MEASUREMENTS AND INDICES

As mentioned in the introductory paragraph, the scope of the measurements embraced in the present study is somewhat more comprehensive than that required of an ordinary racial anthropometric survey. The number of characters measured may appear to be unnecessarily large. Aside however from the author's desire to provide for himself and others as comprehensive as possible a baseline for subsequent detailed comparisons of other relevant material, the deliberate decision to err if necessary on the side of excess rather than paucity of characters measured was made in the light of a certain amount of biometric experience of the sort implied in the following statement of Morant:

"The physical characters which can be most profitably used for the purpose of investigating racial identity or divergence are determined primarily from experience of data collected for them . . . . Their choice becomes modified as our knowledge extends . . . . Experience has shown repeatedly that no single character, or group of a small number of characters, is capable of providing any solution of this problem which can be considered at all reasonable and the fact that such limited evidence is likely to mislead entirely can easily be demonstrated. If a number of characters known to be of racial significance are used in the comparison of samples drawn from two widely divergent racial populations—a Western European and an Oriental, say—then it will usually be found that several, if not the majority, of the chosen characters will fail to distinguish the two samples and the evidence for dissimilarity will depend entirely on the few remaining. But if these few had been omitted it might have been concluded that the two samples represented the same race, which would be a highly unreasonable result. The same will be found in a similar comparison of another pair of samples drawn from any other two widely divergent populations, but the incidence of distinguishing and non-distinguishing characters will be different. The inter-racial correlations between the characters believed to be of greatest racial significance are usually not high, and pairs of such characters may be found which are quite uncorrelated interracially. This observed state of affairs emphasizes the essential need, which is often not appreciated, for basing racial classification on the evidence provided by a considerable number of characters. It is usually found that the results become more reasonable according as the number of characters, considered in conjunction, on which they are based is increased."†

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*Stevenson, P. H., Collected Anthropometric Data on the Chinese. China Medical Journal, Vol. 39, No. 10, 1925.

†Morant, G. M., A Biometricians View of Race in Man, Man, 1934, 126.

The measurements utilized in the present study are listed below. These are divided into two categories: absolute measurements and relative measurements, the latter consisting chiefly of various indices. Of the sixty-six absolute measurements, fifty are direct measurements while fifteen are derived indirectly through additions or subtractions. Including duplications where the same measurement may apply to more than one of the major body divisions, thirty-three of the absolute measurements refer to general body size and related characteristics, twelve to the head and face regions, seventeen to the trunk including the neck, and sixteen to the extremities.

The list of relative measurements has been extended to embrace a rather detailed analysis of a large number of different regional body proportions. In addition to the usual anthropometric indices, such as the cephalic, nasal, sitting-height and other common indices, the relative proportions of practically all the recognized body segments—using the term segment to refer to regional body divisions—are expressed in terms of percentage ratios of (i) total body length, the resulting indices being termed *segmental indices or percentages of total body size* (cf. B:I in the following list, and table 8); (ii) the chief linear measurement of the particular major body division to which the respective segment belongs, the resulting indices being called *intrasegmental indices* (cf. B:II of the list, and tables 9, 10, and 11); and (iii) homologous segments of other major body divisions, the resulting indices being termed *intersegmental indices* (cf. B:III of the list, and table 12). Finally, certain of the more common *constitutional indices* have been included (cf. B:IV of the list, and table 13).

In the list that follows, the serial numbers assigned to the respective measurements are those which will be cited in brackets for identification whenever these measurements are referred to in the subsequent text or tables. Immediately following the names of the measurements are two parenthetical notations. ' The first refers to the measurement in question in the lists of the International Agreement and in Martin's Lehrbuch (*v. infra*) respectively. The second gives the number of the subsequent table wherein the statistical constants for the measurement in question are tabulated. If the measurement happens to be one of only auxilliary importance this fact is noted. The statistical constants for such auxilliary measurements have not been calculated and hence are not tabulated. In order to avoid confusion all

notations referring to absolute measurements are printed in roman (plain) type while those referring to relative measurements, namely the indices, are printed in italics.

LIST OF MEASUREMENTS AND INDICES

A. ABSOLUTE MEASUREMENTS

I. Primary Measurements Relating to General Body Size and Proportions

a) *Heights:*

1. Stature (I. 1; M. 1) (Table 3)
2. Porion (I. 2; M. 2b) (Aux.)
3. Suprasternale (I. 4; M. 4) (Table 3)
4. Thelion (I. 5; M. 7) (Aux.)
5. Omphalion (I. 6; M. 5) (Table 3)
6. Symphysion (I. 7; M. 6) (Table 3)
7. Iliospinale (I. 13; M. 13) (Table 3)
8. Trochanterion (I. 12; M. 14) (Table 3)
9. Tibiale (I. 17; M. 15) (Aux.)
10. Sphyrion (I. 18; M. 16) (Aux.)
11. Acromion (I. 11; M. 8) (Table 3)
12. Radiale (I. 14; M. 9) (Aux.)
13. Stylion (I. 15; M. 10) (Aux.)
14. Dactylion (I. 16; M. 11) (Aux.)

b) *Diameters:*

15. Span (I. 19; M. 17) (Table 3)
16. Biacromial (I. 20; M. 35) (Tablees 3, 5)
17. Bimammillary (I. 22; M. 38) (Table 5)
18. Intercristal (I. 23; M. 40) (Tables 3, 5)
19. Interspinale (I. 24; M. 41) (Table 5)
20. Bitrochanteric (I. 25; M. 42) (Table 3)
21. Transverse Thoracic (I. 27; M. 36a) (Tables 3, 5)
22. Antero-posterior Thoracic (I. 29; M. 37a) (Tables 3, 5)

c) *Circumferences:*

23. Neck (I. 37; M. 63) (Table 5)
24. Thoracic (I. 36; M. 61) (Tables 3, 5)
25. Abdominal (I. 46; M. 62) (Tables 3, 5)
26. Upper Arm (Mid.) (I. 38. M. 65) (Table 6)
27. Forearm (Max.) (I. 40; M. 66) (Table 6)
28. Thigh (Max.) (I. 42; M. 68) (Table 6)
29. Leg (Max) (I. 44; M. 69) (Table 6)

d) *Miscellaneous:*

30. Dynamometer, right hand (Table 7)
31. Dynamometer, left hand (Table 7)
32. Vital capacity (Tables 3, 7)
33. Weight (Tables 3, 7)

II. Measurements Relating to Major Body Divisions

a) *Head:*

34. Head length (I. 1; M. 1) (Table 4)
35. Head breadth (I. 2; M. 3) (Table 4)
36. Head height (I. 3; M. 15) (Table 4)

b) *Face:*

37. Physiognomic length (I. 8; M. 17) (Table 4)
38. Morphological length (I. 9; M. 18) (Table 4)
39. Frontal minimum diameter (I. 4; M. 4) (Table 4)
40. Bizygomatic breadth (I. 6; M. 6) (Table 4)
41. Bigonial breadth (I. 7; M. 8) (Table 4)
42. Nose length (I. 12; M. 21) (Table 4)
43. Nose breadth (I. 13; M. 13) (Table 4)
44. Ear length (I. 19a; M. 29) (Table 4)
45. Ear breadth (I. 19c; M. 30) (Table 4)

c) *Trunk and Neck:*

46. Sitting height (Stem length) (I. 9; M. 23) (Tables 3, 5)
47. Neck length ([2] – [3]) (M. 29, 3) (Table 5)

48. Head and neck length ([36] + [47]) (Table 5)
49. Physiological trunk length ([46] – [48]) (Table 5)
50. Ventral trunk wall ([3] – [6]) (M. 27) (Table 5)
51. Upper anterior segment ([3] – [4]) (M. 33) (Table 5)
52. Middle anterior segment ([4] – [5]) (Table 5)
53. Lower anterior segment ([5] – [6]) (M.32) (Table 5)

Also: Diameters [16], [17], [18], [19], [21] and [22]
Circumferences: [23], [24] and [25]

d) *Extremities:*

54. Upper arm ([11] – [12]) (M. 47a) (Table 6)
55. Forearm ([12] – [13]) (M. 48a) (Table 6)
56. Arm without hand ([11] – [13]) (M. 46a) (Table 6)
57. Hand length (M. 50) (Table 6)
58. Hand breadth (M. 52) (Table 6)
59. Total arm length ([11] – [14]) (M. 45a) (Table 6)
60. Thigh ([7] – [9] – 7%) (M. 55) (Table 6)
61. Lower leg ([9] – [10]) (M. 56) (Table 6)
62. Leg without foot ([60] + [61]) (Table 6)
63. Foot length (M. 58) (Table 6)
64. Foot breadth (M. 59) (Table 6)
65. Total leg length ([62] + [10]) (Table 6)
66. Residual leg length ([1] – [46]) (Table 6)

Also: Circumferences [26], [27], [28] and [29]

B. INDICES

I. Segmental Percentages of Total Body Size: $\frac{\text{Body Segment} \times 100}{\text{Stature}}$ (Table 8).

a) Heights and lengths:

101. Sitting height $\frac{[46] \times 100}{[1]}$

102. Suprasternal height $\frac{[3] \times 100}{[1]}$

103. *Umbilical height* $\frac{[5] \times 100}{[1]}$

104. *Symphysial height* $\frac{[6] \times 100}{[1]}$

105. *Head length* $\frac{[34] \times 100}{[1]}$

106. *Head height* $\frac{[36] \times 100}{[1]}$

107. *Neck length* $\frac{[47] \times 100}{[1]}$

108. *Head and neck length* $\frac{[48] \times 100}{[1]}$

109. *Physiognomic facial length* $\frac{[37] \times 100}{[1]}$

110. *Morphological facial length* $\frac{[38] \times 100}{[1]}$

111. *Nose length* $\frac{[42] \times 100}{[1]}$

112. *Ear length* $\frac{[44] \times 100}{[1]}$

113. *Physiological trunk length* $\frac{[49] \times 100}{[1]}$

114. *Anterior trunk wall length* $\frac{[50] \times 100}{[1]}$

115. *Upper arm length* $\frac{[54] \times 100}{[1]}$

116. *Forearm length* $\frac{[55] \times 100}{[1]}$

117. *Hand length* $\frac{[57] \times 100}{[1]}$

118. *Total arm length* $\frac{[59] \times 100}{[1]}$

119. *Thigh length* $\frac{[60] \times 100}{[1]}$

120. *Lower leg length* $\frac{[61] \times 100}{[1]}$

121. *Foot length* $\frac{[63] \times 100}{[1]}$

122. *Total leg length* $\frac{[65] \times 100}{[1]}$

b) Diameters and breadths:

123. *Span* $\frac{[15] \times 100}{[1]}$

124. *Head breadth* $\frac{[35] \times 100}{[1]}$

125. *Bizygometic breadth* $\frac{[40] \times 100}{[1]}$

126. *Biacromial diameter* $\frac{[16] \times 100}{[1]}$

127. *Intercristal diameter* $\frac{[18] \times 100}{[1]}$

128. *Bitrochanteric diameter* $\frac{[20] \times 100}{[1]}$

129. *Transverse thoracic diameter* $\frac{[21] \times 100}{[1]}$

130. *Antero-posterior thoracic diameter* $\frac{[22] \times 100}{[1]}$

131. *Thoracic circumference* $\frac{[24] \times 100}{[1]}$

132. *Hand breadth* $\frac{[58] \times 100}{[1]}$

133. *Foot breadth* $\frac{[64] \times 100}{[1]}$

II. Intrasegmental Indices

a) Head and face: (Table 9)

134. *Cephalic index* $\frac{[35] \times 100}{[34]}$

135. *Head height-head length index* $\frac{[36] \times 100}{[34]}$

136. *Head height-head breadth index* $\frac{[36] \times 100}{[35]}$

137. *Cephalic module* $\frac{[34] + [35] + [36]}{[3]}$

138. *Fronto-parietal* $\frac{[39] \times 100}{[35]}$

139. *Physiognomic facial index* $\frac{[40] \times 100}{[37]}$

140. *Morphologic facial index* $\frac{[38] \times 100}{[40]}$

141. *Fronto-bizygomatic index* $\frac{[39] \times 100}{[40]}$

142. *Bigonio-bizygomatic index* $\frac{[41] \times 100}{[40]}$

143. *Bigonio-frontal index* $\frac{[41] \times 100}{[39]}$

144. *Nasal index* $\frac{[43] \times 100}{[42]}$

145. *Ear index* $\frac{[45] \times 100}{[44]}$

b) Trunk: (Table 10)

101. *Stem (sitting height)-Stature index* $\frac{[46] \times 100}{[1]}$

146. *Head height-stem length index* $\frac{[36] \times 100}{[46]}$

147. *Neck length-stem length index* $\frac{[47] \times 100}{[46]}$

148. *Head and neck length-stem length index* $\frac{[48] \times 100}{[46]}$

149. *Physiological trunk length-stem length index* $\frac{[49] \times 100}{[46]}$

150. *Ventral trunk wall-stem length index* $\frac{[50] \times 100}{[46]}$

151. *Chest depth-chest breadth index* $\frac{[22] \times 100}{[21]}$

152. *Biacromial diameter-physiological trunk length index* $\frac{[16] \times 100}{[49]}$

153. *Intercristal diameter-physiological trunk length index* $\frac{[18] \times 100}{[49]}$

154. *Bitrochanteric diameter-physiological trunk length index* $\frac{[20] \times 100}{[49]}$

155. *Transverse thoracic diameter-physiological trunk length index* $\frac{[21] \times 100}{[49]}$

156. *Antero-posterior thoracic diameter-physiological trunk length index* $\frac{[22] \times 100}{[49]}$

157. *Thoracic circumference-physiological trunk length index* $\frac{[24] \times 100}{[49]}$

158. *Intercristal diameter-biacromial diameter index* $\frac{[18] \times 100}{[16]}$

159. *Bitrochanteric diameter-biacromial diameter index* $\frac{[20] \times 100}{[16]}$

160. *Interspinal distance-intercristal diameter index* $\frac{[19] \times 100}{[18]}$

161. *Bitrochanteric diameter-intercristal diameter index* $\frac{[20] \times 100}{[18]}$

162. *Neck circumference-chest circumference index* $\frac{[23] \times 100}{[24]}$

163. *Abdominal circumference-chest circumference index* $\frac{[25] \times 100}{[24]}$

c) Extremities: (Table 11)

164. *Upper arm-total arm index* $\frac{[54] \times 100}{[59]}$

165. *Forearm-total arm index* $\frac{[54] \times 100}{[59]}$

166. *Hand length-total arm index* $\frac{[57] \times 100}{[59]}$

167. *Forearm-upper arm index* $\frac{[55] \times 100}{[54]}$

168. *Hand breadth-hand length index* $\frac{[58] \times 100}{[57]}$

169. *Forearm circumference-upper arm circumference index* $\frac{[27] \times 100}{[26]}$

170. *Thigh-total leg index* $\frac{[60] \times 100}{[65]}$

171. *Lower leg-total leg index* $\frac{[61] \times 100}{[65]}$

172. *Foot length-total leg index* $\frac{[63] \times 100}{[65]}$

173. *Lower leg-thigh leg index* $\frac{[61] \times 100}{[60]}$

174. *Foot breadth-foot length index* $\frac{[64] \times 100}{[63]}$

175. *Leg circumference-thigh circumference index* $\frac{[29] \times 100}{[28]}$

III. Intersegmental Indices (Table 12)

176. *Total arm length-total leg length index* $\frac{[59] \times 100}{[65]}$

177. *Upper arm-thigh index* $\frac{[54] \times 100}{[60]}$

178. *Forearm-lower leg index* $\frac{[55] \times 100}{[61]}$

179. *Hand length-foot length index* $\frac{[57] \times 100}{[63]}$

180. *Total arm length-physiological trunk length index* $\frac{[59] \times 100}{[49]}$

181. *Total leg length-physiological trunk length index* $\frac{*[65] \times 100}{[49]}$

182. *Residual leg length-stem lnegth* $\frac{[66] \times 100}{[46]}$

183. *Upper arm circumference-thigh circumference index* $\frac{[26] \times 100}{[28]}$

184. *Forearm circumference-lower leg circumference index* $\frac{[27] \times 100}{[29]}$

IV. Constitutional Indices (Table 13)

185. *Height: weight index (simple)* $\frac{[33] \times 1000}{[1]}$

186. *Height: weight index (Davenport)* $\frac{[33] \times 1000}{[1]^2}$

187. *Height: weight index (Bardeen)* $\frac{[33] \times 100}{[1]^3}$

188. *Ponderal index (Livi)* $\frac{\sqrt[3]{[33]} \times 100}{[1]}$

189. *Pelidisi index (Pignet)* $\frac{\sqrt[3]{[33]} \times 10}{[46]}$

190. *Pignet's factor* $[1] - ([24] + [33])$

With a few necessary exceptions where no such agreement exists all the measurements were made to conform to the *International Agreement for the Unification of Anthropometric Measurements to be Made of the Living Subject* (Geneva, 1912). In matters of detail regarding definitions of landmarks and essential

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* Skelic index of Manouvrier

technique Martin (*Lehrbuch der Anthropologie*, 1928; Bd.1) has been followed, except in the case of head-height, where Hrdlicka's method (*Anthropometry*, 1920) was adopted. Standard anthropometric instruments (Herman, Zurich), with Hrdlicka's model of the spreading compass for most of the head measurements, have been employed throughout. In all cases the subjects were measured completely nude. Linear measurements of the major body segments are to be considered as projected measurements on the anthropometer with the subject in the erect position; the diameters and circumferences are direct measurements between the points concerned.

STATISTICAL ANALYSIS OF THE DATA

In the statistical treatment of the data the possible desirability of subsequent analytical comparisons other than merely those of averages and standard deviations has been kept in mind. The peculiarities of a population with respect to the attributes of its component individuals cannot adequately be appraised statistically without a knowledge of at least four of the parameters of the frequency distributions involved. This means, in terms of the method of moments of Pearson, the calculation of the first four moments of each frequency distribution. These yield respectively the *mean*, the *standard deviation*, $\beta 1$ and $\beta 2$. The first and second of these statistical constants are familiar to most readers, being the usual quantitative expressions of the average size and of the normal variability of a character respectively. From the latter, the standard deviation, are derived the probable errors of the various constants. In order to provide a *relative* measure of variability, thus ruling out the influence of the differences in the units of absolute measurement, the coefficient of variation (V) is also calculated; this being merely the percentage ratio of the standard deviation to the mean.

The last two of the constants mentioned above, $\beta 1$ and $\beta 2$, are derived respectively from the additional calculations of the third and fourth moments of the frequency distribution, and provide the bases of measures of *skewness* or asymmetry of the distribution on the one hand, and of a factor known as *kurtosis* or relative peakedness or flatness of the frequency curve at the mid-point on the other. Although these last two constants have not as yet been calculated for many human populations, nevertheless they are as essential to a complete description of human groups as they are for other biologic groups. The direction of skewness is determined by the sign of the third moment ($\mu 3$) which is tabled immediately after the value of $\beta 1$.