BODY BUILD IN INFANTS

I. THE TECHNIQUE OF MEASURING THE EXTERNAL DIMENSIONS OF THE BODY IN INFANTS

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ABSTRACT OF PAPERS I, II AND III

In these three papers the body build of infants during health and disease is described quantitatively. This is done by comparison of ratios of various external dimensions to the total body length. In the first paper the technique for measuring the external dimensions of the body in infants is described and various sources of error discussed.

In the second paper general empirical formulae for the relationship between various external dimensions and total body length in healthy infants are developed. By comparing two groups of infants from different social environments, it is shown that environment may influence body build.

In the third paper the results obtained in the second paper for healthy infants are used for comparison with sick infants. Various differences in the body build of infants with acute intestinal intoxication, tetany and eczema are described.

This study was designed as an investigation of the relationship between constitution and disease in infants. By constitution, as referred to living things, we mean the sum total of structural and functional properties which result from the reaction of the genetic make-up to its environment. This definition is similar to that of Draper (1) and differs from that of J. Bauer (2) who looks upon constitution as the sum of the characteristics and attributes, transmitted through the germ plasm, and already present at the moment of conception.

Draper defines human constitution as "that aggregate of hereditarial characters, influenced more or less by environment, which determines the individual's reaction, successful or unsuccessful, to the stress of environment."

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Bauer defines constitution as "aus der Summe der durch das Keimplasma übertragenen, also schon im Momente der Befruchtung anlagemässig gegebenen Merkmale und Eigenschaften." "Den gesamten Komplex von Erbanlagen, der die Zugehörigkeit des werdenden Individuums zu seiner Spezies, Rasse und Familie sowie zu seinem Sexus bestimmt, und bei der ungeheuren Mannigfaltigkeit und praktisch absoluten Originalität der Erbanlagenmischung den Grundstock der persönlichen Individualität ausmacht, bezeichnen wir als Konstitution."

The difficulty of dissociating heredity from the environment, as implied in the definition by Bauer, is evident from numerous experiments. Morgan (3) studied a mutant race of Drosophila called vestigial, because only vestiges of the wings are present. When the larvae were bred at the proper temperature, the vestigial forms appeared regularly. When, however, the larvae were bred at a temperature of about 31°C., the rudimentary wings were much longer and in many instances as long as the wings of the wild type. E. Baur (4) was able to produce different colored primroses by varying the temperature at which the plants were grown. When red primrose (Primula Sinensis Rubra), which ordinarily, at a temperature of 15 to 20°C., produces red flowers, is transplanted to a hothouse at a temperature of 30 to 35°C., the flowers which appear are white. When the plants are returned to a cooler place, they again produce red flowers. Similarly, Dorfmeister (5) in 1879 was able to produce butterflies with different colored wings by varying the temperature at which the larvae were grown. These experiments show clearly how environmental factors may influence the somatic expression of the hereditary material.

For convenience of study, constitution has been divided into various constitutents, such as sex, race, body build, skin color, etc. In a recent paper the influence of the sex factor in infant mortality was discussed (6). That race is a factor in the greater prevalence of tetany among Negro infants was shown in studies on dosage of ultraviolet radiant energy (7).

This study is concerned with the relationship between body build and disease in infants. By body build we mean the external form of the body as it is determined by the skeletal and cartilaginous parts. The present paper is devoted to a description of the technique used in this study.

The instruments employed were the anthropometer described by Martin, the small sliding compass (Gleitzirkel), the small spreading calipers (Tasterzirkel), a steel tape and a measuring board similar to that described by Schultz (8).

All instruments were calibrated to 1 mm. and all measurements were made to 1 mm. All unilateral measurements were made on the right side. In general, the dimensions measured and the technique employed were those described by Hrdlicka (9).

DESCRIPTION OF MEASUREMENTS

1. Total body length. From the vertex to the sole with the foot at right angles to the body, taken parallel to the long axis of the body. The measuring board was found to be more accurate than the anthropometer for this measurement and the anthropometer was therefore discarded in the later work.

2. Body weight. Measured in the usual way.

3. Sitting height. From the vertex to the most caudal point over the ischial tuberosities, parallel to the long axis of the body.

4. Circumference of head (occipitofrontal). The largest circumference of the head.

5. Cephalic length. From the most prominent part of the occiput to the glabella in the mid-sagittal plane.

6. Cephalic breadth (biparietal diameter). The greatest width of the head between the parietal eminences, perpendicular to the mid-sagittal plane.

7. Diameter of face (bimalar). The horizontal distance between the 2 malar prominences.

8. Bigonial diameter. The horizontal distance between the most distant points of the angles of the jaw, perpendicular to the mid-sagittal plane.

9. Upper facial length. From the nasion to the prosthion in the midsagittal plane.

10. Height of lower jaw. From the infradentale to the menton in the mid-sagittal plane.

11. Height of nose. From the nasion to the nasal septum where it joins the upper lip.

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12. Breadth of nose. The greatest breadth between the nasal wings without exerting pressure. Care should be taken that the child is quiet when this measurement is being taken.

13. Inter-inner canthus breadth. The horizontal distance between the inner angles of the eyes.

14. Length of palpebral fissure. From the internal to the external angle of the eye.

15. Length of ear (maximum). From the highest point on the border of the helix to the lowermost point on the lobule, perpendicular to the long axis of the ear.

16. Breadth of ear. Distance between 2 lines, parallel to the long axis of the ear, one of these lines being tangent to the anterior, the other to the posterior border of the helix.

17. Circumference of the thorax at nipples. Taken half way between inspiration and expiration. The respiratory excursion of the chest of a quiet infant is small.

18. Biacromial diameter. Straight distance between the most lateral points of the acromial eminences, taken from behind with the child seated, the arms close to the thorax.

19. Bicristal diameter. Straight distance between the most lateral points of the iliac crests, perpendicular to the mid-sagittal plane.

20. Length of humerus. From the most lateral point of the acromial eminence to the most proximal point on the lateral side of the capitulum of the radius in a plane parallel to the long axis of the humerus. This measurement was made with the arm close to the thorax and the forearm extended.

21. Length of radius. From the most proximal point on the lateral side of the capitulum of the radius to the tip of the styloid process of the radius, parallel to the long axis of the radius.

22. Length of hand. From the tip of the styloid process of the radius to the tip of the middle finger taken in a plane parallel to the long axis of the forearm.

23. Length of palm. From the tip of the styloid process of the radius to the fold between the middle finger and the palm, in a plane parallel to the long axis of the forearm.

24. Breadth of palm. With the palm facing forward, from the most lateral point overlying the capitulum of the 2nd metacarpal bone, to

the most medial point overlying the capitulum of the 5th metacarpal bone in a line perpendicular to the long axis of the palm.

25. Length of middle finger. From the metacarpophalangeal joint of the middle finger to the tip.

26. Length of thigh. From the antero-superior spine of the ilium to the lower margin of the internal condyle of the femur in a plane parallel to the long axis of the body.

27. Length of tibia. From the lower margin of the internal condyle of the femur to the tip of the internal malleolus of the tibia with the leg extended at the knee.

28. Height of foot. This was obtained by subtracting from the kneesole measurement the length of tibia. Knee-sole was measured from the lower margin of the internal condyle of the femur to the sole, with the foot at right angles to the leg, in a plane parallel to the long axis of the leg.

29. Length of foot. From the point on the heel over the tuber calcanei which projects furthest back to the tip of the great toe with the foot held at right angles to the leg, in a line parallel to the internal margin of the foot.

30. Breadth of foot. From the most lateral point overlying the capitulum of the fifth metatarsal bone to the most medial point overlying the capitulum of the first metatarsal bone, in a line perpendicular to the long axis of the foot.

SOURCES OF ERROR IN MAKING MEASUREMENTS

1. Experimental errors

Experimental errors in measuring were computed in the following manner: A series of ten measurements of the dimension in question was made on each of a group of infants. The scale on the instrument used was concealed from the anthropometrist by a slip of paper and readings were made and recorded by a second person. The average for each series was calculated, and deviations from the average recorded. All the deviations on all the infants were then grouped and the standard deviations computed. The errors worked out in this manner for the various dimensions are shown in table 1.

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2. Errors due to thickness of subcutaneous tissues

Since all measurements, excepting breadth of nose, length of ear, and the eye measurements, were taken from bony or cartilaginous points, errors due to nutritional status were minimal. Todd (10) found no change in the biiliac diameter of a group of adult cadavers following the injection of formalin. Further measurements, after all the soft tissues had been removed, showed a diminution of 4.7 and 2.8 mm. for male white and male negro cadavers, respectively. These differences amount to less than 2 per cent. The changes reported in our series are well outside of this error.

TABLE 1								
Experimental	errors	in	making	measurements				

Dimension		Number of measure- ments	Average	Standard deviation	Coeffi- cient of variation
			mm.	mm.	per cent
Total body length	14	123	598	2.2	0.4
Sitting height	18	162	449	2.3	0.5
Diameter of face (bimalar)	11	110	86.1	1.03	1.2
Bicristal diameter	14	136	102.0	1.35	1.3
Biacromial diameter	20	206	147.0	1.46	1.0
Circumference of thorax at nipples	13	126	379.7	2.43	0.6

3. Variations in muscle tone

Since the measurement of total body length is made by placing the child on the measuring board and stretching him as much as possible, it is conceivable that infants with good muscle tone might be more difficult to stretch to their full body length and so would appear shorter than infants with poor muscle tone. Such variations might well be selective, healthy infants having better muscle tone and consequently appearing shorter than sick infants or those poorly nourished. This source of error was investigated in the following way: Since differences in muscle tone are manifested principally by the degree of flexion at the knee, the difference between the total length of the lower extremity as measured from the anterior superior iliac spine to the sole and as computed from the sum of the thigh length and the tibia sole length was determined in each of a number of infants. Groups of infants were then compared as to the source of material, sex, and the presence of illness. The results are shown in table 2.

The percentage reduction in total body length varies from 0.7 to 0.9 per cent. It does not vary significantly for the different groups of babies.

Material .	Number of patients	Average total body length	Average dif- ference lower extremity (calculated minus observed)	Percentage reduction in total body length due to flexion at knee	
		mm.	<i>mm</i> .		
Healthy infants, Fifth Avenue Hospital	52	633	5.7	0.9	
Healthy infants, Bellevue Hospital	46	603	4.3	0.7	
Newborns, male	108	505	4.4	• 0.9	
Newborns, female	51	499	4.7	0.9	
Infants with acute intestinal intoxication	21	567	4.2	0.7	

 TABLE 2

 Reduction in total body length due to flexion at the knee

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