FACTORS INFLUENCING THE NORMAL HEART WEIGHT
—A STUDY OF 140 HEARTS—

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Weight of the heart and its various components (muscular and non muscular portions) was measured in 138 specimens. Average heart weight for Indians was comparatively less then that of western population. Difference between the average heart weights for males and females was found to be statistically significant. The heart weight was not influenced by age and body length but by the body built. A statistically significant difference was noticed in emaciated persons.

Ventricular weight constituted 50 to 80 percent of the total heart weight. A close correlation between the heart weight and ventricular weight was seen. Ventricular wall thickness did not correlate well with the heart weight.

The importance of heart as an essential organ of the body has been realised since long by our ancestors. At times it is difficult to assess the effects of the damage to the heart until and unless certain norms of the organ are known for the particular community, state and religion. The literature is at variance on the subject what constitutes the normal heart weight and what are its upper and lower limits.

Workers have tried to correlate the heart weight with body weight, age, body length and body built but obtained variable results. The present study was undertaken to assess the normal heart weight for the Indian population and the factors influencing it. This information may be used as a guide line for assessing the cases of cardiac hypertrophy.

MATERIALS AND METHODS

The material used in the present study was obtained from 138 medicolegal postmortems carried out in the mortuary of M. S. Hospital, Aligarh and 2 postmortems in cases of post natal deaths in the Department of Pathology in whom no cardiac abnormality was noticed. In all the cases data regarding age, sex, height, body built, cause of death, time and date of death and time and date of autopsy were recorded.

The hearts were fixed in 10% formal saline. Before dividing the heart into various components the coronary arteries were dissected out with fine scissors and forceps to assess the incidence of atherosclerosis. The heart was opened up following the route of blood flow inside the chambers. The weight of the heart was recorded after washing out the blood clots.

Key Words:
Normal weight of indian hearts
Factors influencing heart weight

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TABLE I  WEIGHT OF THE HEART IN RELATION TO SEX

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of Cases</th>
<th>Heart weight in grams</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>Male</td>
<td>116</td>
<td>60 - 375</td>
<td>236.1</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>25 - 330</td>
<td>206.6</td>
</tr>
<tr>
<td>Total</td>
<td>140</td>
<td>25 - 375</td>
<td>231.1</td>
</tr>
</tbody>
</table>

TABLE II  HEART WEIGHT IN RELATION TO AGE GROUPS

<table>
<thead>
<tr>
<th>Age group in years</th>
<th>No. of Cases</th>
<th>Heart weight in grams</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>Less than 10</td>
<td>3</td>
<td>25 - 60</td>
<td>40.0</td>
</tr>
<tr>
<td>11 - 20</td>
<td>15</td>
<td>70 - 290</td>
<td>187.2</td>
</tr>
<tr>
<td>21 - 30</td>
<td>50</td>
<td>140 - 375</td>
<td>239.4</td>
</tr>
<tr>
<td>31 - 40</td>
<td>41</td>
<td>80 - 360</td>
<td>236.4</td>
</tr>
<tr>
<td>41 - 50</td>
<td>14</td>
<td>185 - 320</td>
<td>250.4</td>
</tr>
<tr>
<td>51 - 60</td>
<td>6</td>
<td>200 - 280</td>
<td>230.8</td>
</tr>
<tr>
<td>61 - 70</td>
<td>10</td>
<td>195 - 325</td>
<td>254.6</td>
</tr>
<tr>
<td>Above 70</td>
<td>1</td>
<td></td>
<td>250.0</td>
</tr>
</tbody>
</table>

Fig.1. Showing range and average of heart weights in various age groups.

In 138 specimens of heart dissection was carried out to separate them into three main components, the non muscular portion (NMP), right ventricle (RV) and left ventricle plus septum (LV+S) according to the method described by Lamb. The weight of the muscular portion was recorded after removal of epicardial fat. Dissection of the heart was completed within a week after the postmortem. Right ventricular wall thickness was measured in mms. about 1.5 cm below the pulmonary valve (RVP) and at the apex (RVA). In case of left ventricle the maximum thickness (LVM) and thickness at the apex (LVA) was measured. The average thickness for each ventricle was taken by dividing the sum of the two measurements.

RESULTS

Age & Sex: Out of 140 cases, 116 (82.86%) were males and the rest 24 (17.14%) females. The age of the cases ranged from one day to 78 years; maximum number of cases 50 (35.71%) belonged to age group of 21–30 years.

Body Built: The cases were grouped into three categories depending upon the body built. Cases of muscular built were 110 (78.57%), thin built 20 (14.328%) and emaciated 10 (7.15%).

Heart Weight:

(a) Relation to Sex: The average and range of heart weight in relation to sex has been shown in Table I. The average heart weight for two sexes was significantly different as calculated value of 't' (2.157) was high as compared to the

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TABLE III HEART WEIGHT IN RELATION TO BODY BUILT

<table>
<thead>
<tr>
<th>Body Built</th>
<th>No. of Cases</th>
<th>Heart weight in grams</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular</td>
<td>110</td>
<td>25 - 375</td>
<td>237.64</td>
</tr>
<tr>
<td>Thin</td>
<td>20</td>
<td>35 - 315</td>
<td>230.9</td>
</tr>
<tr>
<td>Emaciated</td>
<td>10</td>
<td>60 - 265</td>
<td>159.9</td>
</tr>
</tbody>
</table>

Fig. 2. Average heart weight and weights of different components in relation to body built.

Fig. 3. Average heart weight and weights of the different components in relation to body length.

Tabulated value (1.96). Thus it was concluded that the sex has a telling effect on heart weight.

(b) Relation to Age: It was observed that upto the age of 30 years there was a gradual rise of heart weight and thereafter no correlation was observed (Table II, Fig. 1). This difference was found to be statistically significant. Average heart weights of all the age groups beyond 30 years were more or less equal and the observed difference was nothing but sampling fluctuations.

Upto 30 years, the heart weight (Y) in gms. could be expressed as $Y = 20.2874 e^{0.0695X}$ where $X$ denotes the age in years.

(c) Relation to Body Built: The relation of heart weight and body built is depicted in Table III and Fig. 2. Apparently the average heart weight was more in muscular individuals as compared to those of thin and emaciated persons. Statistically, however, there was no significant difference between the average heart weights belonging to muscular and thin built individuals ($t = 0.473$).

Average heart weight for emaciated persons
TABLE IV  THICKNESS IN MILLIMETERS OF THE VENTRICULAR WALLS IN RELATION TO AGE

<table>
<thead>
<tr>
<th>Age group in years</th>
<th>No. of Cases</th>
<th>Right Ventricle</th>
<th></th>
<th>Left Ventricle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>0 - 10</td>
<td>3</td>
<td>2.5 - 3</td>
<td>2.8</td>
<td>5 - 6</td>
</tr>
<tr>
<td>11 - 20</td>
<td>15</td>
<td>2.9 - 9</td>
<td>5.7</td>
<td>45 - 17</td>
</tr>
<tr>
<td>21 - 30</td>
<td>50</td>
<td>4 - 12</td>
<td>7.8</td>
<td>8 - 18.5</td>
</tr>
<tr>
<td>31 - 40</td>
<td>41</td>
<td>3.5 - 10.5</td>
<td>7.5</td>
<td>6 - 17.5</td>
</tr>
<tr>
<td>41 - 50</td>
<td>14</td>
<td>4.5 - 12</td>
<td>8.1</td>
<td>9 - 17.5</td>
</tr>
<tr>
<td>51 - 60</td>
<td>6</td>
<td>7 - 10</td>
<td>7.8</td>
<td>10 - 12.5</td>
</tr>
<tr>
<td>61 - 70</td>
<td>10</td>
<td>7 - 9.5</td>
<td>8.0</td>
<td>10.5 - 15</td>
</tr>
<tr>
<td>Above 70</td>
<td>1</td>
<td>—</td>
<td>8.0</td>
<td>—</td>
</tr>
<tr>
<td>Above 20</td>
<td>122</td>
<td>3.5 - 12</td>
<td>7.5</td>
<td>6 - 18.5</td>
</tr>
</tbody>
</table>

Fig. 4. RVP plotted against the right ventricular weight.

was significantly different from those of thin and muscular persons as the calculated value of ‘t’ was 3.125 and 4.013 respectively, higher than the tabulated value ($t_{28}$ (0.05) = 2.045 and $t_{118}$ (0.05) = 1.96 respectively).

(d) Relation to Body Length: While comparing the heart weight with body length it was observed that up to 100 cms. body length there was a gradual rise of weight (Fig. 3). Between 131 to 170 cms. body length the variation in heart weight was not following any definite trend or there was no significant difference.

(e) Relationship of ventricular wall thickness with total Heart Weight and Ventricular Weight:

Fig. 5. LVM plotted against the weight of left ventricle and septum.

No correlation between the age and thickness of the ventricular walls was obtained in the present series (Table IV). For adults (above 20 years) the average thickness for right ventricular wall was 7.5 mms and for left 12.7 mms. The coefficient of correlation between right and left ventricular thicknesses was 0.965. The thickness of left ventricle ($Y$) could be expressed as $Y = 2.187 + 1.341 X$ where $X$ represented the thickness in mm of the right ventricle.

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Fig. 6. Relation between total ventricular weight and heart weight.

In case of right ventricle the average thickness of the wall correlated well with the heart weight and right ventricular weight. The coefficient of correlation between the thickness of right ventricle (x) and heart weight (Y₁) was 0.955. Heart weight could be expressed as \( Y₁ = 78.455 + 19.846 \times X \). Similarly the coefficient of correlation between the thickness of right ventricle and its weight (Y₂) was 0.946 and Y₂ could be expressed as \( 16.198 + 4.8 \times X \). While correlating the right ventricular wall thickness measured 1.5 cms below the pulmonic valve (RVP) with the right ventricular weight a discernable relation was obtained but the scatter was so great (30 to 90 Gms at 10 mm) as to be of little value in practice (Fig. 4).

No definite correlation was found between the wall thickness and left ventricular weight and heart weight. The coefficient of correlation between the thickness and left ventricular weight and heart weight was 0.892 and 0.900 respectively. While plotting the maximum thickness (LVM) against its weight there was almost no correlation (Fig. 5).

(f) Relation with Ventricular Weights: The ventricular mass in most of the cases constituted 50 to 80% of the total heart weight (Fig. 6) but beyond 320 gms it constituted 68 to 87%. Besides individual variations in most of the cases the total heart weight reflected the muscular weight. While assessing the relationship of right and left ventricular weights with the total heart weight following linear regression was obtained:

\[
\text{Heart Weight} = 14.576 + 0.485 \times \text{Right Ventricle Weight}
\]

**DISCUSSION**

Marked difference in the weight of the normal heart has been observed by previous workers\(^6,^{10,11}\). Average heart weight in Indians is comparatively on the lower side.\(^12\) In the present series also the average heart weight for males was 236.1 gms. whereas all the foreign workers have reported average heart weight for males ranging from 290 Gms\(^{13}\) to 384 Gms\(^{14}\). Sex has been a telling factor in relation to heart weight as was observed in the present study.

No definite correlation between the age and the heart weight was observed as has also been reported earlier.\(^5,^{6,8,15}\) Heart weight in emaciated persons was found to be statistically different from that of muscular or thin individuals. This was in close agreement to the observations of Zeeck\(^4\) who has emphasized the need of considering sex, state of nourishment and muscular development of unusual built in calculating standards of normal heart weight.

Though the workers\(^1,^{2,6,10,14}\) have tried to express heart weight as a percentage of body weight but in the present study this relationship was not studied as in the mortuary facilities for weighing the dead body were not available and more over the body weight is unstable and affected by the disease process. Therefore, an attempt was made to correlate the heart weight with the body length. Here again, beyond 100 cms body length no specific correlation was observed — a finding quite contrary to the findings of Zeeck.\(^4\)

It is customary for the Morbid Anatomists to accept increased ventricular thickness as an evidence of cardiac hypertrophy but this is very much denied by Lamb.\(^9\) On one hand workers\(^{16,17}\) have reported a close relationship between the wall thickness and the ventricular weight though others\(^8,9\) have failed to obtain any specific correlation between the two. In the present series a close correlation between the average thickness of RV and its weight was obtained but when the readings of RVP were plotted against RV weight a discernable relation was obtained which was of little practical importance. No correlation was observed in case of left ventricle.

Ventricular mass constituted roughly 70% of the total heart weight and a close correlation between the heart weight and total ventricular
weight was observed as has also been reported by Lamb.

Thus the heart weight is affected by sex, body built and not by age and body length. In general, the heart weight reflects the ventricular weight except in those cases where there is an excess of epicardial fat.

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REFERENCES

1. BOYD (1861). Quoted by Bardeen.
6. SMITH, H. I.: The relation of the weight of the heart to the weight of the body and weight of heart to age. Amer. Heart J. 4: 79–93, 1928.

Japanese Circulation Journal Vol. 43, February 1979