

A STUDY OF ASTHMATIC AND RHEUMATIC CHILDREN WITH SPECIAL REFERENCE TO PHYSICAL TYPE.

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INTRODUCTION.

THE central doctrine of Greek medicine was that of crases, or, as usually translated, temperaments or constitutions. It was held that the genesis of disease depended upon the response of the individual temperament to predisposing and

exciting causes, and that, although the latter might sometimes be so potent as to generate disease in any temperament, in general inborn variations of temperament were of primary importance. Galen accordingly, in the most widely read of his works, endeavoured to provide diagnostic criteria of the commonly occurring forms of human temperament (which he classified into nine types) and to specify the kinds of disease to which each type was prone.

When faith was lost in the Galenical pathology, Galen's classification ceased to interest medical men although it was revived for purposes of psychological classification, the word "temperament" indeed coming to have a mainly psychological connotation. The pioneers of modern pathological anatomy, such as Virchow, however, again attempted to classify human types, using, of course, very different criteria from those adopted by Galen.

The constitutional aspect of disease held a very prominent place in medical literature of the early and middle parts of the nineteenth century, as may be seen by reference to the well-known works of the eminent British clinicians, Addison (1855), Laycock (1862) and Hutchinson (1884), who were among the chief exponents of the subject. All these writers give descriptions of the types of people who seemed to be susceptible to certain diseases, and apparently held the belief that physical form bore an important relationship to disease. Later, with the growth of pathology and bacteriology and the advances in knowledge which followed the application of bacteriological, biochemical and physical methods to the investigation of morbid conditions, the attention of clinicians was largely diverted from the constitutional aspect to the external agents and other features of disease, interest in the question of diathesis waned, and its very conception, if not entirely discredited, practically fell into disrepute. In recent years there have been many indications, however, that clinicians are again becoming more interested in the relationship between the constitutional factors and disease. The revival of interest has been more apparent in America and the Continent than in this country, but prominent physicians in England, notably Garrod (1923 and 1927), Hurst (1927) and Ryle (1926), have also made important contributions to the literature of the subject. It is becoming more generally realised that a study of the characteristics of those afflicted with some very prevalent diseases at least may be of great interest and importance, if not perhaps quite as important as the study of the maladies themselves. In 1924 Draper published the book embodying his views on human constitution in relation to disease. He looks upon the term "human constitution" as connoting "that aggregate of hereditary characters, influenced more or less by environment, which determines the individual's reaction, successful or unsuccessful, to the stress of environment"; or more concisely, the summation of the morphological, physiological, immunological and psychological characters with which an individual is born. These four aspects or "panels" must be taken together to provide a complete picture or record of the individual. Though external morphological form may not always be a very dependable index or criterion of other inward qualities of the individual, Draper asserts that the

morphological panel or aspect is usually related so closely to the other aspects of the constitution that a careful analysis of the principal features of this panel in an individual may enable one to draw inferences regarding the probable characteristics in the other panels with a fair degree of confidence. There is considerable variation amongst normal individuals in the characteristics which comprise the different panels. Extreme variation in one direction may be advantageous to the individual, variation in the other may be harmful and may increase his liability to develop certain diseases. The term "diathesis" when used by writers in the past has not always borne the same significance, but the generally accepted, modern conception of diatheses has been well defined by Hurst (1927) as "the inborn and often inherited characteristics which make an individual liable to react to physical, chemical or psychological stimuli in such a manner that a condition of disease results." Though information regarding the morphological characteristics of an individual can only provide an incomplete picture of his constitution in the sense defined by Draper, the view that there is some association between type of build and quality of reaction, if not even predisposition, to certain diseases has been steadily gaining ground. The assertion has been made by various authors, including Draper (1925) and Davenport (1927), that a population selected on the basis of a particular disease has often a different form from that of the general population. While there appears to be some fairly reliable evidence in support of the view that pulmonary tuberculosis may be more prevalent in persons of a particular type of build—relatively taller and with relatively smaller chest girth than the general population—although Draper's observations on tuberculous subjects do not support this conclusion, the evidence is less convincing for the statement made by Davenport (1927) that populations with such diverse diseases as asthma, goitre, varicose veins, myopia, mitral insufficiency and tachycardia really differ from the average in morphological type. The view that inborn characters such as resistance or immunity to infection may be associated with particular external physical characteristics in individuals appears to receive support from the results of MacDonald's (1911) study of the incidence of some of the infectious fevers in the Glasgow hospitals. He found that the susceptibility to these seemed to differ significantly in groups of children with different types of hair and eye colour. A very detailed analysis of Italian military statistics by Boldrini (1925) also led him to the conclusion that the individual body is capable of a greater or lesser resistance to the various disease factors according to its constitution considered both from a morphological and a functional aspect.

Attempts to assign both adults and children to particular types of body build have long been of interest to many clinicians. The principal types recognised by different writers vary in number from two to six or even more. Though such a subdivision of builds into a few types is frequently made and has proved very useful, it will be readily understood that the classification is quite arbitrary. The types are not discrete or clear cut. Builds, like other biological characters,

really form a continuous series, running from one end of the range to the other, one build merging gradually and imperceptibly into the next in the series. The broad groupings or main types of build thus admit of a further classification into subtypes, or types intermediate to the main types may be identified.

Various descriptive terms have been devised and used by different observers to indicate the morphological types into which human beings may be broadly classified from general inspection. The simplest and widest classification that is made is a binary one into long, thin or slender and short, thick-set or stocky types. For these two types, Stockard (1923) uses the terms "linear" and "lateral"; Bean (1923) the terms "hyperontomorph" and "meso-ontomorph," and Bryant (1915) the terms "carnivorous" and "herbivorous." For the same or closely analogous types, other authors have used the terms "longitype" and "brachytype" or "leptosome" and "eurysome." Some writers have used a threefold classification, allocating a proportion of the population to two somewhat analogous structural types to those already described and placing the remainder in a third, intermediate, mixed or normal group; thus we have the longitype, the normotype and the brachytype; the macroskel, the mesoskel and the brachyskel of Manouvrier; the microsplanchnic, the mesosplanchnic and the megalosplanchnic of Viola; the asthenic or leptosome, the athletic and the pyknic of Kretschmer (1925); the slender, medium and fleshy of Davenport; and the schmal, normal and breit of Aschner. Still others have favoured a fourfold classification, for example, the asthenic, hyposthenic, sthenic and hypersthenic types of Mills (1917). In France, a fourfold classification of body build, introduced apparently by Hallé before 1800 and revived later by Sigaud (1914), is now in more or less general use, respiratory, muscular, digestive and cerebral types being recognised.

The various classifications of types of body build were primarily based chiefly on the observer's subjective impressions of series of individuals. Later, exact anthropometric methods were introduced with the object of establishing a more dependable method of recording differences in conformation. De-Giovanni of Padua in 1880 was among the first to adopt a detailed anthropometric technique for clinical purposes.

Most of the published work on bodily conformation or habitus relates to adults, but there is a good deal of evidence that a subdivision of children into similar or closely analogous morphological types can likewise be made. Krasusky (1930) gives a useful survey of the literature on types of build in children.

Attempts have been made to use one or other of the various indices of body build which usually depend upon formulae derived from two or more of the body characters, stature, chest girth and body weight, for the purpose of obtaining a more precise classification into the various morphological types than can be hoped for from subjective impression or general inspection alone. Certain ranges of the index are considered to correspond to the several types of

body build. Schemes of this nature have not so far, however, received very general support.

Much of the evidence on which the alleged association between particular physical types and predisposition to certain diseases rests has been based on relatively small numbers of observations. When an opportunity was provided recently for obtaining a long series of anthropometric measurements in fairly adequate numbers of children ranging in age from 4 to 12 years, who were attending hospital clinics established for the treatment of certain diseases, it seemed desirable to use the data for the purpose of determining whether the groups of children with these diseases were really on the average different from one another or from the general population of children in bodily conformation or physical type.

MATERIAL FOR INVESTIGATION.

The children whose measurements were taken and on whom observations in regard to physical characters were made were attending the special clinics established at the Hospital for Sick Children, Great Ormond Street, for asthma and rheumatism respectively. A similar series of measurements and observations was made in groups of children at the same ages who were attending the Out-patients' Department of the Hospital for minor or trivial ailments but with no history of rheumatism or asthma or obvious impairment of general health. These will be referred to as the normal¹ groups. There were thus three groups of children of each sex at certain ages available for comparison, a rheumatic, an asthmatic and a control series.

As the numbers of observations at some of the individual ages were not reasonably large and as there were relatively few records of children with rheumatism under six years of age, it was decided to compare the measurements of the children of corresponding sex in the three groups for the two-yearly age periods 6-8, 8-10 and 10-12. For the whole age period, 6-12 years, the characters of approximately 1212 children have been dealt with. Of these, 368, 236 boys and 132 girls; 459, 189 boys and 270 girls; and 385, 195 boys and 190 girls, were considered to be asthmatic, rheumatic and normal respectively. The approximate numbers available at the different ages in the separate sexes are shown in Table I.

MEASUREMENTS AND OBSERVATIONS MADE.

The measurements were all taken and the observations made by Dr Bonnard. The several particulars which were noted in the individual children are shown in the accompanying list (p. 440). The vertical measurements were taken in the children entirely divested of clothes and standing erect on a cork mat in a warm room. The heights of the various anatomical points from the ground were determined by means of an all-metal graduated measuring rod or anthropometer. The perpendicular position of the rod was ensured and

¹ It should be noted that the word "normal" is employed here, throughout the text and in the tables in a specially defined and not quite the usual sense.

Measurements and observations.

Ref. No.

Name				
Age				
Sex				
Disease				
Full stature				
Sternal height				
Ziphisternal height				
Umbilical height				
Symphysial height				
Trochanteric height				
Knee height				
Ankle height				
Porion height				
Acromial height				
Elbow height				
Wrist height				
Mid-finger height				
Stem length				
Greatest transverse span				
Biacromial diameter				
Transverse diameter of chest				
Bicristal diameter				
Antero-post. diameter of chest				
Chest girth: 1.	2.	3.		
Subcostal angle				
Vertebral border of scapula:	Conv.	Straight	Conc.	
Max. length of head				
Max. breadth of head				
Min. frontal diameter				
Full face height:				
Upper face height: 1.	2.			
Nasal height				
Bizygomatic breadth of face				
Bigonial breadth of face				
Nasal breadth				
Colour of hair				
Colour of eyes				
Posture				
Bodily habitus: Hypersthenic	Sthenic	Hyposthenic	Asthenic	
Body weight				

Table I. *Numbers of boys and girls at the several ages in the different groups available for measurement.*

Age groups	Boys.			Totals	
	Asthma	Rheumatism	Normal		
6-8	101	43	68		
8-10	81	79	80		
10-12	54	67	47		
Totals	236	189	195		620
	Girls.			Totals	
	Asthma	Rheumatism	Normal		
6-8	58	42	54		
8-10	49	101	77		
10-12	25	127	59		
Totals	132	270	190		592
Grand totals	368	459	385		1212

maintained by observation of a small spirit level attached to the sleeve of the horizontal sliding rod. In measuring the sitting height or stem length with the anthropometer the child was seated on the floor with the back against the wall and the knees flexed. The chest girth was measured by a tape at the level of the fourth costo-sternal junction (1) in quiet breathing, (2) in full inspiration, and (3) in full expiration. The values for chest girth used are the means of (2) and (3).

The diameters of the chest were taken at the same level in quiet breathing with special callipers. These callipers were also used for the biacromial and bicristal diameters.

The measurements of the head and face were made with Flower's callipers. For the assessment of the colour of hair and eyes, the standards—a set of hanks of hair and a set of artificial eyes—used by the Anthropometric Committee of the Board of Education and the Ministry of Health in their survey of English school children were made available.

Records were made of the form of the vertebral border of the scapula because of the interest of Graves's (1924) observations on its varying character and possible relation to morbidity.

The attempt to assign each child from general inspection to one or other of Mills's (1917) four types of bodily habitus, asthenic, hyposthenic, sthenic and hypersthenic, was unfortunately only begun after the investigation was well under way so that the classification is not available for some of the children. The classification as regards type of posture or manner in which the child stood erect was a fivefold one with the following grades: very bad, poor, fair, good and very good. The weight of each child was taken without clothes to the nearest quarter of a pound.

By a series of subtractions of the heights of the various anatomical points or landmarks from the ground which are given in the first part of the list (p. 440), the lengths in projection of the segments of the various parts of the body and the limbs were obtained, and from these the various ratios or indices were calculated which serve to show the relative proportions of the different parts of the body.

COMPARISON OF THE PRINCIPAL CHARACTERS IN THE THREE GROUPS OF CHILDREN.

A. *The absolute measurements.*

(1) *Standing height or full stature.* The mean values and variabilities of this character at the different ages considered for the three groups of children, asthmatic, rheumatic and normal, are shown in Table II, the results for boys and girls being tabulated separately.

The averages for the rheumatic boys are rather less than those for the asthmatic and the normal boys at the corresponding ages, but in no instance is the difference so great that it can be considered significant on the numbers available.

In the girls at ages 6–8 years the mean statures in the asthmatic and rheumatic groups do not differ significantly, but they are probably both significantly less than the normal average at the same age. At ages 8–10 years the differences observed in the three mean values are only such as might readily arise from random sampling. At ages 10–12 years the means for the asthmatic and rheumatic groups do not differ, but they are both rather less than the mean of the normal group.

From an analysis of 200 consecutive observations on children with asthma from 3 years onwards attending the same clinic, Bray (1931) came to the conclusion that the asthmatic child was of correct height for its age.

Table II. *Standing height.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6–8	M.	118.68 ± 0.60	117.42 ± 1.06	119.35 ± 0.69
	S.D.	5.98	6.96	5.65
	No.	101	43	68
8–10	M.	128.26 ± 0.87	127.61 ± 0.69	129.10 ± 0.72
	S.D.	7.85	6.12	6.46
	No.	81	79	80
10–12	M.	137.22 ± 0.95	135.00 ± 0.85	137.00 ± 1.07
	S.D.	7.00	6.96	7.36
	No.	54	67	47
Girls.				
6–8	M.	116.41 ± 0.79	117.14 ± 0.83	119.41 ± 0.76
	S.D.	6.00	5.39	5.58
	No.	58	42	54
8–10	M.	126.47 ± 0.86	127.91 ± 0.58	128.43 ± 0.70
	S.D.	6.00	5.83	6.13
	No.	49	101	77
10–12	M.	135.43 ± 1.35	135.82 ± 0.65	138.08 ± 0.89
	S.D.	6.76	7.27	6.83
	No.	25	127	59

M. = Mean and its standard error in cm.

S.D. = Standard deviation

No. = Number of observations

(2) *Stem length or sitting height.* The comparison of the sitting height or stem length at corresponding ages in the three groups of children is shown in Table III.

In the boys the differences in mean value in the asthmatic and rheumatic groups are only such as might arise readily by chance. At ages 6–8 years the average stem length in the normal group exceeds that in both the asthmatic and rheumatic groups to a significant degree, and at ages 8–10 years the normal mean is also significantly in excess of the asthmatic, but at ages 10–12 years the differences in mean value in the three groups are only such as might arise from random sampling.

In girls the differences in mean stem length in the asthmatic and rheumatic groups can only be regarded as fortuitous on the numbers available. The

averages in the normal series are not significantly in excess of the corresponding means in any of the diseased groups with the exception of the asthmatic group at ages 10-12 years.

Table III. *Sitting height.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	63.06 ± 0.27	62.48 ± 0.51	64.04 ± 0.35
	S.D.	2.76	3.37	2.99
	No.	101	43	68
8-10	M.	66.12 ± 0.35	66.26 ± 0.34	67.10 ± 0.30
	S.D.	3.16	3.02	2.70
	No.	81	79	80
10-12	M.	69.74 ± 0.45	69.02 ± 0.41	69.84 ± 0.54
	S.D.	3.33	3.35	3.72
	No.	54	67	47
Girls.				
6-8	M.	61.97 ± 0.37	61.98 ± 0.43	62.59 ± 0.36
	S.D.	2.82	2.81	2.65
	No.	58	42	54
8-10	M.	65.56 ± 0.40	66.18 ± 0.31	66.38 ± 0.33
	S.D.	2.83	3.07	2.93
	No.	49	101	77
10-12	M.	68.38 ± 0.66	69.48 ± 0.30	70.17 ± 0.42
	S.D.	3.32	3.40	3.20
	No.	25	127	58

Table IV. *Body length.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	36.45 ± 0.24	36.03 ± 0.34	37.47 ± 0.25
	S.D.	2.40	2.21	2.10
	No.	100	43	68
8-10	M.	38.50 ± 0.27	38.56 ± 0.21	39.55 ± 0.28
	S.D.	2.43	1.83	2.45
	No.	81	79	79
10-12	M.	41.24 ± 0.40	40.57 ± 0.29	41.18 ± 0.31
	S.D.	2.97	2.40	2.16
	No.	54	67	47
Girls.				
6-8	M.	35.64 ± 0.23	36.50 ± 0.29	36.54 ± 0.25
	S.D.	1.79	1.90	1.86
	No.	58	42	54
8-10	M.	38.32 ± 0.31	38.43 ± 0.21	39.02 ± 0.23
	S.D.	2.19	2.16	2.03
	No.	49	101	77
10-12	M.	40.54 ± 0.41	40.56 ± 0.21	40.91 ± 0.30
	S.D.	2.04	2.37	2.34
	No.	25	127	59

(3) *Body length (suprasternal notch to upper symphysial border).* Table IV gives the comparison of the means and variabilities of this character at corresponding ages in the different groups. In the boys belonging to the asthmatic and rheumatic groups the differences are only such as might arise readily by chance. At ages 6-8 and 8-10 years the averages in the normal groups are significantly in excess of those in both the asthmatic and rheumatic groups, but at ages 10-12 years there is no real difference in the three values.

In girls at ages 6–8 years the mean value in the asthmatic group is significantly less than the corresponding values in the rheumatic and normal groups which are practically equivalent. At ages 8–10 and 10–12 years the mean values in the asthmatic group are practically identical with those in the rheumatic group and do not differ significantly from the averages in the normal group.

(4) *Chest girth.* The average girth of the chest at the level of the 4th costal cartilage in the different groups is compared in Table V. In boys at ages 6–8

Table V. *Chest girth.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6–8	M.	60.72 ± 0.27	60.20 ± 0.45	60.49 ± 0.34
	S.D.	2.68	2.95	2.84
	No.	101	43	68
8–10	M.	64.43 ± 0.33	63.92 ± 0.35	63.73 ± 0.31
	S.D.	3.01	3.15	2.82
	No.	81	79	80
10–12	M.	68.61 ± 0.49	67.05 ± 0.47	66.16 ± 0.52
	S.D.	3.59	3.86	3.55
	No.	53	67	47
	Girls.			
6–8	M.	58.93 ± 0.42	57.96 ± 0.44	58.75 ± 0.38
	S.D.	3.19	2.84	2.77
	No.	58	41	53
8–10	M.	62.72 ± 0.41	62.34 ± 0.35	61.84 ± 0.35
	S.D.	2.85	3.52	3.07
	No.	49	101	76
10–12	M.	66.10 ± 0.77	65.90 ± 0.36	65.35 ± 0.47
	S.D.	3.86	4.09	3.59
	No.	25	127	59

and 8–10 years there are no significant differences in the mean values of the three comparable groups, but at ages 10–12 years the mean chest girth in the asthmatic group exceeds the corresponding measurements in both the rheumatic and the normal groups to a significant degree; at the last-mentioned age the rheumatic mean also slightly exceeds the normal but not sensibly.

In girls the mean chest girth of the asthmatic group does not differ significantly from that of the rheumatic group or that of the normal group at any of the ages under review.

Bray's conclusion from his analysis of 200 consecutive observations on asthmatic children from the same clinic was that the chest measurements in these were slightly under the average, but that this was due to lack of fleshy covering and not to diminution in diameter.

(5) *Transverse diameter of chest.* The mean measurements for this character in the different groups are shown in Table VI.

In boys there are no significant differences in the corresponding mean values in the asthmatic and rheumatic groups at any of the ages considered. The only real difference observed between the normal and the other groups is at ages 6–8 years where the normal average exceeds the average for the rheumatic group.

Table VI. *Transverse diameter of chest.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	18.07 ± 0.09	17.75 ± 0.17	18.27 ± 0.11
	S.D.	0.91	1.14	0.92
	No.	101	43	68
8-10	M.	18.84 ± 0.12	18.93 ± 0.12	19.11 ± 0.12
	S.D.	1.12	1.09	1.08
	No.	81	79	80
10-12	M.	20.17 ± 0.18	19.80 ± 0.15	19.82 ± 0.18
	S.D.	1.33	1.23	1.20
	No.	54	67	47
Girls.				
6-8	M.	17.53 ± 0.13	17.23 ± 0.16	17.81 ± 0.14
	S.D.	0.97	1.02	1.06
	No.	58	41	54
8-10	M.	18.47 ± 0.15	18.36 ± 0.09	18.35 ± 0.14
	S.D.	1.04	0.94	1.19
	No.	49	101	77
10-12	M.	19.08 ± 0.21	19.31 ± 0.12	19.44 ± 0.18
	S.D.	1.04	1.30	1.42
	No.	25	127	59

In girls there are no significant differences between the asthmatic and rheumatic groups at any of the ages. The only average in these groups which really differs from the normal is that at ages 6-8 years in the rheumatic group which, as in boys, is less than the normal.

(6) *Antero-posterior diameter of chest.* The comparison of the antero-posterior measurements of the chest in the different groups is shown in Table VII.

Table VII. *Antero-posterior diameter of chest.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	13.70 ± 0.09	13.06 ± 0.14	13.55 ± 0.12
	S.D.	0.93	0.90	0.97
	No.	101	43	68
8-10	M.	14.16 ± 0.10	13.73 ± 0.10	14.17 ± 0.12
	S.D.	0.92	0.85	1.04
	No.	81	79	80
10-12	M.	15.07 ± 0.16	14.17 ± 0.12	14.48 ± 0.16
	S.D.	1.17	1.01	1.07
	No.	53	67	47
Girls.				
6-8	M.	13.35 ± 0.11	12.95 ± 0.13	13.23 ± 0.12
	S.D.	0.85	0.83	0.90
	No.	58	41	54
8-10	M.	14.02 ± 0.16	13.37 ± 0.10	13.44 ± 0.09
	S.D.	1.11	0.99	0.79
	No.	49	99	77
10-12	M.	14.62 ± 0.21	13.93 ± 0.10	13.91 ± 0.13
	S.D.	1.03	1.12	0.99
	No.	25	127	58

In the rheumatic boys the mean diameter in all the three age groups is significantly less than the corresponding diameter in the asthmatic children. It is also significantly less than the corresponding diameter in the normal boys

at ages 6-8 and 8-10 years; the defect at ages 10-12 years as compared with the normal cannot, however, be considered real on the numbers available. At ages 6-8 and 8-10 years the asthmatic means are in close agreement with the normal, but at ages 10-12 years the asthmatic mean significantly exceeds that in the normal children.

In girls the rheumatic group means are significantly less than the asthmatic at all the three ages, but are in close agreement with the normal means. At ages 6-8 years the asthmatic mean does not sensibly exceed the normal, but in the two later age groups the asthmatic means are significantly in excess of the normal averages.

(7) *Biacromial diameter*. The comparable measurements of the biacromial diameter are shown in Table VIII.

Table VIII. *Biacromial diameters*.

Age groups		Boys.		
		Asthma	Rheumatism	Normal
6-8	M.	26.16 ± 0.12	25.90 ± 0.23	26.54 ± 0.17
	S.D.	1.21	1.51	1.37
	No.	101	43	68
8-10	M.	28.00 ± 0.18	27.78 ± 0.18	28.46 ± 0.17
	S.D.	1.65	1.61	1.54
	No.	81	79	80
10-12	M.	29.92 ± 0.26	29.21 ± 0.22	29.49 ± 0.27
	S.D.	1.88	1.79	1.85
	No.	54	67	47
		Girls.		
6-8	M.	25.65 ± 0.21	25.05 ± 0.19	26.20 ± 0.17
	S.D.	1.61	1.21	1.25
	No.	58	41	54
8-10	M.	27.60 ± 0.21	27.65 ± 0.14	27.85 ± 0.17
	S.D.	1.44	1.44	1.50
	No.	49	101	77
10-12	M.	29.47 ± 0.36	29.41 ± 0.15	29.68 ± 0.21
	S.D.	1.80	1.73	1.59
	No.	25	127	59

With regard to this character, the rheumatic boys do not differ significantly from the asthmatic boys at ages 6-8 or 8-10 years, but at ages 10 to 12 the mean in the former group is sensibly less than that in the latter. The rheumatic means are significantly less than the normal at ages 6-8 and 8-10 years, but at ages 10-12 there is no real difference in the means for the two groups. At none of the ages compared does the asthmatic mean differ significantly from the normal average.

In girls at ages 6-8 years the rheumatic mean is significantly less than the asthmatic mean and the normal mean; the mean in the asthmatic group, however, probably does not differ significantly from the normal. At the ages 8-10 and 10-12 years the corresponding mean values for all the three groups do not show greater variation than might readily arise from random sampling.

(8) *Bicristal diameter*. The comparison of this character in the three groups is shown in Table IX. In boys the bicristal diameter in the rheumatic group does not differ significantly from that in the asthmatic group at any of the

three ages. In all the age groups the rheumatic means are sensibly less than the normal means. The asthmatic boys only differ significantly from the normal boys in the intermediate of the three age groups when their average is less.

Table IX. *Bicristal diameter.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	18.65 ± 0.13	18.51 ± 0.17	19.00 ± 0.16
	S.D.	1.30	1.13	1.34
	No.	101	43	68
8-10	M.	19.89 ± 0.15	19.74 ± 0.12	20.54 ± 0.15
	S.D.	1.31	1.10	1.31
	No.	81	79	80
10-12	M.	21.11 ± 0.17	20.63 ± 0.17	21.24 ± 0.19
	S.D.	1.28	1.40	1.32
	No.	54	67	47
Girls.				
6-8	M.	18.07 ± 0.19	18.20 ± 0.16	18.56 ± 0.16
	S.D.	1.41	1.04	1.18
	No.	58	41	54
8-10	M.	19.48 ± 0.14	19.54 ± 0.12	19.78 ± 0.14
	S.D.	0.99	1.25	1.23
	No.	49	101	77
10-12	M.	20.23 ± 0.24	20.85 ± 0.13	21.26 ± 0.18
	S.D.	1.22	1.48	1.39
	No.	25	127	59

In girls the corresponding means in the rheumatic and asthmatic groups do not differ at ages 6-8 and 8-10 years, but at ages 10-12 the asthmatic mean is sensibly less than the rheumatic mean. The mean values in the rheumatic groups do not really differ from the corresponding values in the normal groups at any of the ages, but the asthmatic mean at ages 10-12 years is significantly lower than the normal average.

(9) *Sternal length.* The mean values of the sternal length (suprasternal notch to ziphisternal junction) for the different groups are shown in Table X. In the boys the mean measurements of this character do not show any real differences in the three groups at any of the ages compared, unless at ages 8-10 years, when the mean value for the asthmatic group is less than that in the rheumatic group.

In the girls the corresponding mean values of the characters do not differ significantly at any age in the asthmatic, rheumatic and normal groups.

(10) *Subcostal angle.* The comparison of the values of this character in the three groups is shown in Table XI.

In boys the means for the asthmatic and rheumatic groups do not differ from one another to a significant degree at any of the ages except the youngest, at which the asthmatic mean is sensibly less than the rheumatic mean. Neither the asthmatic means nor the rheumatic means differ significantly from the normal means at corresponding ages.

In girls the mean values of the angle in the asthmatic and rheumatic groups do not differ significantly from one another, nor from the corresponding values in the normal children at any of the ages compared.

Table X. *Sternal length.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	9.93 ± 0.13	10.15 ± 0.21	10.13 ± 0.15
	S.D.	1.31	1.37	1.21
	No.	100	42	68
8-10	M.	10.49 ± 0.16	11.00 ± 0.14	10.71 ± 0.16
	S.D.	1.40	1.22	1.45
	No.	81	79	80
10-12	M.	11.15 ± 0.19	11.60 ± 0.16	11.24 ± 0.20
	S.D.	1.43	1.34	1.38
	No.	54	67	47
Girls.				
6-8	M.	9.71 ± 0.14	10.07 ± 0.24	9.67 ± 0.18
	S.D.	1.07	1.57	1.31
	No.	58	42	54
8-10	M.	10.69 ± 0.17	10.69 ± 0.12	10.98 ± 0.15
	S.D.	1.17	1.18	1.33
	No.	49	100	77
10-12	M.	10.89 ± 0.30	11.45 ± 0.12	11.15 ± 0.18
	S.D.	1.52	1.37	1.35
	No.	25	125	58

Table XI. *Subcostal angle.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	54.44 ± 0.73	57.99 ± 1.42	55.47 ± 0.76
	S.D.	7.30	9.32	6.25
	No.	101	43	68
8-10	M.	51.44 ± 0.79	53.66 ± 1.00	52.40 ± 0.67
	S.D.	7.10	8.90	6.02
	No.	81	79	80
10-12	M.	53.91 ± 0.91	54.62 ± 0.87	54.78 ± 0.79
	S.D.	6.66	7.05	5.44
	No.	54	66	47
Girls.				
6-8	M.	54.53 ± 0.89	53.09 ± 1.14	55.20 ± 0.84
	S.D.	6.75	7.33	6.18
	No.	58	41	54
8-10	M.	54.99 ± 1.23	54.64 ± 0.81	55.38 ± 0.73
	S.D.	8.62	8.06	6.41
	No.	49	100	77
10-12	M.	56.72 ± 1.43	55.49 ± 0.64	53.59 ± 0.90
	S.D.	7.15	7.25	6.95
	No.	25	127	59

(11) *Length of arm.* The mean measurements of the length of the arm are shown in Table XII.

In boys the means in the asthmatic and rheumatic groups do not differ sensibly at any of the ages compared. The means in these groups do not differ from the normal at any age except at ages 8-10 years when the rheumatic average seems to be rather less than the normal average.

In the girls the means in the asthmatic and rheumatic groups do not show significant differences at any of the ages compared. The asthmatic mean at ages 6-8 years and the rheumatic mean at ages 10-12 years are significantly less than the corresponding normal means, but at the other ages the means for the girls with one or other disease do not differ from the normal.

Table XII. *Length of arm.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	39.56 ± 0.27	39.30 ± 0.49	40.23 ± 0.23
	S.D.	2.66	3.20	2.68
	No.	98	43	66
8-10	M.	43.31 ± 0.35	43.06 ± 0.29	44.08 ± 0.43
	S.D.	3.15	2.58	2.76
	No.	81	79	80
10-12	M.	46.92 ± 0.37	46.19 ± 0.35	47.06 ± 0.43
	S.D.	2.67	2.87	2.97
	No.	53	67	48
Girls.				
6-8	M.	38.22 ± 0.34	38.63 ± 0.39	39.50 ± 0.31
	S.D.	2.55	2.49	2.30
	No.	58	40	54
8-10	M.	42.50 ± 0.36	42.53 ± 0.26	43.01 ± 0.27
	S.D.	2.53	2.57	2.33
	No.	48	101	77
10-12	M.	45.17 ± 0.62	45.60 ± 0.27	46.52 ± 0.36
	S.D.	3.08	3.04	2.75
	No.	25	126	58

Table XIII. *Length of leg.*

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	53.55 ± 0.37	53.02 ± 0.62	54.59 ± 0.42
	S.D.	3.68	4.05	3.41
	No.	98	43	66
8-10	M.	59.49 ± 0.49	59.66 ± 0.49	60.48 ± 0.47
	S.D.	4.38	4.34	4.17
	No.	81	79	80
10-12	M.	65.75 ± 0.60	64.31 ± 0.55	65.13 ± 0.70
	S.D.	4.40	4.47	4.88
	No.	53	67	48
Girls.				
6-8	M.	53.21 ± 0.47	53.60 ± 0.53	55.41 ± 0.47
	S.D.	3.56	3.35	3.46
	No.	58	40	54
8-10	M.	59.04 ± 0.54	60.29 ± 0.36	60.69 ± 0.42
	S.D.	3.74	3.67	3.70
	No.	48	101	77
10-12	M.	65.04 ± 0.87	65.49 ± 0.40	66.93 ± 0.54
	S.D.	4.34	4.45	4.12
	No.	25	126	58

(12) *Length of leg.* The comparison of the mean measurements of this character in the several groups is shown in Table XIII.

In boys the asthmatic and rheumatic averages do not differ significantly at any of the ages under consideration. At ages 6-8 years the normal mean is probably just significantly in excess of the mean in the rheumatic group, but the normal averages do not differ significantly from the averages in the rheumatic children at the higher ages. The differences between the means of the normal and asthmatic boys are only such as might readily arise from sampling.

In the girls the mean values for the asthmatic and rheumatic groups do not differ significantly at any of the ages. At ages 6-8 years both the asthmatic and rheumatic averages seem to be sensibly under the normal. At ages 8-10 years

the asthmatic mean, and at ages 10–12 years the rheumatic mean, are also probably sensibly less than the normal average, but the means for the rheumatic group at ages 8–10 years and the asthmatic group at ages 10–12 cannot be said to differ from the normal averages on the numbers available.

(13) *Body weight.* As the body weights of the children were recorded, the mean weights for the different groups have been calculated. These are shown in Table XIV. The mean weights of the boys at the respective ages in the asth-

Table XIV. *Body weight.*

Age groups		Boys.			
		Asthma	Rheumatism	Normal	
6–8	M.	48.40 ± 0.73	47.91 ± 1.08	50.10 ± 0.83	
	S.D.	6.93	6.89	6.50	
	No.	89	41	62	
8–10	M.	56.14 ± 1.01	57.66 ± 0.89	59.64 ± 1.01	
	S.D.	8.78	7.71	8.61	
	No.	75	75	73	
10–12	M.	66.50 ± 1.27	64.89 ± 1.25	67.30 ± 1.45	
	S.D.	9.06	9.83	9.71	
	No.	51	62	45	
		Girls.			
6–8	M.	46.58 ± 0.99	46.60 ± 1.02	49.03 ± 0.80	
	S.D.	7.15	6.44	5.68	
	No.	52	40	51	
8–10	M.	54.72 ± 1.31	57.56 ± 0.85	57.56 ± 0.85	
	S.D.	8.88	8.18	7.09	
	No.	46	93	70	
10–12	M.	64.28 ± 2.29	67.55 ± 1.03	66.67 ± 1.33	
	S.D.	11.22	11.19	9.70	
	No.	24	117	53	

matic and rheumatic groups are in fairly close agreement. At no age can such differences as are observed be considered significant. Though the means in the asthmatic and rheumatic groups are generally slightly lower than the normal averages at the corresponding ages, the only one of these which can probably be deemed really less than the normal on such numbers as are available is the asthmatic at ages 8–10 years.

In the girls the means of the asthmatic groups at all the ages and of the rheumatic group at ages 6–8 years appear to be rather less than the normal, but at none of the ages is the difference in mean value observed of such a size that the asthmatic and rheumatic girls can be considered to differ significantly from one another or from the normal.

Bray (1931), from an analysis of 200 consecutive observations on asthmatic children attending his clinic at the Sick Children's Hospital, reached the conclusion that the asthmatic child though of correct height for its age was under weight, the decrease in weight reaching a maximum of 11 lb. at 11 years of age.

While the fact that the asthmatic means in all the groups, both boys and girls, considered in the present investigation are rather less than the normal, though in only one instance (boys at 8–10 years) is the defect real, is probably rather suggestive of underweight, there is no definite evidence in the data under review of such a deficiency in weight as that found by Bray.

As the present inquiry is essentially concerned with bodily proportions which are not likely to be influenced to any appreciable degree by the state of nutrition of the children, little stress will be laid on these apparently slight differences in mean body weight.

B. Relative measurements or bodily proportions.

Having compared the mean absolute measurements of the more important of the dimensions in the three groups of children, we now pass on to consider some of the percentage ratios or indices which give expression to the shape or form or relative proportions of the different parts of the body. It is a common practice to express the various physical dimensions or measurements as proportions of the full stature with the object of eliminating the influence of variations of stature thereon. Not infrequently, many of the bodily dimensions are expressed as proportions of the stem length or of the trunk length to indicate the relative degree of development of the different characters by referring them to a common standard. In the present investigation no attempt has been made to express all the characters that have been measured as proportions of the full stature. The average statures at the corresponding ages in the three comparable groups were so nearly equivalent that the calculation of the numerous ratios to allow for differences of stature did not seem to be necessary. Only two indices with full stature as the denominator will be considered.

(1) $100 \times \text{stem length} / \text{full stature or standing height}$. The comparison of this index in the three groups at corresponding ages is shown in Table XV.

Table XV. $100 \times \text{Sitting height} / \text{standing height}$.

Age groups		Boys.		
		Asthma	Rheumatism	Normal
6-8	M.	53.21 ± 0.15	52.97 ± 0.22	53.27 ± 0.16
	S.D.	1.56	1.41	1.32
	No.	101	43	68
8-10	M.	51.67 ± 0.18	51.93 ± 0.21	51.98 ± 0.18
	S.D.	1.65	1.90	1.57
	No.	81	79	80
10-12	M.	50.81 ± 0.21	51.21 ± 0.19	51.04 ± 0.23
	S.D.	1.57	1.53	1.58
	No.	54	67	47
		Girls.		
6-8	M.	53.36 ± 0.19	52.92 ± 0.24	52.51 ± 0.18
	S.D.	1.45	1.55	1.29
	No.	58	42	54
8-10	M.	51.84 ± 0.22	51.75 ± 0.14	51.76 ± 0.17
	S.D.	1.52	1.43	1.49
	No.	49	101	77
10-12	M.	50.53 ± 0.38	51.17 ± 0.13	50.95 ± 0.18
	S.D.	1.89	1.47	1.37
	No.	25	127	58

From the table it will be readily seen that in boys the ratios at corresponding ages in the asthmatic, rheumatic and normal groups are in very close agreement. Any differences that are observed are only such as might arise from sampling errors.

The average values in the asthmatic and rheumatic groups of girls at corresponding ages do not show any differences that can be considered real on the numbers available. The mean index in the girls with rheumatism does not differ from that in the normal girls at any of the ages under consideration. The mean indices in the asthmatic girls are also in close agreement with those in the normal girls at ages 8–10 and 10–12 years, but at ages 6–8 the average index in the asthmatic group is probably significantly in excess of the corresponding normal average.

As the index just described shows no material differences at the corresponding ages in the three comparable groups, the complemental index ($100 \times (\text{full stature} - \text{stem length}) / \text{full stature}$), or approximately, $100 \times \text{height of great trochanter from the ground} / \text{full stature}$, would presumably not show differences.

(2) $100 \times \text{body length} / \text{full stature}$. The comparison of this index in the three groups is shown in Table XVI.

Table XVI. $100 \times \text{body length} / \text{standing height}$.

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6–8	M.	30.84 ± 0.13	30.77 ± 0.19	31.17 ± 0.17
	S.D.	1.33	1.26	1.36
	No.	100	43	68
8–10	M.	30.05 ± 0.12	30.24 ± 0.13	30.70 ± 0.14
	S.D.	1.08	1.17	1.28
	No.	81	79	79
10–12	M.	30.07 ± 0.20	30.15 ± 0.13	30.06 ± 0.17
	S.D.	1.47	1.05	1.13
	No.	54	67	47
Girls.				
6–8	M.	30.77 ± 0.19	31.15 ± 0.20	30.60 ± 0.16
	S.D.	1.43	1.37	1.17
	No.	58	42	54
8–10	M.	30.26 ± 0.19	30.20 ± 0.11	30.46 ± 0.16
	S.D.	1.34	1.09	1.37
	No.	49	101	77
10–12	M.	29.96 ± 0.21	29.85 ± 0.10	29.65 ± 0.15
	S.D.	1.07	1.13	1.13
	No.	25	126	59

In boys the mean measurements at the corresponding ages in the asthmatic and rheumatic groups are in very close agreement. Such small differences as are observed are not significant. At ages 6–8 and 10–12 years both the asthmatic and rheumatic means do not differ significantly from the normal at these ages, but at ages 8–10 the mean values of the index in both asthmatic and rheumatic groups are probably significantly less than the normal average.

The mean values in the asthmatic groups of girls are in close agreement with the corresponding values in the rheumatic groups. At none of the three ages does the asthmatic mean differ from the normal average. The averages in the rheumatic group do not differ from the corresponding normal means at ages 8–10 and 10–12 years, but at ages 6–8 the mean in the rheumatic group seems to exceed the normal average.

Two indices in which physical characters are expressed as proportions of the body length or trunk length (upper sternal to upper symphysial border) have been computed. They are:

(3) $100 \times \text{sternal length/body length}$. The comparison of this index in the different groups is shown in Table XVII.

Table XVII. $100 \times \text{sternal length/body length}$.

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6-8	M.	27.10 ± 0.33	28.36 ± 0.50	26.93 ± 0.36
	S.D.	3.32	3.27	2.93
	No.	99	42	67
8-10	M.	27.28 ± 0.36	28.46 ± 0.33	26.83 ± 0.35
	S.D.	3.26	2.97	3.14
	No.	81	79	79
10-12	M.	27.04 ± 0.41	28.40 ± 0.33	27.39 ± 0.43
	S.D.	3.02	2.68	2.95
	No.	54	67	47
Girls.				
6-8	M.	27.12 ± 0.39	27.31 ± 0.59	26.50 ± 0.47
	S.D.	2.96	3.85	3.48
	No.	58	42	54
8-10	M.	28.01 ± 0.44	27.72 ± 0.26	28.15 ± 0.37
	S.D.	3.09	2.65	3.26
	No.	49	100	77
10-12	M.	26.85 ± 0.62	28.12 ± 0.24	27.42 ± 0.42
	S.D.	3.12	2.66	3.25
	No.	25	125	59

The boys with rheumatism would appear to have a relatively long sternum, as the indices in this group seem to exceed the corresponding values in the asthmatic group at all the three ages and the values in the normal group at ages 6-8 and 8-10 years. The averages in the asthmatic group, on the other hand, are in close agreement with the values in the normal group at all three ages.

The mean indices in the asthmatic girls do not differ from the corresponding values in the rheumatic group, and both sets of means do not differ from the normal to a greater extent than might be expected to arise from errors of sampling.

(4) $100 \times \text{biacromial diameter/body length}$. This index expresses the relative breadth of the shoulder region. The comparison in the different groups is shown in Table XVIII.

In the boys the means for the asthmatic group do not differ significantly from the corresponding means in the rheumatic group at any of the ages, and neither of these groups can be considered to differ from the normal.

In the girls at ages 8-10 and 10-12 years the asthmatic and rheumatic group averages are in close agreement with one another and with the normal averages, but at ages 6-8 years the mean in the rheumatic group appears to be rather less than the corresponding means in the asthmatic and normal groups. While the difference between the asthmatic and rheumatic means at this age cannot be considered real on the numbers available, that between the rheumatic and normal means practically attains the 1 in 20 level of significance.

(5) $100 \times \text{bicristal diameter} / \text{biacromial diameter}$. This index expresses the width of the pelvic region relatively to that of the shoulders. The comparison of its values in the different groups of children is shown in Table XIX.

Table XVIII. $100 \times \text{biacromial breadth} / \text{body length}$.

Age groups	Asthma		Boys.		
			Rheumatism	Normal	
6-8	M.	71.79 \pm 0.39	71.80 \pm 0.62	70.85 \pm 0.45	
	S.D.	3.93	4.05	3.69	
	No.	100	43	68	
8-10	M.	72.90 \pm 0.42	72.08 \pm 0.48	72.03 \pm 0.46	
	S.D.	3.74	4.26	4.07	
	No.	81	79	79	
10-12	M.	72.74 \pm 0.64	72.05 \pm 0.48	71.67 \pm 0.59	
	S.D.	4.67	3.95	4.02	
	No.	54	67	47	
			Girls.		
6-8	M.	71.84 \pm 0.55	70.30 \pm 0.58	71.87 \pm 0.52	
	S.D.	4.16	3.70	3.80	
	No.	58	41	54	
8-10	M.	71.90 \pm 0.56	71.80 \pm 0.39	71.39 \pm 0.52	
	S.D.	3.91	3.93	4.54	
	No.	48	101	77	
10-12	M.	72.84 \pm 1.02	72.44 \pm 0.35	72.70 \pm 0.55	
	S.D.	5.12	3.91	4.25	
	No.	25	126	59	

Table XIX. $100 \times \text{bicristal breadth} / \text{biacromial breadth}$.

Age groups	Asthma		Boys.		
			Rheumatism	Normal	
6-8	M.	71.25 \pm 0.38	71.76 \pm 0.57	71.68 \pm 0.47	
	S.D.	3.80	3.75	3.91	
	No.	101	43	68	
8-10	M.	71.01 \pm 0.38	71.03 \pm 0.37	72.09 \pm 0.39	
	S.D.	3.41	3.30	3.53	
	No.	81	79	80	
10-12	M.	70.52 \pm 0.64	70.44 \pm 0.38	72.22 \pm 0.63	
	S.D.	4.67	3.12	4.29	
	No.	54	66	47	
			Girls.		
6-8	M.	70.49 \pm 0.57	71.13 \pm 0.48	70.89 \pm 0.50	
	S.D.	4.35	3.09	3.66	
	No.	58	41	54	
8-10	M.	70.66 \pm 0.53	70.84 \pm 0.38	70.91 \pm 0.45	
	S.D.	3.68	3.79	3.90	
	No.	49	101	76	
10-12	M.	68.75 \pm 0.82	70.92 \pm 0.34	71.53 \pm 0.50	
	S.D.	4.09	3.85	3.86	
	No.	25	127	59	

The averages in the asthmatic and rheumatic boys at corresponding ages are in close agreement. At ages 6-8 years the average indices in the asthmatic and rheumatic groups do not differ from the average in the normal boys, but at ages 8-10 and 10-12 years the averages in both asthmatic and rheumatic groups are so far in defect of the normal that the differences may probably be considered significant.

In the girls the average indices at ages 6-8 and 8-10 years in the asthmatic group do not differ from the corresponding averages in the rheumatic group,

but at ages 10–12 the average in the asthmatic group is significantly less than the average in the rheumatic group. The average indices in the normal girls at ages 6–8 and 8–10 years are in close agreement with the corresponding averages in the asthmatic and rheumatic girls. At ages 10–12 years the index in the rheumatic girls does not differ significantly from the normal average, but the average index in the asthmatic girls is sensibly less than the normal.

(6) $100 \times \text{length of arm} / \text{length of leg}$. The index expressing the relative proportions of the upper and lower limbs may also be referred to briefly. The average values of the index in the comparable groups are shown in Table XX.

Table XX. $100 \times \text{arm}/\text{leg}$.

Age groups	Boys.			
		Asthma	Rheumatism	Normal
6–8	M.	73.98 ± 0.55	74.41 ± 0.45	73.76 ± 0.35
	S.D.	3.42	2.98	2.87
	No.	98	43	66
8–10	M.	72.81 ± 0.34	72.37 ± 0.35	72.40 ± 0.37
	S.D.	3.10	3.15	3.31
	No.	81	79	80
10–12	M.	71.59 ± 0.36	72.05 ± 0.34	72.31 ± 0.39
	S.D.	2.62	2.75	2.73
	No.	53	67	48
6–8	Girls.			
	M.	71.90 ± 0.45	72.05 ± 0.42	71.33 ± 0.39
	S.D.	3.45	2.63	2.87
8–10	M.	71.40 ± 0.39	70.54 ± 0.29	70.94 ± 0.33
	S.D.	2.67	2.89	2.90
	No.	48	101	77
10–12	M.	69.51 ± 0.62	69.74 ± 0.22	69.64 ± 0.32
	S.D.	3.11	2.45	2.42
	No.	25	126	58

In the three corresponding age groups the average indices in the asthmatic, rheumatic and normal boys do not show greater differences than might readily arise from random sampling.

Such differences as occur in the mean indices for the three groups of girls at corresponding ages cannot be considered real on the numbers available.

(7) *Cephalic and facial indices*. The mean cephalic index ($100 \times \text{head breadth} / \text{head length}$) was calculated for each of the three groups of boys, the asthmatic, the rheumatic and the normal. Boys of all ages were taken together as the cephalic index does not change appreciably with age. The index was approximately 79 in each group. This value is practically identical with the mean cephalic index, 78.9, found in a long series of fully 2000 English boys of the professional classes by Pearson and Tippett (1924).

The mean proportions of the face represented by both the facial indices—upper and total—namely, $100 \times \text{nasion to alveolar point} / \text{bizygomatic breadth}$, and $100 \times \text{nasion to submental point} / \text{bizygomatic breadth}$, were also calculated for the three groups of boys at ages 8–10 years, but no real differences were found.

As there was no evidence that the asthmatic and rheumatic boys differed

from one another or from the normal boys in general form of head and face, it was not considered necessary to make any detailed comparison of the other measurements of the head and face which had been recorded.

C. *Non-measurable or qualitative characters.*

Having discussed the principal "quantitative" physical characters in the three groups of children, some of the "qualitative" characters may now be considered. The characters brought under review are: hair colour, eye colour, character of vertebral border of scapula, type of bodily posture and bodily habitus.

(1) *Hair colour.* For the assessment of the colour of the hair, a set of six hanks of hair of standard colours similar to that approved and adopted by the Special Investigation Committee of the Board of Education and the Ministry of Health for their anthropometric survey of children in the English schools was used. The colours distinguished were black, dark brown, brown, light brown, auburn and blonde. The frequency distributions of these colours were compared in each pair of groups of boys, asthmatic and rheumatic, asthmatic and normal and rheumatic and normal by Pearson's "Goodness of Fit" or χ^2 test to ascertain if the differences observed were greater than might be expected to occur fortuitously in the samples available. Similar comparisons were made of the corresponding distributions in the groups of girls. The values of χ^2 and the *P*'s or probabilities that such differences as are observed might occur by chance are shown in Table XXI. The relatively small numbers available did not war-

Table XXI. *Hair colour.*

	Asthma and rheumatism	Asthma and normal	Rheumatism and normal
Boys	$\chi^2 = 1.73; P = 0.78$	$\chi^2 = 9.98; P = 0.04$	$\chi^2 = 3.97; P = 0.41$
Girls	$\chi^2 = 7.03; P = 0.14$	$\chi^2 = 18.07; P = 0.001$	$\chi^2 = 5.58; P = 0.24$

Colours: Black, dark brown, brown, light brown, auburn and blonde.

The records of black hair were so few in number that in making the comparisons black hair was included with dark brown. In estimating the values of *P*, *n* was taken as = 4.

rant any subdivision into age groups so that all ages from 6 to 12 years have been taken together. As the mean ages in the groups compared are approximately equivalent, the comparisons should not be materially vitiated by the well-known fact that the hair tends to darken appreciably with increasing age. Adopting the usual convention that *P*, the probability that random sampling would lead to a divergence as large as or larger than that observed in the two frequency distributions, must be less than 0.05 or 1 in 20 before it can be considered significant or real, the figures in the table lead to the conclusion that neither in boys nor girls can the distribution of hair colour in these affected with asthma be considered to differ from the distribution in the rheumatic children. The frequency distributions of hair colour in the rheumatic boys and girls do not show any real differences from those found in the normal boys, and girls. There is no evidence in these data of any special predilection of rheumatism for the blond type as has been alleged by Shrubsall (1903). Both

the asthmatic boys and girls, however, show distributions of hair colour which appear to differ from the normal to a greater degree than might be expected by chance. There is a relative defect in the dark haired type and an excess of blonds as compared with the normal.

(2) *Eye colour.* For the assessment of eye colour, a set of six artificial eyes similar to that adopted by the Anthropometric Investigation Committee of the Board of Education, to which reference has already been made, was used. The colours distinguished by this scheme were dark brown, brown, greenish grey, grey, blue and light blue. The frequency distributions of hair colour in the pairs of groups of boys and girls were also compared by the χ^2 test and the results are set out in Table XXII. The conclusions to be drawn from this table

Table XXII. *Eye colour.*

	Asthma and rheumatism	Asthma and normal	Rheumatism and normal
Boys	$\chi^2 = 7.40; P = 0.19$	$\chi^2 = 1.65; P = 0.89$	$\chi^2 = 9.74; P = 0.08$
Girls	$\chi^2 = 15.27; P = 0.01$	$\chi^2 = 4.44; P = 0.49$	$\chi^2 = 7.43; P = 0.19$

Colours: dark brown, brown, greenish grey, grey, blue and light blue. In estimating the values of P , n was taken = 5.

are that while there is no real difference in the distributions of eye colour in the asthmatic and rheumatic groups of boys, the corresponding distributions in the girls apparently differ to a greater degree than might be expected to occur from sampling errors; girls with asthma have a relative deficiency of brown eyes and an excess of blue eyes as compared with the rheumatic girls. Neither in the asthmatic boys or girls nor the rheumatic boys or girls can the frequency distributions be deemed to show a significant divergence from the corresponding distributions in the normal groups.

(3) *Hair and eye colour in boys and girls.* It is of interest to note that the frequency distributions of hair colour and eye colour in the asthmatic, rheumatic and normal groups of boys do not differ from the corresponding distributions in the girls to a greater degree than might be accounted for by sampling. The values of χ^2 and of P (the probability that such a difference as that observed or a greater one might arise by chance in a particular case) obtained by comparison of the distributions in the two sexes are shown in Table XXIII. All the values of P clearly exceed the 0.05 or 1 in 20 level of significance.

Table XXIII. *Hair and eye colour in boys and girls.*

	Asthmatic boys and girls	Rheumatic boys and girls	Normal boys and girls
Hair colour	$\chi^2 = 2.22; P = 0.70$	$\chi^2 = 3.25; P = 0.52$	$\chi^2 = 3.05; P = 0.56$
Eye colour	$\chi^2 = 6.45; P = 0.26$	$\chi^2 = 7.36; P = 0.19$	$\chi^2 = 5.10; P = 0.40$

For hair colour: $n = 4$. For eye colour: $n = 5$.

(4) *Posture.* An attempt was made to assess the posture or attitude or general bearing of the children from inspection, and to grade it in five categories varying from "very bad" through "poor," "fair," "good" to "very good."

“Very bad” posture may be taken to indicate an attitude with the head rather forward, drooping shoulders and protuberant abdomen, “very good” that in which the lower abdomen is held well in and flat, the head up and the shoulders square; “poor,” “fair” and “good” represent arbitrary grades of betterment between these extremes.

The frequency distributions of the several grades were compared in each pair of groups of boys and of girls by the χ^2 test to see if such differences as were observed in these were really significant; the results are set out in Table XXIV.

Table XXIV. *Posture.*

	Asthma and rheumatism	Asthma and normal	Rheumatism and normal
Boys	$\chi^2 = 2.78; P = 0.43$	$\chi^2 = 5.08; P = 0.17$	$\chi^2 = 1.65; P = 0.65$
Girls	$\chi^2 = 9.55; P = 0.02$	$\chi^2 = 4.31; P = 0.23$	$\chi^2 = 7.67; P = 0.06$

Grades of posture: bad, poor, fair, good and very good.

As the numbers in the “very good” grades were scanty, “very good” records were included with “good” in making the comparisons.

In estimating the values of P , n was taken as = 3.

The values of P for the boys clearly indicate that the distributions of grades of posture in the asthmatic and rheumatic groups do not differ from the normal nor from one another to a greater degree than might readily occur by chance. In the girls the grading of posture in the asthmatic and rheumatic groups cannot be said to differ from the normal, although the distribution in the rheumatic group diverges from the normal to such a degree as almost to attain the 1 in 20 level of significance. The distribution of grades of posture in the rheumatic girls must, however, be considered to differ significantly from that in the asthmatic group. Relatively more of the girls with rheumatism show a very bad posture and fewer a good posture than is found in the asthmatic group.

(5) *Bodily habitus.* After the observer had received some instruction in regard to the general features which serve to differentiate the four types of body build, hypersthenic, sthenic, hyposthenic and asthenic, described by Mills (1917), an attempt was made to classify the children under these headings from general inspection. Unfortunately many of the children had already been measured before the classification was begun, so that particulars of the bodily type or habitus are only available for a relatively small proportion of the normal children and of those with asthma. The number of rheumatic children in which the physical type was noted was quite inadequate for comparative purposes. The frequency distributions of the types of bodily habitus in the normal and asthmatic children were compared by the χ^2 method. The morphological type had been assessed in 52 girls with asthma and in 145 of the normal group. For the four categories χ^2 was 3.03 and $P = 0.39$. There was thus no evidence in these samples that the distribution of bodily types in the asthmatic girls differed from the normal. The grading of children into the four types presents some difficulty, however, and the grading in the present instance was probably not very satisfactory, as relatively more of the asthmatic girls were

considered to be of hypersthenic and hyposthenic types and fewer of the sthenic and asthenic types than occurred in the normal girls. As the hypersthenic type is really an exaggerated form of the sthenic and the hyposthenic, a less well-developed form of the asthenic, one might have expected that the asthenic and hyposthenic would have shown the same tendency to be in excess or defect in the asthmatic girls, and that the hypersthenic and sthenic would have shown a like but opposite tendency. Combining the numbers in the hypersthenic and sthenic categories and the hyposthenic and asthenic categories to obtain a binary classification, the proportions of children in these two classes in the asthmatic group are practically the same as in the normal children.

For comparison of the physical types in boys there were 100 records of boys with asthma and 141 records of normal boys available. So few boys were classified as hypersthenic that it was necessary to include these in the sthenic group. For the two groups of three categories χ^2 was 10.38, giving a P of 0.005. Such a value of P would suggest that the frequency distribution of types in the asthmatic boys is really different from the normal, the asthmatic boys having a relative excess of the asthenic and a relative defect of the sthenic (including hypersthenic) types. The hyposthenic type, which is closely related to the asthenic type, appears, however, to show a relative defect in the asthmatic group as compared with the normal. Assuming that, owing to difficulty in differentiating these two types, a more satisfactory subdivision of the whole series would be obtained by taking them together, thus making a binary classification of categories as in the girls, the percentages of the boys that fall into the respective classes, hyposthenic and asthenic together and sthenic and hypersthenic together in the asthmatic group, seem to show some divergence from the proportions in the corresponding classes in the normal group of boys, but with such relatively small samples as are available the difference observed is not of such a degree that it can be considered real.

(6) *Form of vertebral border of scapula.* In view of Graves's (1924) extensive observations on the character of the vertebral border of the scapula or shoulder blade and its relation to problems of morbidity and other conditions, it seemed to be of interest to ascertain if the frequency of the several types which he describes differed in their relative incidence in the three groups of children, the asthmatic, the rheumatic and the normal. The character is readily recognisable by the methods of inspection and palpation. Graves describes the vertebral border of the scapula below the root of the spine as variable in its formation; it ranges in different individuals from an extremely convex form through straight to extremely concave, but can be broadly classified into three types, convex, straight and concave, or convex, straight scaphoid and concave scaphoid. He states that, of many thousands of observations made on the living subject and on the skeleton in the age interval from birth to 10 years, 80 per cent. were of the scaphoid (straight and concave) type and only 20 per cent. of the convex type. Graves states also that the scapular types are common to all

human races and stocks, and that any particular scapular type may be found in any human type regardless of sex, health, disease, social level or environment. In his data he finds grounds for the inference that a larger number of the possessors of the scaphoid type than of the convex type are what he describes as the "peculiarly disease susceptible," and asserts that scapular classification brings the first morphological proof of the thesis that "as human beings are innately unequal physically, mentally, etc., hence they differ innately in capacity for health, disease, etc."

The records in the present investigation are obviously not comparable with the figures given by Graves, as the proportions amongst these ascribed to the convex and scaphoid types are definitely less and greater respectively than those noted by the American observer. The proportions deemed to be convex, straight and concave respectively should be comparable, however, in the different groups of children as the characters of the vertebral border therein were all assessed by one observer.

The frequency distributions of the three types in the different groups of boys and girls were compared by the χ^2 test and the results are shown in Table XXV. The values of P in this table seem to warrant the inference that

Table XXV. *Form of vertebral border of scapula.*

	<i>Asthma and rheumatism</i>	<i>Asthma and normal</i>	<i>Rheumatism and normal</i>
Boys	$\chi^2 = 3.95; P = 0.14$	$\chi^2 = 4.26; P = 0.12$	$\chi^2 = 5.68; P = 0.06$
Girls	$\chi^2 = 0.51; P = 0.77$	$\chi^2 = 8.21; P = 0.02$	$\chi^2 = 13.71; P = 0.001$

Types: Convex, straight and concave. $n = 2$.

the distributions of scapular types in boys with asthma and with rheumatism do not differ from the normal nor from one another to a degree that can be considered significant. The distributions in the asthmatic and rheumatic groups of girls are almost identical but both seem to differ from that found in normal girls. Both asthmatic and rheumatic girls seem to show a relative excess of the straight type and relative deficiencies in the concave and convex types as compared with the normal. If we combine the concave and straight types, as Graves does, to obtain the scaphoid type, the proportions that may be considered of scaphoid and of convex type in the asthmatic and rheumatic girls cannot be deemed to differ significantly from the proportions of the corresponding types in the normal girls. The total number assigned to the convex type in the present inquiry is so relatively small, however, that probably too much importance should not be attached to the inferences drawn from the figures.

SUMMARY AND CONCLUSIONS.

The present communication deals with an analysis and comparison of the principal physical measurements, physical characters and relative bodily proportions in groups of boys and girls at corresponding ages who were under treatment for asthma and rheumatism respectively in the special clinics established at the Sick Children's Hospital, Great Ormond Street, and of other

groups of boys and girls of similar ages with no history of asthma or rheumatism and no obvious serious impairment of general health who were attending the Outdoor Department of the hospital for treatment of trivial ailments. The last-mentioned series of boys and girls have been assumed to represent the normal hospital population and have been referred to throughout as the normal¹ groups. The object of the investigation was to determine if there was any real evidence that the asthmatic and rheumatic children differed from one another or from the normal children in general physical type or build. The inquiry has been restricted to children in the age period 6–12 years, and these have been taken in two-yearly age groups in order to provide more adequate numbers of observations for comparison. In all, the characters of approximately 1212 children have been dealt with. Of these, 368, 236 boys and 132 girls; 459, 189 boys and 270 girls; and 385, 195 boys and 190 girls, were considered to be asthmatic, rheumatic and normal respectively. A study of the frequency distributions, mean values and variabilities of the characters compared at the corresponding ages in the three groups of boys and girls seems to provide a reasonable basis for the following conclusions:

1. The corresponding averages of practically all the absolute physical measurements brought under review are in such close agreement in the contrasted groups of asthmatic and rheumatic children that the data provide no evidence of any real difference in the general dimensions of children with the respective diseases. Though the average antero-posterior diameter of the chest is probably greater in the asthmatic than the rheumatic children, no emphasis can be laid on this feature as it may be, in part, the result of the disease.

2. Though at some ages the mean dimensions of a few characters in the asthmatic and rheumatic groups do differ from the corresponding averages in the normal series, the differences are not sufficiently consistent at the different ages and in the two sexes to indicate any real divergence from the normal.

3. A comparison of the relative proportions of the body as expressed by the percentage ratios or indices, stem length/stature, body length/stature, biacromial diameter/body length, bicristal diameter/biacromial diameter and length of arm/length of leg, at corresponding ages in the asthmatic and rheumatic children does not provide any definite evidence that children suffering from these two diseases differ from one another in morphological type.

4. Though occasionally, at one or more ages, one or more of the indices used to express the relative proportions of the body may appear to differ in mean value from the normal averages at the corresponding ages the differences are not sufficiently consistent in regard to age and sex to suggest any real divergence from the normal.

5. Comparison of the frequency distributions of hair colour shows that the asthmatic children do not really differ from the rheumatic children in respect of pigmentation. The rheumatic children do not differ from the normal, but both the asthmatic boys and girls show a relatively greater excess of the blonde

¹ See footnote on p. 439.

haired type and a greater deficiency in the dark haired as compared with the normal than might be expected to occur as a chance variation.

6. With regard to distribution of eye colour, the asthmatic boys do not differ from the rheumatic boys, but the asthmatic girls appear to have a relative defect in brown eyes and a relative excess in blue eyes as compared with the rheumatic group; neither in boys nor girls with asthma or rheumatism can the distribution of eye colour be said to differ significantly from the normal on the data available.

7. There is no definite evidence that the proportions of relatively long and slender and short and thick-set types, as appraised by general inspection, amongst asthmatics differ from the normal.

8. There is no evidence in the data for boys or girls that the distribution of grades of posture differs significantly in either the asthmatic or rheumatic groups from the normal, though in girls with rheumatism the habitual posture appears to be relatively worse than in those with asthma.

9. Both in regard to form of face, as expressed by the upper and total facial indices, and form of head, as represented by the cephalic index, the groups of asthmatic and rheumatic children do not differ significantly from one another or from the normal.

10. The differences in the three groups of children, the asthmatic, the rheumatic and the normal, in respect of the aggregate of physical characters brought under review are relatively so slight that they cannot be considered to support the view that asthmatic and rheumatic children really differ on the average from one another or from the general population of children from which they are drawn in bodily conformation or physical type, though they may possibly, indeed probably, differ in other constitutional traits.

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