys and girls.

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years (where the coefficient for girls exceeds that of boys), at $10\frac{1}{2}$ years, where the reverse is true, and at $12\frac{1}{2}$ years where the girls show a very much greater variation than boys.

The coefficients for heights for boys and girls are fairly close together, and the general trend is the same, the greatest variation being at $12\frac{1}{2}$ years, but the divergence is not so large as in the case of weight. As before at $9\frac{1}{2}$ years the girls are slightly more variable than the boys, at $10\frac{1}{2}$ years the coefficients are practically equal. At $10\frac{1}{2}$ years the difference in variability shows itself more prominently in weight, and is also more significant for weight at $12\frac{1}{2}$ years.

Comparisons between results of this study and those of other studies.

In the larger study, of which this is a part, comparisons were made between the Barry data and those of other studies. The tabular matter has been omitted as the graphs illustrate the facts brought out.

The following series of records were used for this purpose:

1. England and Wales (recent). Taken from Arthur Greenwood (1913). These were calculated for the whole of England and Wales from the Annual Reports of the School Medical Officers.

2. United States of America (recent). Children in Maryland, Virginia and N. and S. Carolina. Taken from U.S. Public Health Reports (1922). The children of this study seem to be taken from districts similar in type to Barry.

3. United States of America—State of Iowa. Taken from Baldwin (1922), Chapter III, Table XXII and following.

4. Town Children—Artisan Class. Taken from Report of Anthropometric Committee of the British Association for Advancement of Science (1883).

Note 1. In comparing the Graphs V and VI the United States Public Health Service (U.S.P.H.S.) measurements and those given by Baldwin were the only ones taken *with* footgear[1].

Note 2. The graphs representing the growth of children in England and Wales as a whole practically coincided with those of the Barry children.

The general similarity and the upward parallel trend of the corresponding series of curves tend to support the view that the "cross section" method leads to satisfactory and reliable results, and is not likely to differ seriously from those obtained either by the partial "cross section" method of this study, or from those based on consecutive measurements on the same group of children.

Remarks on Graphs V and VI.

1. *Weight.* The series of graphs of American children both for boys and girls showed marked regularity, indicating regular growth through the ages considered, whereas the graphs for (i) British Town Children (Artisan Class),

[1] There seems to be some ambiguity in the description of the British Association data. The exact words used in the report are "weight with clothing, and height without boots." Miss Elderton (*op. cit.* p. 291) assumes that the British Association's weights included boots.—Ed.

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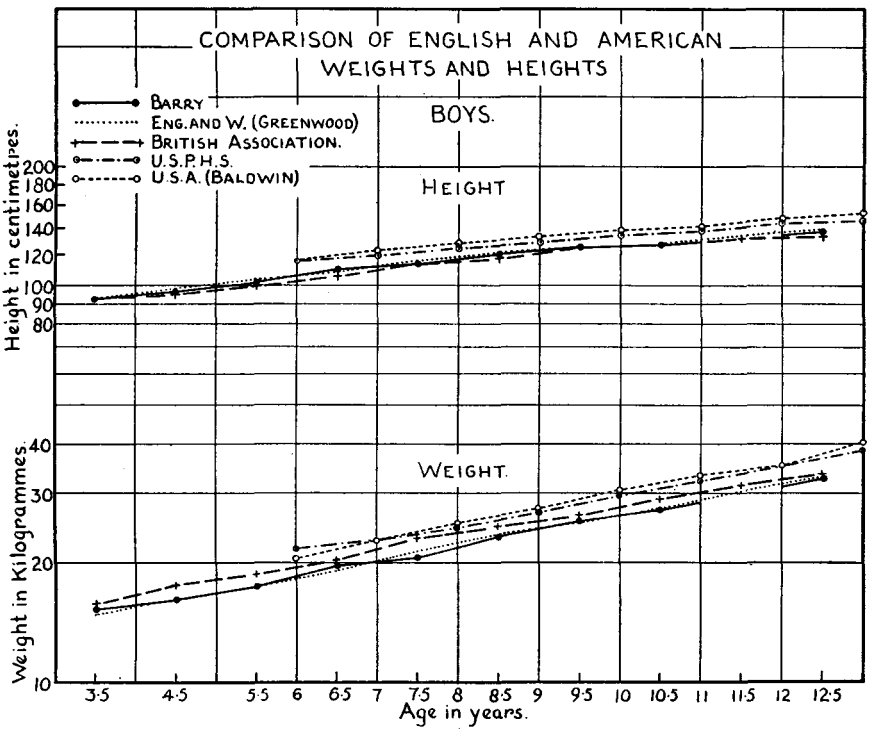
and (ii) for the Barry children show more deviation from the straight line, indicating irregularities in the rates of growth in weight at various ages. The graphs for England and Wales as a whole showed similar irregularities.

Comparing the upper series of graphs we observe that the Barry boys and girls are lighter than the others under consideration.

The retardation between the ages of $6\frac{1}{2}$ and $7\frac{1}{2}$ years, and between $9\frac{1}{2}$ and $10\frac{1}{2}$ years, noted for the Barry children, is slightly indicated in the American children, between the ages of 6 and 7 years. The rate of growth for American children between 6 and 7 years is slower than that between 7 and 8 years; but the data do not go back earlier than 6 and 7 years, hence we cannot say



Graph V.

whether this is a retardation. The U.S.P.H.S. (1922) children are heavier than the Boston (U.S.A. 1877)[1] and this difference is greater at the earlier ages for boys, but in the case of girls the difference is much the same at all ages.

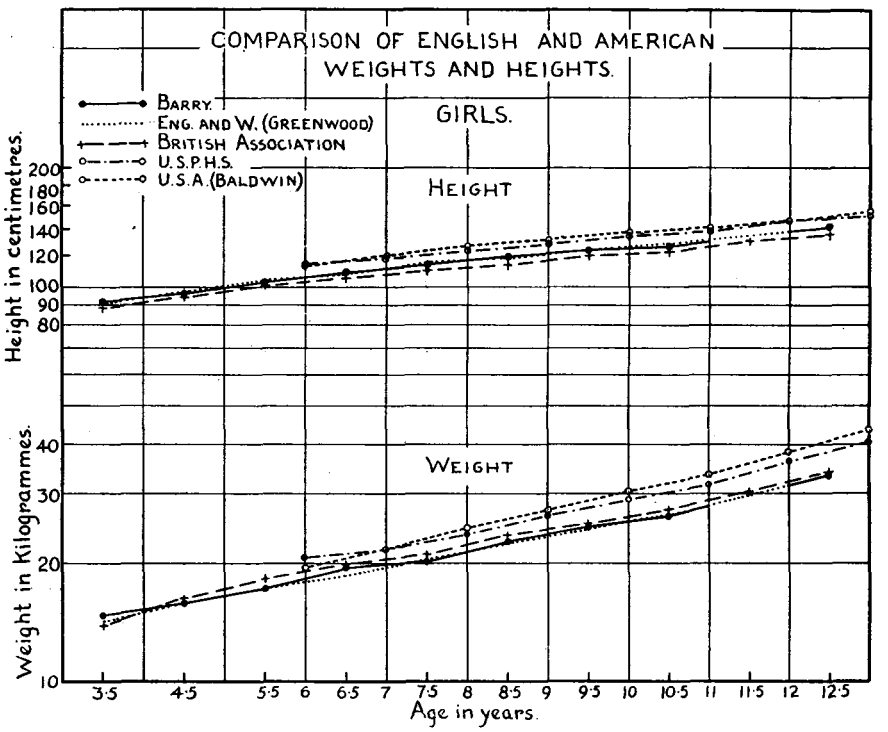
Assuming the average weight of a child's pair of boots or shoes to be about $1\frac{1}{2}$ pounds, and that the samples under discussion are typical and similar, the American children of to-day appear to be heavier than those of the past.

In considering the lower pairs of graphs we are comparing the records of samples of children of the Artisan Class. Although Barry children are lighter

[1] It was not found practicable to plot all six sets of observations in Graphs V and VI, therefore the American observations for 1877 (Bowditch) were omitted.

(by about 2 lb. at each age) there is similarity in the shape of the curves, particularly in the case of the girls. The retardation noticed previously for Barry girls finds a parallel in the 1883 Town girls (Artisan Class) whereas the Town boys (Artisan Class) show a quicker growth for the period $6\frac{1}{2}$–$7\frac{1}{2}$ years, following a slower growth.

The similarity between the shapes of the lower curves especially for girls tends to support the view that probably there are factors influencing the growth of children of the Artisan Class which are not at work in the case of American children.



Graph VI.

In comparing the graphs for England and Wales with those of Barry the latter show more unevenness, and the former practically pass as it were through the Barry graphs, the difference in shape being due to the mean weights at the following ages, $6\frac{1}{2}$, $7\frac{1}{2}$, $9\frac{1}{2}$ and $10\frac{1}{2}$ years, both for boys and girls. It must of course be remembered that the averages for Barry depend on some 12,000, those for England and Wales upon 800,000 observations.

2. *Height.* Considering the upper series of graphs we see that the Barry children are shorter than both the American samples. Here again, in the case of the U.S.P.H.S. (1922) children the differences (two to three inches approximately) are too great to be accounted for by the fact that they are

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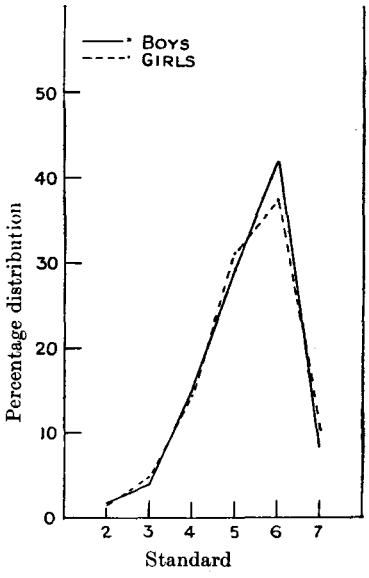
measured *with* footgear. The American (U.S.P.H.S. 1922) children recently examined were taller than those of 1877.

In the lower graphs those of the Barry children and Artisan children are similar in general trend, but are not quite as similar in shape as in the case of weight. The American (Baldwin 1922) children are considerably taller than the Barry children.

Comparing Barry children with those of England and Wales as a whole the same peculiarity of shape, as noted for weight, is also to be noted here. At some ages the former appeared to be above those of the latter, whilst at other ages the reverse seemed to be true. The chief differences in shape causing the greater unevenness of the Barry graphs were due to the differences in the mean heights at the ages of $5\frac{1}{2}$, $6\frac{1}{2}$ and $7\frac{1}{2}$ years for boys and girls, and in addition at $10\frac{1}{2}$ years for the girls.

Ratios of $\frac{\textit{mean weight}}{\textit{mean height}}$.

The ratios of $\frac{\text{mean weight}}{\text{mean height}}$ at the various ages have been compared in Graphs II and III but only for Barry children and the Baldwin children. In the case of the former the ratios at all ages are below those of the latter, *i.e.* the U.S.A. (Baldwin) children for both sexes are heavier per centimetre



Graph VII. Percentage distribution of Barry children, age 12·5 years, in order of school standard.

of height than the Barry, but whereas Baldwin found that the ratios were higher for girls than for boys at all ages, the Barry data show the reverse at all ages considered, except at the age of $12\frac{1}{2}$ years.

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On page 160 of the book previously referred to he gives the ratios for boys of different nationalities at two ages, 8 years and 15 years. These are quoted at this point.

Nationality	Investigator	Weight-height index (kilo. per cm.) 8 years	15 years
Russian	Erismann	·201	·361
American	Baldwin	·196	·306
Italian	Pagliani	·175	·275
Filipinos	Bobbett	·174	·268
Japanese	Misawi	·168	·265

The Weight-Height Index for Barry boys at the age of 8 years is 0·1875, below that of the Americans. Hence the Russian and the American children are heavier for their stature than the other nationalities represented.

Referring to his general results on the growth of American children Baldwin states:

"The norms which are among the highest in the world show what school medical inspection, physical training and directed play can do for children, for many of these boys and girls who were sickly and undernourished when small are Hebrews, who are racially of small stature and small features."

Dispersion and variability.

When the U.S.P.H.S. children were compared with Barry children, from the point of view of dispersion and variability at the various ages, the former were at all ages more widely distributed and they showed greater variability. The standard deviations for weight and height were not given in the case of the New York children; but these children likewise showed greater variability than the Barry children.

It is not possible with the data at hand to do other than point out influences that are likely to account for these facts. No attempt is made to estimate the extent of the influence of any particular factor. There seems to be no doubt that the American race, growing out of an unlimited mixture of races, has progressed in physique, and is in advance of the races of the Old World in point of physical development. While the American children have grown taller and heavier between 1877 and 1922 the British town children (Artisan Class) appear to have remained at much the same height, but to have lost weight between 1883 and the present time. In other words, the American children have improved in stature, whilst ours have remained more or less stationary—and the former appear to be better nourished.

Investigators have shown that the higher the social scale the better is the physique, and that is true of children. Hence it may be that comfort and a more generous diet may be partly the cause of the physical superiority of the American children.

Some writers have suggested that in most European lands height and weight are slightly decreasing, and as far as this country is concerned the results tend to support that view, though the data at hand do not permit of any definite conclusions being drawn.

The factors likely to cause this superiority in physique of the American children can be summarised thus:

1. Environmental, *e.g.* improved economic and social conditions, medical inspection, directed play, control of liquor traffic.
2. Nutritional, *e.g.* better or more varied diet.
3. Geographical, *e.g.* climatic conditions.
4. Racial, *e.g.* superior heredity, medical inspection of more recent immigrants, racial intermarriage.

PART II. PHYSIQUE AND MENTALITY.

"Or is it possible that intelligence or intellectual structure resembles physical stature in respect of its distribution through the population?"—MCDOUGALL.

During the years 1919–20 the Barry Education Authority published in the Minutes the Reports of visits received from His Majesty's Inspector of Schools after his visits to the various schools in the locality under his jurisdiction. Among the points dealt with in these reports the following are of special interest:

1. That many children are old for their standards.
2. There is evidence that the conditions are not always favourable to the best efficiency in many of the schools, *e.g.* large classes, and two classes in one room.
3. There is a distinct falling away noticed as early as Standard I.
4. Special classes and curricula are organised in some schools for the older backward pupils.

The Chief Medical Officer of the Board of Education in his Annual Report for 1921 states that some 10 per cent. of the children in attendance at Public Elementary Schools, though not mentally deficient, prove to be seriously dull and backward, and unable to take advantage of the ordinary education provided. These findings indicate the existence of a serious educational problem requiring investigation. The object of this part of the study is to trace the connection between the physique of a child measured by weight, height and the weight-height index, and its mentality as judged by the school standard.

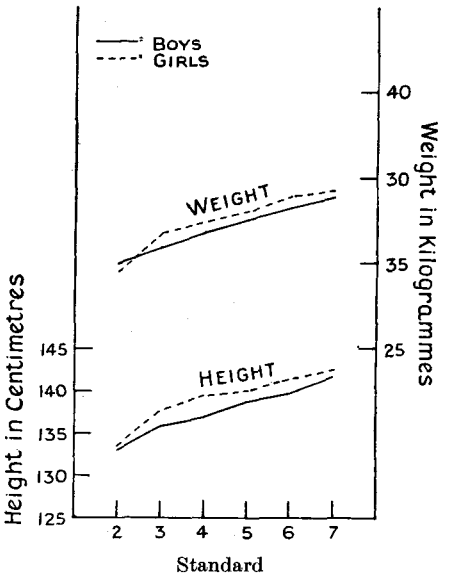
CHILDREN BETWEEN THE AGE OF 12–13 YEARS.

The age period 12–13 years was common to all medical history cards selected. These were dealt with first, and were classified according to the school standards; the few that were in Standard I were considered with those of Standard II and similarly, those in Standard Ex-VII, again few in number, were taken with those in Standard VII.

The mean weights, mean heights and the ratios of the mean weight to the mean height were calculated for the children in each standard. Table IX (Graph VII) shows the actual and percentage distributions of boys and girls in school standards for the age 12–13 years.

Table IX. *Actual and percentage distributions of Barry boys and girls at* $12\frac{1}{2}$ *years in school standards.*

	Boys			Girls		
Class	Number	Percentage	Cumulative percentage	Number	Percentage	Cumulative percentage
2	36	1·8	1·8	25	1·3	1·3
3	79	3·9	5·7	90	4·8	6·1
4	302	14·9	20·6	279	14·7	20·8
5	593	29·3	49·9	592	31·3	52·1
6	844	41·8	91·7	712	37·6	87·7
7	167	8·3	100·0	195	10·3	100·0
All children	2021	100·0	—	1893	100·0	—



Graph VIII. Mean weights and heights of Barry children, age 12·5 years, in order of school standard.

The distributions are similar for both sexes. Practically 50 per cent. of the boys and girls are in or above the normal classes, Standard VI, and 80 per cent. are in or above Standard V. Children at $12\frac{1}{2}$ years who are below Standard V must be considered to be backward; about 20 per cent. of the boys and girls are in this category. This figure is higher than the estimate of the Chief Medical Officer of the Board of Education.

The mean weights and heights are presented in Table X (Graph VIII).

In practically all cases the girls are taller and heavier than the boys.

We could reasonably expect to find these groups of boys and girls to be of the same mean weight and height, but on the contrary we note that there is a steady increase in the means, both of weight and height, as we proceed along the standards.

This would be more clearly brought out by considering the deviations of the mean weight and height from the means for all children.

Table X. *Mean weights and heights of Barry boys and girls classified according to school standards at the age of 12½ years.*

	Weight (kg.)				Height (cm.)				Mean weight (kg.) / Mean height (cm.)	
Class	Boys	P.E.	Girls	P.E.	Boys	P.E.	Girls	P.E.	Boys	Girls
2	29·98	±·506	29·54	±·770	133·1	±·760	133·6	±1·060	·225	·221
3	31·05	±·260	31·87	±·430	135·9	±·460	137·8	±·630	·228	·231
4	31·84	±·146	32·40	±·199	136·9	±·240	139·5	±·275	·233	·232
5	32·59	±·112	33·03	±·146	138·7	±·180	140·1	±·207	·235	·236
6	33·22	±·098	33·93	±·134	139·6	±·154	141·5	±·178	·238	·240
7	33·68	±·230	34·27	±·260	141·8	±·312	142·5	±·330	·241	·242
All children	32·72	±·062	33·30	±·083	138·7	±·099	140·6	±·114	·2356	·238

Table XI. *Deviations of mean weights and heights of various groups of Barry children at 12½ years from the mean weight and height of all children at that age.*

	Weight (kg.)				Height (cm.)			
Class	Boys		Girls		Boys		Girls	
	+	−	+	−	+	−	+	−
2		2·74		3·76		5·6		7·0
3		1·67		1·43		2·8		2·8
4		0·88		0·90		1·8		1·1
5		0·13		0·27		0·0		0·5
6	·50		·60		0·9		0·9	
7	·96		·97		3·1		1·9	
Total range	3·7		4·73		8·7		8·9	

There is a general similarity in these numbers for boys and girls, and the range is considerable. This strongly suggests that the children who tend to drop behind in school are those who are below the mean in stature and weight, and that those who are above the average in these respects are to be found in the top classes.

We could reasonably expect all these groups of the same age to have the same ratio $\frac{\text{mean weight}}{\text{mean height}}$. This ratio, too, increases as we pass along the standards. That is, the children are heaviest per centimetre of height as we proceed up the classes. This fact is very important, and strongly indicates that weight is a more powerful factor than height in the distribution of children into standards at the age of 12½ years.

From the above results, we can deduce that there is a very close relationship between physique and mental ability at the age of 12½ years, which suggests that improvement of the former might favourably affect the development of the latter.

CHILDREN AT THE EARLIER AGES.

The children at 12½ years previously considered have been separated into groups according to the age of the intermediate routine medical examination, and hence we get a few groups at two school ages.

Four large groups were obtained:

A. 861 boys at average ages of 8½ years and 12½ years
B. 692 ,, ,, ,, 9½ ,, 12½ ,,
C. 820 girls ,, ,, 8½ ,, 12½ ,,
D. 669 ,, ,, ,, 9½ ,, 12½ ,,

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The remainder of the boys and girls at 12½ years are distributed between the age groups 7–8, 10–11, and 11–12, but the numbers, first in the groups and secondly in the standards, when each separate group is divided, are comparatively small, too small to allow any reliable conclusion to be drawn.

Table XII. *Comparison of mean weights and heights and ratios* $\frac{\text{mean weight}}{\text{mean height}}$ *of groups of boys and girls classified according to school standard at two school ages.*

A. 861 *boys at* 8½ *years and at* 12½ *years.*

At 8½ years					At 12½ years				
Class	No.	Mean weight (kg.)	Mean height (cm.)	Mean weight / Mean height	Class	No.	Mean weight (kg.)	Mean height (cm.)	Mean weight / Mean height
I	241	22·85	119·2	·1915	—	—	—	—	—
II	537	23·37	120·3	·1942	—	—	—	—	—
III	82	23·53	123·5	·1905	II & III	42	31·28	135·8	·2298
IV	1	27·50	129·0	·2131	IV	120	32·22	137·7	·2341
—	—	—	—	—	V	235	32·83	139·2	·2358
—	—	—	—	—	VI	375	33·25	139·6	·2381
—	—	—	—	—	VII	89	33·32	139·9	·2383
All classes	861	23·24	120·14	·193	—	861	32·75	139·0	·236

B. 692 *boys at* 9½ *years and at* 12½ *years.*

At 9½ years					At 12½ years				
I	60	24·29	122·4	·1985	—	—	—	—	—
II	252	24·62	124·1	·1985	—	—	—	—	—
III	321	26·21	127·0	·2065	II & III	43	29·98	134·4	·2222
IV	59	26·30	126·4	·2081	IV	97	31·83	137·9	·2309
—	—	—	—	—	V	214	32·43	138·1	·2348
—	—	—	—	—	VI	304	33·53	139·1	·2412
—	—	—	—	—	VII	34	34·80	142·6	·2440
All classes	692	25·44	125·0	·204	—	692	32·60	138·5	·236

C. 820 *girls at* 8½ *years and at* 12½ *years.*

At 8½ years					At 12½ years				
I	258	22·11	118·6	·1864	—	—	—	—	—
II	478	22·78	119·9	·1900	—	—	—	—	—
III	83	23·30	121·8	·1913	II & III	32	33·00	139·6	·2365
IV	1	21·50	115·0	—	IV	114	32·53	139·4	·2334
—	—	—	—	—	V	228	33·09	139·7	·2368
—	—	—	—	—	VI	325	33·74	141·8	·2379
—	—	—	—	—	VII	121	34·40	142·4	·2416
All classes	820	22·62	119·7	·189	—	820	33·60	140·7	·238

D. 669 *girls at* 9½ *years and at* 12½ *years.*

At 9½ years					At 12½ years				
I	73	24·49	123·0	·1990	—	—	—	—	—
II	239	24·12	122·1	·1978	—	—	—	—	—
III	311	25·36	124·9	·2030	II & III	58	29·86	135·0	·2212
IV	46	26·47	127·3	·2080	IV	96	32·16	139·1	·2312
—	—	—	—	—	V	225	32·67	139·9	·2335
—	—	—	—	—	VI	253	34·26	141·6	·2419
—	—	—	—	—	VII	37	34·68	142·1	·2439
All classes	669	24·82	124·35	·200	—	669	32·85	140·1	·238

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The figures indicate that wherever at the earlier ages there were irregularities in the upward trend of the mean weight, mean height, and ratios of mean weights to mean heights as we passed along the standards, they were invariably smoothed out by the later age of $12\frac{1}{2}$ years. The following table will show this perhaps more clearly. Two terms, regular (R) and irregular (I) are used, the former when the series of means increases from standard to standard, and the latter when there are any fluctuations.

	Intermediate ages			Later ages		
Group	Weight	Height	Mean weight / Mean height	Weight	Height	Mean weight / Mean height
A	R	R	I	R	R	R
B	I	I	R	R	R	R
C	R	R	R	R	R	R
D	I	I	I	R	R	R

In Group C, the means for Standards II and III were slightly above those of Standard IV, but as the numbers in the former were small this cannot be regarded as significant or likely to affect the general argument. Otherwise, all the irregularities at the earlier age have been completely smoothed out, and we have at the later age a steady progression in the mean weight, mean height, and mean weight/mean height ratios.

The numbers obtained at the age of $10\frac{1}{2}$ years in this classification were not large enough to justify separating into standards. As stated in Part I the numbers at this age were supplemented by additional records, and the results for this reinforced group are submitted at this point.

Table XIII. *Mean weights, heights, and ratios* $\frac{\textit{mean weight}}{\textit{mean height}}$ *of* 324 *boys and* 333 *girls at the age of* $10\frac{1}{2}$ *years classified in school standards.*

	Boys				Girls			
Class	No.	Mean weight (kg.)	Mean height (cm.)	Mean weight / Mean height	No.	Mean weight (kg.)	Mean height (cm.)	Mean weight / Mean height
I	18	23·89	122·7	·1948	20	24·70	123·7	·1996
II	75	26·15	126·1	·2074	86	25·69	125·7	·2043
III	147	27·28	128·4	·2124	141	25·87	127·0	·2038
IV	71	28·51	131·4	·2170	68	27·33	130·3	·2098
V	13	29·50	133·5	·2210	18	27·64	130·8	·2113
All classes	324	27·19	128·5	·212	333	26·13	127·4	·205

With one exception, viz., the $\frac{\text{mean weight}}{\text{mean height}}$ for girls in Standard III being slightly below that for those in Standard II, all the above are free from irregularity.

The same series of means have been prepared for those boys and girls who were first examined at the age of $7\frac{1}{2}$ years.

The few irregularities can be accounted for by the fact that where they occur the numbers are comparatively small.

Table XIV. *Mean weights, heights and ratios* $\frac{\text{mean weight}}{\text{mean height}}$ *of 467 boys and 388 girls who were first examined between 7–8 years, at the age of* $12\frac{1}{2}$ *years.*

	Boys				Girls			
Class	No.	Mean weight (kg.)	Mean height (cm.)	Mean weight / Mean height	No.	Mean weight (kg.)	Mean height (cm.)	Mean weight / Mean height
II & III	31	30·18	134·1	·2250	28	32·10	135·8	·2364
IV	70	31·50	136·1	·2315	59	32·58	139·9	·2328
V	170	32·86	138·5	·2373	153	33·04	140·3	·2412
VI	186	33·66	140·0	·2399	136	34·50	142·0	·2430
VII	10	33·40	142·6	·2342	12	36·50	143·7	·2541

All the groups of children considered above can be traced back to the Infants' School. Similar calculations were made for those, but as the classification into standards varies considerably from school to school, and age is generally the most important factor in classification, they have not been discussed.

As the children grow older the process of smoothing out the irregularities is apparent, until by the age of $12\frac{1}{2}$ years they appear to have been completely eliminated. During the senior school period both weight and height singly and conjointly seem to be exerting an influence upon the distribution of boys and girls into standards, or stated differently, on their mental development. The evidence is in favour of the view that the children who tend to lag behind mentally are those who fall below the mean in physique.

Age of entry into school and consequent mental development.

Much discussion has taken place in the past about the most effective age for attendance at school, obligatory or otherwise. As the information was available the question has been considered by making a comparison of the distribution into standards at $12\frac{1}{2}$ years of groups of boys and girls who entered school at various ages. Assuming that the age of entry corresponded with the date of the entrants' routine examination, four groups of boys and a similar number for girls were obtained, entering school between the ages of 3 and 4, 4 and 5, 5 and 6, 6 and 7 years. The percentage distributions into Standards at $12\frac{1}{2}$ years are given in Table XV.

Table XV. *Percentage distribution in standards at the age of* $12\frac{1}{2}$ *years of various groups of children who entered school at different ages.*

Average age of entry	Boys Standard					Girls Standard				
	II & III	IV	V	VI	VII	II & III	IV	V	VI	VII
$3\frac{1}{2}$	2·8	14·0	24·3	48·6	10·3	3·9	12·6	30·0	37·9	15·6
$4\frac{1}{2}$	3·2	14·2	27·1	43·0	12·5	4·2	11·8	29·2	40·0	14·8
$5\frac{1}{2}$	8·4	12·8	29·4	43·4	6·0	6·6	13·6	28·6	39·3	11·9
$6\frac{1}{2}$	7·8	17·8	29·4	41·9	3·1	10·9	18·2	28·5	39·4	3·0
All children	5·7	14·9	29·3	41·7	8·3	6·0	14·7	31·3	37·6	10·3

These several distributions are, in general, similar to each other, and also to those for both sexes at $12\frac{1}{2}$ years. The percentages of children in Standards V

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and VI do not vary much over the four groups, except for boys who entered at $4\frac{1}{2}$ years, but there are differences at the extremes. The older the children are at entry the more marked is the retardation, the percentage on the lowest standards increasing as we pass from $3\frac{1}{2}$ years to $4\frac{1}{2}$ years, whilst the percentage in Standard VII is greatest for those who entered at $3\frac{1}{2}$ and gradually decreases as we ascend the age of entry scale.

The children who entered school early seem to have gained to a slight degree over those who entered later. It is also very probable that under modern conditions prevailing in Infant Schools, the gain is considerably greater that these figures suggest, for many of the children would benefit from the superior environmental influences of the school over those of the home.

CONCLUSION.

The claim is made that so far as the relation between physique and mentality is concerned, the following points have been established:

1. The Barry physical data resemble those of England and Wales, but are inferior to those of the U.S.A.

2. What is true of the physique of Barry children can be taken to be generally true of the children of England and Wales as a whole.

3. Although in early childhood children vary in physique, as they grow older the dispersion increases; nutrition may fairly be held to control such a dispersion.

4. Similarly, as children grow older, an increasing dispersion in mentality is found; the dispersion in mentality resembles that in physique.

5. The best children mentally are the best physically.

These facts point to mentality and physique being controlled by a common factor; and it is suggested that this factor is what is known as "nutrition." No effort is made to define the term with regard to food, light or other hygienic influences, which affect growth. The outstanding matter is that greater attention to this factor is required. It is required at once in the interests of physique and mentality: the latter is the interest of the educational authorities, but it is closely associated with the former.

Each child starts life with a certain capacity for development, mental and physical. The efficient adult is the one whose physique is developed to its full capacity, and whose mind has been fully trained. The school period is the time when this development and training take place. The facts presented indicate how fundamentally both may be influenced by "nutrition."

The nation cannot expect to obtain the best return for the vast amount of money spent on education until the fundamental conditions for development are materially improved.

An improvement in the nutritional status of children would not only result in improved physique, but also provide more favourable conditions for their mental development, for education appears to be most beneficial to those who are best nourished.

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