

## Physique and Athletic Ability

By

H. CULLUMBINE

(*Department of Physiology and Pharmacology, University of Ceylon, Colombo*).

As a result of a survey of the physical fitness of the people of Ceylon, certain relationships between anthropometric characters and the capacity for various types of muscular effort have been suggested (Cullumbine, 1949 a and b). The validity of these relationships was supported by noting the parallel changes in capacity for exercise and the related anthropometric characters which occurred with variations in race, environment (wet and dry zones) and economic status. The relationships suggested the type of physique necessary to run with speed, to perform efficiently rapid, severe effort to exhaustion or moderate muscular effort to exhaustion, and for the possession of strength. The efficient performance of some of these varying types of muscular effort is abnormally developed in athletes and, if the suggested anthropometric—exercise ability relationships are true, then the various types of athlete should have certain definite anthropometric characters. Casual observation at athletic meets suggests that this is so and measurement made upon athletes gives more detailed support (Karpovich, 1947). These measurements have been made upon athletes living and performing in temperate climates; our relationships were deduced from observations made upon people living in tropical Ceylon. It seemed necessary, therefore, to see whether these anthropometric—exercise relationships also applied to athletes in Ceylon.

### Methods

The following groups of athletes were examined :—

- (a) Competitors at the Ceylon Public Schools Athletic Meet (1949). The senior boys (aged 18 years) were examined and they had all qualified for the meet by winning at their Divisional or Provincial Schools Meets. They represented, therefore, the best of the boy athletes in Ceylon.
- (b) Competitors at the Ceylon A.A.A. Championships (1948), and whose ages ranged between 21-30 years inclusively.

The following measurements were made for each subject :—height, weight, surface area (Du Bois), Chest circumference (rest), chest breadth, chest depth, chest length, bi-acromial diameter, bi-iliac diameter, leg length and bi-zygomatic diameter. From these measurements, the following indices have been calculated :—weight/height, leg length/height, bi-acromial/height, bi-iliac/height, chest circumference/height, bi-iliac/bi-acromial, chest depth/chest breadth, chest length/sitting height, chest breadth/sitting height.

The maximum circumferences of the arm, forearm, thigh, and calf in extension and the thickness of the skin and subcutaneous tissues at these sites have also been

measured and, from these measurements, the arm and leg muscle developments (Cullumbine, 1949c) have been calculated for each subject. In addition the resting systolic blood pressure and the resting pulse rate of each subject have been recorded.

### Results

We have previously distinguished five basic aspects of dynamic physical fitness, *viz.*, speed, strength, the ability to sustain moderate exercise for a short period, the ability sustain moderate exercise to exhaustion, and the ability to perform rapid and severe exercise until fatigued (Cullumbine, 1949a). The property of speed is, of course, highly developed in sprinters and, since we have concluded that the ability to run with speed is correlated positively with weight, surface area, chest circumference, chest breadth, bi-acromial diameter, bi-iliac diameter, bi-zygomatic diameter, leg length, weight/height, chest circumference/height, the resting systolic blood pressure and leg muscle development (Cullumbine, 1949a), we should expect these related anthropometric and physiological characters to be greater in sprinters than in "average" members of the population. To test this hypothesis we have compared the mean values of these characters for the group of schoolboy sprinters (aged 18 years) and for the adult sprinters (aged 21 to 30 years) with the mean figures obtained from groups of male subjects aged 18 years and 21 to 30 years respectively during the physical fitness survey of the population of Ceylon (Cullumbine, 1949d). The detailed figures are given in the Appendix and the comparison of the means, by Student's "t" test, shows that, as predicted, the 18 year-old sprinters have greater means of weight ( $P = < 0.001$ ), surface area ( $P = < 0.001$ ), chest circumference ( $P = 0.001$ ), chest breadth ( $P = 0.001$ ), bi-acromial diameter ( $P = < 0.001$ ), bi-zygomatic diameter ( $P = < 0.001$ ), weight/height index ( $P = 0.01$ ), chest circumference/height index ( $P = 0.05$ ), resting systolic blood pressure ( $P = < 0.001$ ), and leg development ( $P = 0.01$ ) than have the sample of subjects from the general population. The mean leg length and the mean bi-iliac diameter, although greater for the sprinters, do not differ significantly (at a level of significance of  $P = 0.05$ ) from the means possessed by the general population sample. Otherwise the predicted differences are well demonstrated.

More or less similar differences are discovered when the older age group (21 to 30 years) of sprinters is compared with the sample from the general population. Thus, these sprinters have significantly greater means of weight ( $P = < 0.001$ ), surface area ( $P = < 0.001$ ), chest breadth ( $P = 0.05$ ), bi-acromial diameter ( $P = 0.001$ ), bi-zygomatic diameter ( $P = 0.02$ ), leg length ( $P = 0.001$ ), weight/height index ( $P = 0.001$ ), resting systolic blood pressure ( $P = 0.001$ ), and leg development ( $P = 0.02$ ). There were not significant differences between the means of chest circumference, of bi-iliac diameter and of chest circumference/height index for the two samples.

In general, however, the noted differences between the physical and physiological characteristics of sprinters and the population in general agree with the correlations noted during the physical fitness survey.

Strength gives similar correlations with anthropometric and physiological characters to those presented by speed and strength is one of the main properties possessed by put-shot performers at athletic meets. We should expect this type of athlete, therefore, to present somewhat similar differences from the general population to those already noted for the sprinters.

Among our 18 year-old athletes, the shot-putters had greater means of weight ( $P = < 0.001$ ), surface area ( $P = < 0.001$ ), chest circumference ( $P = < 0.001$ ), chest breadth ( $P = < 0.001$ ), leg length ( $P = < 0.001$ ), bi-iliac diameter ( $P = 0.05$ ), bi-acromial diameter ( $P = 0.05$ ), bi-zygomatic diameter ( $P = < 0.001$ ), weight/height index ( $P = < 0.001$ ), resting systolic blood pressure ( $P = 0.02$ ), and arm muscle development ( $P = 0.05$ ) than had the sample group of 18 year-old males from the general population. The chest circumference/height index, although expected to be so, was not greater.

Almost similar differences were noted between the older shot-putters, aged 21-30 years, and the corresponding control sample. Here, the athletes presented greater means of weight ( $P = < 0.001$ ), surface area ( $P = < 0.001$ ), chest circumference ( $P = 0.01$ ), chest breadth ( $P = 0.01$ ), leg length ( $P = < 0.001$ ), bi-acromial diameter ( $P = 0.01$ ), bi-iliac diameter ( $P = 0.01$ ), bi-zygomatic diameter ( $P = 0.05$ ), weight/height index ( $P = < 0.001$ ), arm muscle development ( $P = 0.01$ ) and resting systolic blood pressure ( $P = 0.01$ ). The chest circumference/height index did not differ between the two groups.

Therefore, the noted differences conform to the predictions, except in the case of the chest circumference/height index.

That property of physical fitness, the ability to sustain rapid, severe muscular effort to fatigue is probably best developed among athletes in the group of the middle distance runners (e.g. half-mile and one mile runners) though, here, other factors may also be important. We have previously noted (Cullumbine, 1949a), that the ability to sustain rapid, severe muscular effort is significantly but negatively correlated with the bi-iliac diameter, the bi-iliac/bi-acromial diameter, leg muscle development and a slim physique and, among both the 18 year-old athletes and the 21 to 30 year athletes, the middle distance runners have smaller mean bi-iliac diameters ( $P = 0.01$  at 18 years;  $P = 0.01$  at 21-30) bi-iliac/bi-acromial indices ( $P = 0.05$  at 18;  $P = 0.01$  at 21-30), leg muscle developments ( $P = < 0.001$  at 18;  $P = 0.05$  at 21-30), and weight/height ratios ( $P = 0.02$  at 18;  $P = < 0.01$  at 21-30).

It must be admitted that there are other physical differences between the athletes and the general population than those already detailed. These further differences can be summarised as follows :—

*Sprinters :—*

Age 18 :—Have greater mean arm—muscle development ( $P = 0.05$ ).

Age 21-30 :—Have smaller mean of bi-iliac/height index ( $P = 0.01$ ) and bi-iliac/bi-acromial index ( $P = 0.001$ ).

*Shot-Putters :—*

Age 18 :—Have greater means of chest depth ( $P = 0.001$ ), chest breadth/sitting height index ( $P = 0.02$ ) and height ( $P = 0.001$ ) and a smaller mean of bi-iliac/height index ( $P = 0.02$ ).

Age 21-30 :—Have greater means of chest depth ( $P = 0.05$ ), chest length ( $P = 0.01$ ), chest breadth/sitting height index ( $P = 0.02$ ), and leg muscle development ( $P = 0.001$ ) and smaller means of chest depth/chest breadth ( $P = 0.001$ ) and chest length/sitting height ( $P = 0.001$ ).

*Middle Distance Runners :—*

Age 18 :—Have greater means of height ( $P = 0.01$ ) and leg length ( $P = 0.05$ ) but smaller means of bi-iliac/height index ( $P = 0.001$ ), chest depth/chest breadth ( $P = 0.02$ ), and arm-muscle development ( $P = 0.001$ ).

Age 21-30 :—Have greater means of chest breadth ( $P = 0.05$ ) and bi-acromial diameter ( $P = 0.01$ ) and smaller means of bi-iliac/height index ( $P = 0.01$ ), chest circumference/height ( $P = 0.001$ ), chest length/sitting height ( $P = 0.01$ ), bi-zygomatic diameter ( $P = 0.05$ ).

It will be seen that, except in the instances of chest depth of the shot-putters and bi-iliac/height index of the middle-distance runners, these extra differences in physique are not shown by both age groups. This suggests that these differences may be due to a cause other than the possession of a particular type of athletic ability, while the reality of our suggested anthropometric—exercise ability relationships is further emphasised.

Therefore, the three types of athletes studied do, when compared with subjects of a similar age and representative of the general population, show differences of physique which support the conclusions drawn from the physical fitness survey. It can be objected that we should expect physique differences between athletes and the general population: the athletes will be better nourished since they will be more conscious of their diet and, in Ceylon at least, athletes almost invariably live in favourable social and economic environments. It has already been shown that environment can profoundly influence the physical characteristics of people (Cullumbine, 1949c) so that this factor may account for the better physique shown by the sprinters and the shot-putters. This cannot, however, account for the smaller anthropometric measurements of the middle-distance runners.

This difference in physique between middle-distance runners on the one hand and shot-putters and sprinters on the other is further illustrated by comparing the mean physical characteristics of these groups of athletes (Tables 1 and 2).

TABLE 1

*Male Subjects Aged 18 Years. Significant Differences in Anthropometric Characters between different Types of Athletes.*

| Anthropometric Character             | Sprinters (A) cf. Shot-Putters (B) | Shot-Putters (A) cf. Middle Distance Runners (C) | Sprinters (A) cf. Middle Distance Runners (C) |
|--------------------------------------|------------------------------------|--|---|
| Height .. ..                         | B > A, P = < 0.001                 | B > C, P = < 0.001                               | —   |
| Weight .. ..                         | B > A, P = < 0.001                 | B > C, P = < 0.001                               | A > C, P = 0.05                               |
| Surface Area .. ..                   | B > A, P = < 0.001                 | B > C, P = < 0.001                               | A > C, P = 0.05                               |
| Chest Circumference .. ..            | B > A, P = 0.001                   | B > C, P = < 0.001                               | A > C, P = 0.02                               |
| Chest Breadth .. ..                  | B > A, P = 0.01                    | B > C, P = < 0.001                               | A > C, P = 0.05                               |
| Chest Depth .. ..                    | —                                  | —  | —   |
| Chest Length .. ..                   | B > A, P = 0.05                    | B > C, P = 0.01                                  | A > C, P = 0.01                               |
| Bi-acromial Diameter .. ..           | —                                  | B > C, P = 0.02                                  | A > C, P = < 0.001                            |
| Bi-iliac Diameter .. ..              | —                                  | B > C, P = 0.01                                  | A > C, P = 0.05                               |
| Bi-zygomatic Diameter .. ..          | B > A, P = 0.01                    | B > C, P = < 0.001                               | A > C, P = < 0.001                            |
| Leg Length .. ..                     | B > A, P = 0.001                   | B > C, P = 0.02                                  | —   |
| Weight/Height .. ..                  | —                                  | B > C, P = < 0.001                               | A > C, P = 0.01                               |
| Leg Length/Height .. ..              | —                                  | —  | —   |
| Bi-acromial/Height .. ..             | A > B, P = 0.05                    | —  | A > C, P = < 0.001                            |
| Bi-iliac/Height .. ..                | —                                  | —  | —   |
| Chest Circumference/Height .. ..     | —                                  | B > C, P = 0.02                                  | A > C, P = 0.02                               |
| Bi-iliac/Bi-acromial .. ..           | —                                  | —  | —   |
| Chest Depth / Chest Breadth .. ..    | B > A, P = 0.01                    | B > C, P = 0.05                                  | —   |
| Chest Length / Sitting Height .. ..  | —                                  | —  | A > C, P = 0.01                               |
| Chest Breadth / Sitting Height .. .. | —                                  | —  | —   |
| Arm Muscle Development .. ..         | —                                  | B > C, P = 0.01                                  | A > C, P = 0.01                               |
| Leg Muscle Development .. ..         | A > B, P = 0.05                    | —  | A > C, P = < 0.001                            |

P = Probability.

TABLE 2

*Male Subjects Aged 21-30 Years. Significant Differences in Anthropometric Characters between Different Types of Athletes.*

| Anthropometric Character                | Sprinters (A) of Shot-Putters (B) | Shot-Putters (B) of Middle Distance Runners (C) | Sprinters (A) of Middle Distance Runners (C) |
|---|-----------------------------------|---|--|
| Height .. ..                            | —                                 | —   | —  |
| Weight .. ..                            | B > A, P = 0.01                   | B > C, P = 0.001                                | —  |
| Surface Area .. ..                      | B > A, P = 0.05                   | B > C, P = 0.001                                | —  |
| Chest Circumference ..                  | B > A, P = 0.05                   | B > C, P = 0.01                                 | —  |
| Chest Breadth ..                        | B > A, P = 0.05                   | B > C, P = 0.05                                 | —  |
| Chest Depth .. ..                       | —                                 | —   | —  |
| Chest Length ..                         | —                                 | B > C, P = 0.01                                 | —  |
| Bi-acromial Diameter ..                 | —                                 | —   | —  |
| Bi-iliac Diameter ..                    | B > A, P = 0.01                   | B > C, P = 0.001                                | —  |
| Bi-zygomatic Diameter                   | —                                 | B > C, P = 0.01                                 | A > C, P = 0.001                             |
| Log Length .. ..                        | —                                 | B > C, P = 0.01                                 | —  |
| Weight/Height ..                        | B > A, P = 0.02                   | B > C, P = 0.001                                | A > C, P = 0.05                              |
| Leg Length/Height ..                    | —                                 | —   | —  |
| Bi-acromial/Height ..                   | —                                 | —   | —  |
| Bi-iliac/Height ..                      | B > A, P = 0.05                   | B > C, P = 0.02                                 | —  |
| Chest Circumference/<br>Height .. ..    | —                                 | B > C, P = 0.02                                 | —  |
| Bi-iliac/Bi-acromial ..                 | —                                 | —   | —  |
| Chest Depth / Chest<br>Breadth .. ..    | —                                 | —   | —  |
| Chest Length / Sitting<br>Height .. ..  | —                                 | —   | —  |
| Chest Breadth / Sitting<br>Height .. .. | —                                 | B > C, P = 0.01                                 | —  |
| Arm Muscle Develop-<br>ment .. ..       | B > A, P = 0.05                   | B > C, P = 0.02                                 | —  |
| Leg Muscle Development                  | B > A, P = 0.01                   | B > C, P = 0.001                                | A > C, P = 0.01                              |

P = Probability.

Similar differences in the means are to be found in the two age groups studied, although these differences are more often significant in the 18 year-old group. This is, no doubt, explained by the large variation between the measurements of the older group of subjects.

It will also be seen that the groups of sprinters and shot-putters, although each possessing mean anthropometric measurements and indices greater than those of

the sample population, do differ when compared with each other. In general, these differences are such that the shot-putters possess the greater mean measurements. Therefore, although the sprinters and the shot-putters do possess a similar physique when compared with the general population, they do differ from each other, so that each type of exercise ability (speed and strength) must demand a different optimum, bodily configuration and the physique required for strength is an exaggeration of that required for speed. Our physical fitness survey did not fully reveal this difference; probably because the numbers of subjects with large anthropometric measurements are relatively few in Ceylon. There was a suggestion of such a difference since we noted that obese subjects had a different level of exercise ability (Cullumbine *et al*, 1950).

### Summary

The mean anthropometric characters of sprinters, shot-putters and middle-distance runners have been compared with those of a sample of the general population and significant differences have been noted.

A physical fitness Survey had previously suggested certain significant relationships between anthropometric characters and the capacity for various types of muscular effort. The validity of these relationships had been supported by noting the parallel changes in capacity for exercise and the related anthropometric characters which occurred with variations in race, environment and economic status. The differences here reported between the athletes and the general population are further evidence in favour of the reality of these anthropometric—exercise correlations.

### References

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APPENDIX

TABLE 3

Mean Values for some Physical and Physiological Characters of Athletes and of a Sample Group of the General Population.  
(All Subjects Males Aged 18 years).

| Character                            | Population Sample<br>n = 225 |         | ATHLETES            |        |                        |        |                                   |        |
|--------------------------------------|------------------------------|---------|---------------------|--------|------------------------|--------|-----------------------------------|--------|
|                                      | Mean                         | S.e. ±  | Sprinters<br>n = 26 |        | Shot-Putters<br>n = 10 |        | Middle Distance Runners<br>n = 30 |        |
|                                      |                              |         | Mean                | S.e. ± | Mean                   | S.e. ± | Mean                              | S.e. ± |
| Height .. ..                         | 162.7                        | 0.31    | 163.8               | 1.52   | 175.9                  | 2.10   | 165.6                             | 0.970  |
| Weight .. ..                         | 40.0                         | 0.63    | 53.2                | 1.54   | 62.6                   | 1.62   | 48.7                              | 1.22   |
| Surface Area .. ..                   | 1.495                        | 0.0083  | 1.561               | 0.0133 | 1.763                  | 0.0202 | 1.517                             | 0.0162 |
| Chest Circumference .. ..            | 77.7                         | 0.241   | 81.3                | 0.868  | 87.4                   | 1.50   | 78.5                              | 0.697  |
| Chest Breadth .. ..                  | 24.1                         | 0.148   | 25.7                | 0.432  | 27.4                   | 0.446  | 24.4                              | 0.394  |
| Chest Depth .. ..                    | 16.6                         | 0.223   | 16.2                | 0.210  | 19.3                   | 0.424  | 15.9                              | 0.415  |
| Chest Length .. ..                   | 30.4                         | 0.170   | 30.6                | 0.727  | 34.3                   | 2.04   | 27.9                              | 0.534  |
| Bi-acromial Diameter .. ..           | 32.0                         | 0.239   | 36.8                | 0.571  | 35.3                   | 1.22   | 32.1                              | 0.448  |
| Bi-iliac Diameter .. ..              | 25.1                         | 0.141   | 26.2                | 1.025  | 25.8                   | 0.330  | 23.9                              | 0.413  |
| Bi-zygomatic Diameter .. ..          | 12.3                         | 0.077   | 13.1                | 0.100  | 13.4                   | 0.074  | 12.5                              | 0.100  |
| Leg Length .. ..                     | 101.5                        | 0.720   | 102.6               | 1.200  | 111.0                  | 2.05   | 104.6                             | 1.38   |
| Weight/Height .. ..                  | 0.302                        | 0.0038  | 0.326               | 0.0123 | 0.356                  | 0.0119 | 0.284                             | 0.0060 |
| Leg Length/Height .. ..              | 0.625                        | 0.0025  | 0.628               | 0.0079 | 0.631                  | 0.0073 | 0.632                             | 0.0054 |
| Bi-acromial/Height .. ..             | 0.205                        | 0.0015  | 0.219               | 0.0031 | 0.201                  | 0.0079 | 0.194                             | 0.0022 |
| Bi-iliac/Height .. ..                | 0.154                        | 0.00098 | 0.151               | 0.0038 | 0.147                  | 0.0026 | 0.144                             | 0.0023 |
| Chest Circumference/Height           | 0.481                        | 0.0032  | 0.407               | 0.0081 | 0.498                  | 0.0093 | 0.474                             | 0.0027 |
| Bi-iliac/Bi-acromial .. ..           | 0.760                        | 0.0062  | 0.715               | 0.0322 | 0.730                  | 0.0321 | 0.734                             | 0.0112 |
| Chest Depth/Chest Breadth            | 0.698                        | 0.0668  | 0.636               | 0.0108 | 0.703                  | 0.0162 | 0.653                             | 0.0167 |
| Chest Length/Sitting Height          | 0.497                        | 0.0051  | 0.509               | 0.0177 | 0.458                  | 0.0278 | 0.443                             | 0.0138 |
| Chest Breadth / Sitting Height .. .. | 0.935                        | 0.0041  | 0.433               | 0.0211 | 0.424                  | 0.0106 | 0.397                             | 0.0106 |
| Arm Muscle Development ..            | 27.8                         | 0.202   | 29.1                | 0.601  | 29.2                   | 0.593  | 25.0                              | 0.261  |
| Leg Muscle Development ..            | 46.5                         | 0.202   | 48.6                | 0.741  | 45.9                   | 1.001  | 44.3                              | 0.468  |
| Resting Systolic B.P. ..             | 108.1                        | 0.75    | 117.5               | 1.59   | 115.1                  | 2.58   | 110.3                             | 2.22   |
| Resting Diastolic B.P. ..            | 66.7                         | 0.63    | 70.2                | 1.39   | 69.1                   | 3.42   | 68.6                              | 1.42   |
| Resting Pulse Rate ..                | 84                           | 0.88    | —                   | —      | —                      | —      | 83                                | 1.18   |

Weight in Kg. Height, etc. in cm. Surface Area in m<sup>2</sup>, Blood Pressure in mm. Kg. Pulse Rate in pulsations/minute.

TABLE 4

*Mean Values for some Physical and Physiological Characters of Athletes and of a Sample Group of the General Population.*

*(All Subjects Males Aged 21-30 Years).*

| Character                         | Population Sample<br>n = 520 |         | ATHLETES            |        |                        |        |                                   |        |
|-----------------------------------|------------------------------|---------|---------------------|--------|------------------------|--------|-----------------------------------|--------|
|                                   |                              |         | Sprinters<br>n = 24 |        | Shot-Putters<br>n = 16 |        | Middle Distance Runners<br>n = 23 |        |
|                                   | Mean                         | S.e. ±  | Mean                | S.e. ± | Mean                   | S.e. ± | Mean                              | S.e. ± |
| Height .. ..                      | 162.5                        | 0.082   | 169.5               | 1.51   | 171.4                  | 3.46   | 165.9                             | 2.06   |
| Weight .. ..                      | 47.0                         | 0.301   | 59.0                | 1.66   | 70.5                   | 3.47   | 53.6                              | 2.30   |
| Surface Area .. ..                | 1.501                        | 0.0051  | 1.663               | 0.033  | 1.805                  | 0.050  | 1.573                             | 0.044  |
| Chest Circumference ..            | 79.9                         | 0.228   | 81.3                | 1.51   | 90.4                   | 3.75   | 77.6                              | 1.25   |
| Chest Breadth .. ..               | 24.6                         | 0.089   | 25.5                | 0.444  | 29.0                   | 1.47   | 25.4                              | 0.391  |
| Chest Depth .. ..                 | 17.3                         | 0.078   | 17.4                | 0.605  | 18.8                   | 0.738  | 16.9                              | 0.740  |
| Chest Length .. ..                | 30.3                         | 0.112   | 32.3                | 2.48   | 35.3                   | 1.67   | 28.9                              | 0.986  |
| Bi-acromial Diameter ..           | 33.4                         | 0.161   | 36.7                | 0.93   | 37.2                   | 1.34   | 35.9                              | 0.888  |
| Bi-iliac Diameter ..              | 25.2                         | 0.062   | 25.0                | 0.236  | 27.0                   | 0.562  | 24.3                              | 0.304  |
| Bi-zygomatic Diameter ..          | 12.4                         | 0.035   | 13.0                | 0.225  | 13.2                   | 0.350  | 11.9                              | 0.207  |
| Leg Length .. ..                  | 100.4                        | 0.243   | 106.4               | 1.60   | 109.5                  | 1.62   | 101.9                             | 1.80   |
| Weight/Height .. ..               | 0.313                        | 0.0019  | 0.347               | 0.0092 | 0.406                  | 0.0216 | 0.301                             | 0.0032 |
| Leg Length/Height ..              | 0.623                        | 0.0017  | 0.623               | 0.0055 | 0.653                  | 0.0196 | 0.613                             | 0.0061 |
| Bi-acromial/Height ..             | 0.208                        | 0.00098 | 0.219               | 0.0056 | 0.219                  | 0.0097 | 0.217                             | 0.0020 |
| Bi-iliac/Height .. ..             | 0.156                        | 0.00055 | 0.149               | 0.0021 | 0.157                  | 0.0031 | 0.146                             | 0.0027 |
| Chest Circumference/Height        | 0.497                        | 0.0017  | 0.482               | 0.0083 | 0.533                  | 0.0247 | 0.468                             | 0.0079 |
| Bi-iliac/Bi-acromial ..           | 0.756                        | 0.0037  | 0.684               | 0.0176 | 0.732                  | 0.0298 | 0.683                             | 0.0214 |
| Chest Depth/Chest Breadth         | 0.707                        | 0.0035  | 0.684               | 0.0165 | 0.651                  | 0.0152 | 0.687                             | 0.0233 |
| Chest Length/Sitting Height       | 0.500                        | 0.0033  | 0.516               | 0.0563 | 0.482                  | 0.0025 | 0.450                             | 0.0161 |
| Chest Breadth / Sitting Height .. | 0.407                        | 0.0026  | 0.368               | 0.0706 | 0.534                  | 0.0525 | 0.386                             | 0.0113 |
| Arm Muscle/Development            | 29.0                         | 0.131   | 29.6                | 0.667  | 33.8                   | 1.81   | 29.0                              | 0.574  |
| Leg Muscle Development ..         | 46.5                         | 0.202   | 49.4                | 1.14   | 53.2                   | 0.853  | 45.8                              | 0.265  |
| Resting Systolic B.P. ..          | 106.1                        | 0.53    | 113.0               | 2.00   | 113.1                  | 2.36   | 111.2                             | 3.30   |
| Resting Diastolic B.P. ..         | 66.7                         | 0.61    | 70.3                | 1.98   | 71.3                   | 3.58   | 70.5                              | 2.96   |
| Resting Pulse Rate ..             | 76                           | 0.96    | 75.6                | 2.82   | 72.8                   | 3.83   | 68.4                              | 2.47   |

Weight in Kg. Height, etc. in cm. Surface Area in m<sup>2</sup>, Blood Pressure in mm. Hg. Pulse Rate in pulsation/minute.