# ATOMIC BOMB CASUALTY COMMISSION-JAPANESE NATIONAL INSTITUTE OF HEALTH ADULT HEALTH STUDY HIROSHIMA 1958-60
## Cardiovascular Project Report Number 6
## HEART SIZE NORM

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## ABCC—予研 成人健康調査 広島 1958—60
## 心臓脈管調査第６報：心臓の大きさの基準

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(昭和38年12月26日受付)

ABCC における被検者の詳細な臨床検査で得た資料を用いて，広島の一般人口集団における心臓の大きさの標準値を求めた．通常の背腹方向胸部X線写真による心臓横径を，身長，体重および年

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令と関連して示す公式を導いた．解析は，男女別に行なつた．この公式によつて計算した値を心臓の大きさの標準値とみなすことができる．この標準値からの偏差は，正常者群においては個人差と解釈される．その標準偏差は約9mmである．この標準を異常者群に適用した場合，標準値からの偏差と血圧または明白な心臓疾患存在の事実との間に，明らかに，高い相関関係が認められる．したがつて，この標準にもとづく心臓の相対的大きさは，他の関連する要因とともに，心臓脈管系疾患の診断および研究に有用と考えられる．

実用に役立つよう計算図表を考案した．(この計算図表の写しは，広島 ABCC で入手できる．)

## INTRODUCTION

While the fairly close association between cardiac enlargement and cardiovascular disease or hypertension is well known, standards for delineation of such enlargement of the heart are not necessarily clear. A quantitative expression for cardiac enlargement should, therefore, contribute much to the study of heart disease and hypertension. Heart size standards in various forms have been provided by many investigators and have been used clinically to diagnose cardiac enlargement. The cardio-thoracic ratio was among the first to be employed.[1] Then, an attempt was made to describe the standard size of the transverse cardiac diameter as a function of weight, height, and age.[2,3] The mean value of the transverse diameter of the normal heart may be expressed[4] by a simple formula $C\sqrt{\frac{W}{H}}$ where C is a numerical value.

Obviously, a standard developed for a particular population cannot be universally applied and therefore standards developed in other populations and racial groups are not applicable for the Japanese population. Japanese investigators have published certain data intended for application in the estimation of cardiac size from routine chest roentgenograms.[5] However, the purpose of this study was to derive a standard for the population included in the Adult Health Study of the Atomic Bomb Casualty Commission (ABCC). A similar earlier investigation at ABCC was not completed.[6] The representative samples of the Hiroshima and Nagasaki exposed and comparison groups under detailed clinical investigation at ABCC[7] offer the opportunity to study sufficiently large numbers of subjects to permit reliable assessment of cardiac size in a Japanese population.

In this study, radiologically recorded heart size has been correlated with sex, age, height, and weight, of subjects within defined clinical classifications.

## DESCRIPTION OF THE SAMPLE

The sample for the ABCC Adult Health Study is composed of four age-sex balanced components :

Group 1 Proximal Exposed within 2,000 meters of the hypocenter ;
reported radiation symptoms ;

Group 2 Proximal Exposed within 2,000 meters of the hypocenter ;
reported no radiation symptoms ;

Grop 3 Distal Exposed 3,000 to 3,499 meters of the hypocenter ;

Group 4 Nonexposed Beyond 10,000 meters from the hypocenter or not in the city at the time of bomb.

The Hiroshima sample totals slightly more than 13,000 persons fifteen years of age or older at the time of examination in 1958 and 1959 who receive detailed clinical examinations at approximately two year intervals. The entire sample is equally divided into 24 examination groups, designated A through X. Each month, one of these alphabetically designated groups is scheduled for routine clinical examination at ABCC. This study utilizes data accumulated in 1958-1959 during routine examinations for 10 of the 24 groups.

Obviously, if accurate measurement of heart size is to be attempted, subjects with certain cardiac abnormalities must be excluded. Following are the criteria used for screening such subjects from this study :

**ABNORMALITIES EXCLUDED FROM THIS STUDY**

Developmental

- Pectus excavatum with cardiac shift
- Scoliosis, marked
- Kyphosis, marked
- Large apical fat pad with indistinct left cardiac border

Post-infection

- Pleural thickening, marked, causing distortion of cardiac silhouette
  - Mediastinal, causing indistinct cardiac borders
  - Lateral chest wall, with marked obliteration of costophrenic sulcus
- Parenchymal scarrimg, marked, with cardiac shift

Post-traumatic

- Fractures, costal and vertebral
- Pneumothorax with cardiac shift

Post-surgical

- Thoracoplasty, etc.

Neoplasms causing mediastinal and cardiac distortion

- Mediastinal
- Parenchymal
- Pleural

Other

- Pneumothorax, spontaneous, with mediastinal shift
- Diaphragmatic deformities, abnormal position (Phrenic nerve paralysis, eventration, large hiatus hernia, pneumoperitoneum, pregnancy, intra-abdominal mass or fluid)
- Pulmonary emphysema

Technical difficulties prevented accurate interpretation of a few of the chest roentgenograms and films were excluded if any of the following were found :

- Rotation of patient
- Incomplete inspiration
- Improper exposure
- Superimposition of dorsal spine on right cardiac border rendering latter indistinct

Following these exclusions, the remaining subjects were divided into three clinical classifications :

Class 1 Without overt heart disease or hypertension

Class 2 Without overt heart disease but with hypertension, defined as blood pressure higher than 140/90

Class 3 With overt heart disease with or without hypertension.

Overt heart disease was diagnosed clinically with the aid of electrocardiography according to the following International Statistical Code criteria :

**CRITERIA FOR CLASS 3**

Rheumatic fever (400-402)

Chronic rheumatic heart disease (410-416)

Arteriosclerotic and degenerative heart disease (420-422)

Other diseases of heart (430-434) excluding functional disease of heart (433) and unspecified disease of heart (434. 4)

Cardiovascular syphilis (023)

Congenital malformations of circulatory system (754)

Electrocardiographic criteria for abnormalities :

Frequent extrasystoles, supraventricular and ventricular

Paroxysmal tachycardia, supraventricular and ventricular

Atrial fibrillation and flutter

Nodal rhythm

Complete atrioventricular block

Bundle branch block

Intraventricular block, unclassified

Wolfe-Parkinson-White syndrome

Ventricular hypertrophy, left, right, or combined

S-T depression and T wave abnormality

Myocardial ischemia

Myocardial infarction

Final composition of the sample is shown by age, sex, and clinical classification in Table 1.

TABLE 1 SAMPLE FOR STUDY OF HEART NORM, HIROSHIMA, BY AGE, SEX, AND CLINICAL CLASSIFICATION

表1 心臓の大きさの標準値研究の標本; 年齢, 性および臨床分類別, 広島

| AGE 年齢 | TOTAL 計 | | CLINICAL CLASSIFICATION 臨床分類 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | CLASS 分類 1 | | CLASS 分類 2 | | CLASS 分類 3 | |
| | MALE 男 | FEMALE 女 | MALE 男 | FEMALE 女 | MALE 男 | FEMALE 女 | MALE 男 | FEMALE 女 |
| 10-19 | 94 | 119 | 78 | 113 | 13 | 3 | 3 | 3 |
| 20-29 | 168 | 208 | 162 | 201 | 18 | 5 | 8 | 2 |
| 30-39 | 147 | 336 | 120 | 302 | 19 | 21 | 8 | 13 |
| 40-49 | 192 | 358 | 133 | 250 | 46 | 90 | 13 | 18 |
| 50-59 | 233 | 358 | 112 | 178 | 90 | 130 | 31 | 50 |
| 60-69 | 191 | 212 | 73 | 70 | 85 | 89 | 33 | 53 |
| 70+ | 61 | 80 | 6 | 11 | 33 | 44 | 22 | 25 |
| TOTAL 計 | 1106 | 1671 | 684 | 1125 | 304 | 382 | 118 | 164 |

## METHOD

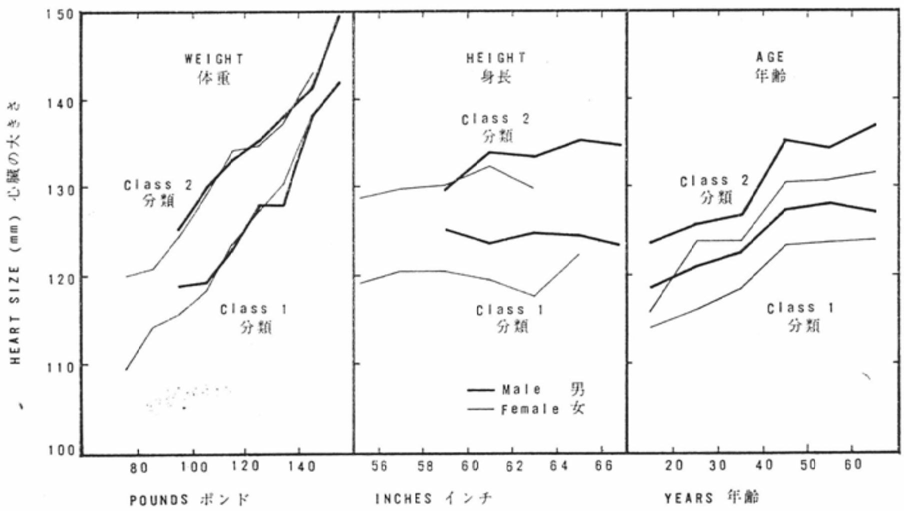
### CARDIAC MEASUREMENT

In this study measurements are based on the frontal cardiac silhouette. Routine examination of the chest consisted of obtaining 14×17 inch posteroanterior and lateral chest roentgenograms at a target-film distance of 72 inches. The maximum transverse diameter of the heart which is obtained from the posteroanterior roentgenogram was considered most practical for deriving a standard which could be applied in routine roentgenographic examinations of the chest. The fact that data obtained from this investigation could have practical application in interpretation of routine chest roentgenograms of the Japanese population made other more complicated methods of measurement seem less desirable. This transverse cardiac diameter was applied, together with other related data obtained from clinical study, to devise formulae.

### DERIVATION OF STANDARD

Analysis revealed no difference in heart size related to radiation exposure status ; therefore the proximal, distal, and nonexposed groups were combined. Heart size data for clinical classifications 1 and 2 were tabulated according to sex, weight, height, and age. (Figure 1)

FIGURE 1 HEART SIZE FOR CLINICAL CLASSES 1 AND 2 BY WEIGHT, HEIGHT, AND AGE
図1 臨床分類1および2における心臓の大きさ; 体重, 身長および年齢別




*CLASS 1* - *Without overt heart disease or hypertension*
分類1 — 明白な心臓疾患または高血圧症のないもの
*CLASS 2* - *Without overt heart disease but with hypertension*
分類2 — 明白な心臓疾患はないが, 高血圧症のあるもの

In general, the quantitative relations in Figure 1 show :

Heart size increases with weight

Heart size is not affected by height

Heart size increases with age

These trends are similar in clinical classifications 1 and 2, but with a constant difference in the level for each age and weight class.

The intercorrelations of weight, height, and age were investigated as shown in Figure 2. Heart size data for weight, height, and age specific groups for clinical classifications 1 and 2 were plotted separately by sex for each of the tabulated variables.

FIGURE 2 HEART SIZE FOR CLINICAL CLASSES 1 AND 2 PARTIALLY SPECIFIED FOR EACH VARIABLE

図2 臨床分類1および2における心臓の大きさ，体重，身長および年齢別

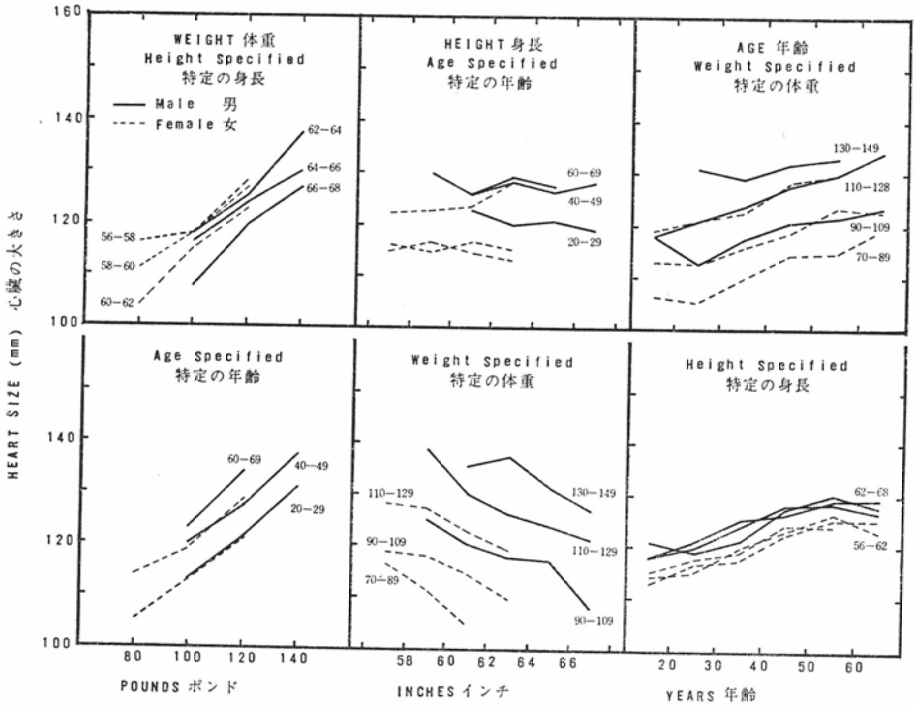



Figure 2 illustrates these points:

Heart size increases with weight when height or age is specified;

Heart size decreases with height when weight is specified–a trend obscured in the previous figure considering heart size by height only;

Heart size increases with age when weight or height is specified;

The different lines on each chart, which represent different values for the variable being fixed, are generally parallel. Thus, in computing standards for heart size the following formula seems appropriate:

Heart size = weight factor + height factor + age factor

The variance of heart size may be partitioned into components representing each of the three factors shown in the formula plus a residual component which cannot be accounted for by these factors. An analysis of variance applied to a balanced subsample supported this partition of variability as well as the linearity of the relation. (Table 2)

Thus, the problem is reduced to the determination of constants $\alpha$, $\beta$, $\gamma$, and $\delta$ in the linear relation:

$$HD = \alpha W + \beta H + \gamma A + \delta \qquad (1)$$

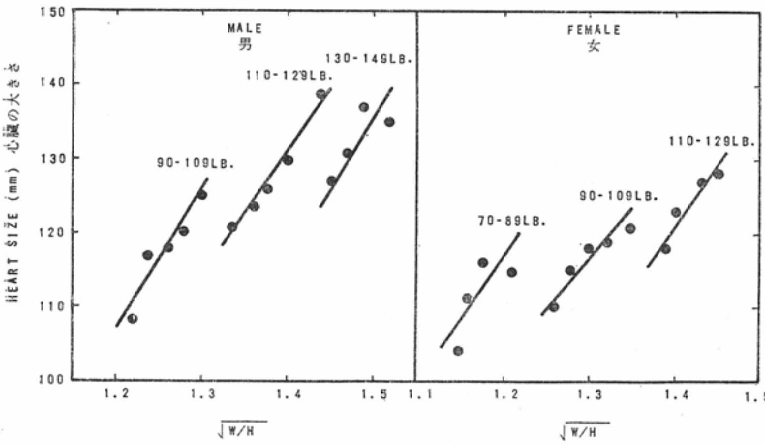
where HD, W, H and A denote heart size in transverse diameter, weight, height and age respectively while $\delta$ is a term specific to the individual. This is the same formula earlier adopted by Hodge and Eyster.[3] Another form HD=Const. $\times\sqrt{\frac{W}{H}}$ has been proposed by Ungerleider.[4] The heart size versus weight-height ratio curve shown in Figure 3 tests the fit of this formula.

TABLE 2 ANALYSIS OF VARIANCE FOR HEART SIZE
表2 心臓の大きさの分散分析

| SOURCE OF VARIANCE 要因 | | MALE 男 | | | | FEMALE 女 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | SUM OF SQUARES 二乗の和 | DEGREES OF FREEDOM 自由度 | MEAN SQUARE 平均二乗和 | F RATIO F−比 | SUM OF SQUARES 二乗の和 | DEGREES OF FREEDOM 自由度 | MEAN SQUARE 平均二乗和 | F RATIO F−比 |
| WEIGHT 体重 | (W) | 2723.46 | 3 | 907.82 | 12.8 ** | 8059.84 | 3 | 2686.61 | 42.5 ** |
| | $W_1$ | 2604.01 | 1 | 2604.01 | 36.7 ** | 7986.83 | 1 | 7986.83 | 126.6 ** |
| | $W_2$ | 117.04 | 1 | 117.04 | 1.65 | 68.88 | 1 | 68.88 | 1.09 |
| | $W_3$ | 2.41 | 1 | 2.41 | - | 4.15 | 1 | 4.15 | - |
| HEIGHT 身長 | (H) | 157.75 | 2 | 78.88 | 1.11 | 808.57 | 2 | 404.28 | 6.40** |
| | $H_1$ | 115.56 | 1 | 115.56 | 1.63 | 731.53 | 1 | 731.53 | 11.59** |
| | $H_2$ | 42.19 | 1 | 42.19 | - | 77.04 | 1 | 77.04 | 1.22 |
| AGE 年齢 | (A) | 968.38 | 3 | 322.79 | 4.56** | 1909.09 | 3 | 636.36 | 10.10** |
| | $A_1$ | 940.80 | 1 | 940.80 | 13.26** | 1812.25 | 1 | 1812.25 | 28.8 ** |
| | $A_2$ | 5.05 | 1 | 5.05 | - | 45.05 | 1 | 45.05 | - |
| | $A_3$ | 22.52 | 1 | 22.52 | - | 51.80 | 1 | 51.80 | - |
| W x H | | 338.67 | 6 | 56.45 | - | 333.39 | 6 | 55.56 | - |
| H x A | | 198.50 | 6 | 33.08 | - | 586.14 | 6 | 97.69 | 1.55 |
| A x W | | 363.12 | 9 | 40.35 | - | 1120.14 | 9 | 124.46 | 1.97* |
| W x H x A | | 1326.75 | 18 | 73.71 | 1.04 | 1130.07 | 18 | 72.20 | 1.14 |
| W H A | | 6086.63 | 47 | | | 13947.24 | 47 | | |
| RESIDUAL 残差 | | 3406.00 | 48 | $71.00 = 8.44^2$ | | 9098.25 | 48 | $63.10 = 7.86^2$ | |
| TOTAL 計 | | 9492.63 | 95 | | | 23045.49 | 95 | | |

** Highly significant $P \leq .01$ 高度に有意
* Significant $.01 \leq P \leq .05$ 有意
$W_1$, $H_1$, $A_1$; Components linear to W,H,A. W, H, A に比例する項
$W_2$, $H_2$, $A_2$; Components quadratic to W,H,A. W, H, A の二乗に比例する項
$W_3$, $A_3$, ; Components cubic to W,A. W, A の三乗に比例する項

FIGURE 3 HEART SIZE IN RELATION TO WEIGHT/HEIGHT RATIO FOR FIXED WEIGHT CLASSES
図3 心臓の大きさと体重／身長比の関係; 特定の体重区分につき



Discrepancies between curves for various weight values suggest that the affects of weight and height cannot be completely accounted for by a single combined variable as expressed in the previously mentioned[4] formula $C\sqrt{\frac{W}{H}}$. Some modification to reduce discrepancies may be possible but was not attempted.

Another current method is use of the cardiothoracic ratio. While this may have an advantage in that it is less affected by error in measurement, it does not take into consideration differences in body build. The linear form, therefore, was adopted here.

In addition to fitting the linear formula(1) to the data for Class 1 subjects, it appeared desirable to apply the formula to Class 2 subjects, with some appropriate modification. Since variations in heart size in hypertensive Class 2 subjects parallel variations in Class 1 subjects as shown in Figure 1, the term $\varepsilon$ B may be added to describe the variations in Class 1 and Class 2 simultaneously, with $\varepsilon$ a constant to be determined from the data while B=0 for Class 1 and B= 1 for Class 2. Thus, the curve (II) may be applied:

$$HD = \alpha W + \beta H + \gamma A + \delta + \varepsilon B \qquad (II)$$

In determining values for the constants $\alpha$, $\beta$, $\gamma$, $\delta$, and $\varepsilon$ in equation (II) differences between observed and computed cardiac diameter were minimized as follows:

$$\phi = \frac{1}{N} \sum (HD_{obs} - HD_{comp})^2 \qquad N = \text{Number of cases}$$

The usual least squares computation procedure provided the following result:

$$HD = \begin{cases} 135.9 + 0.5109W - 1.2620H + 0.2408A + 4.427B & \text{for Males} \\ 124.7 + 0.4650W - 1.0680H + 0.2612A + 3.289B & \text{for Females} \end{cases}$$

where the unit for weight is pounds; for height, inches; years for age; and millimeters for heart diameter. If kilogram and centimeter values are to be used for weight and height, respectively, the computation may be presented as follows:

$$HD = \begin{cases} 135.9 + 1.1265W - 0.48685H + 0.2408A + 4.427B & \text{for Males} \\ 124.7 + 1.0253W - 0.43047H + 0.2612A + 3.289B & \text{for Females} \end{cases}$$

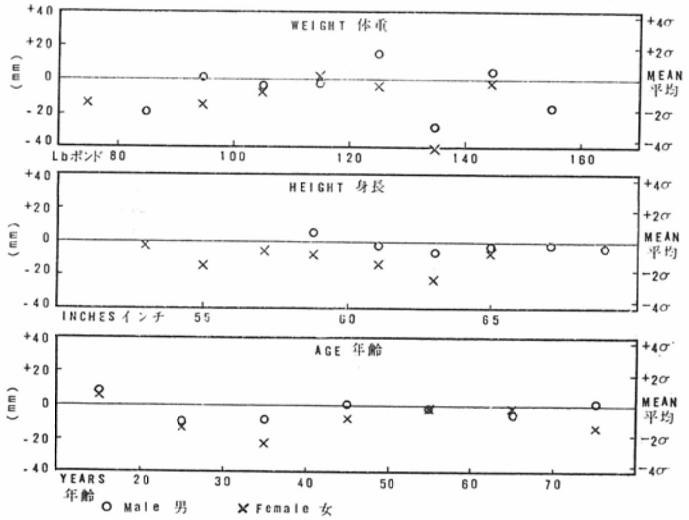
Again, the value of B = O for Class 1 and for hypertensive Class 2, B = 1. The standard deviation of observed heart size minus standard heart size, or the minimum value of $\phi$, is estimated as $(9.4mm)^2$ for males and $(8.7mm)^2$ for females.

Total variance for transverse heart diameter was $(12.4mm)^2$. The values for $\phi$ shown above are approximately half this figure. The residual variance for heart diameter after eliminating the effects of age, weight, and height was $(8.2mm)^2$ ……very near the values for $\phi$ shown above. This comparison shows that the proposed formula provided a good fit. The adequacy of the proposed formula also was checked for various specified subgroups. In Figure 4, the deviations between observed and computed values are plotted against weight, height, and age. No residual trend is apparent with regard to any of the three variables.

**INTERPRETATION OF THE TERM "WEIGHT"**

In this formulation the body weight has been interpreted as a part of normal change relative to the individual body build. However, it is apparent that weight beyond a certain range may be interpreted as obesity, and it is possible to introduce an idea of a standard

FIGURE 4 DEVIATION OF OBSEVED AND COMPUTED HEART SIZE BY WEIGHT, HEIGHT, AND AGE
図４ 心臓の大きさの観察値と算定値からの偏差; 体重，身長および年齢別




weight, presumably as a function of height and age. Thus, cardiac enlargement due to obesity is considered abnormal and the formula for deriving standard heart size, can be modified by substituting standard weight value for actual weight.

For such modification the height-specific mean value of weight is shown below for the same sample without detailed discussion :

in the pound-inch system,

$W_s = 3.32H - 90.92$ for Males $3.21H - 81.04$ for Females

in the kilogram-centimeter system,

$W_s = 0.593H - 41.234$ for Males $0.573H - 36.753$ for Females

This formula is, of course, merely descriptive, and makes no attempt to distinguish between cardiac enlargement associated with obesity, and cardiac enlargement associated with a large frame.

## NOMOGRAPH FOR STANDARD HEART SIZE AND DEVIATION

The nomograph devised for computing standard heart size for each sex utilizes five parallel vertical lines labeled height, weight, height plus age, age, and standard heart size. Height in centimeters and inches, age in years, and weight in kilograms and pounds are registered on the vertical scales so designated.

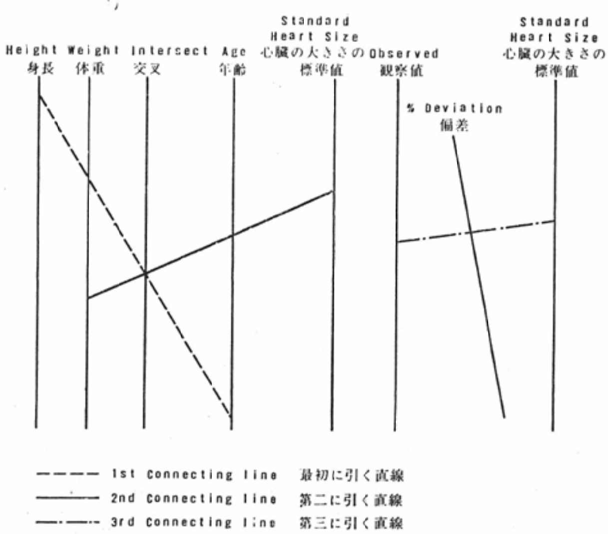
The first connecting line is drawn between the points registered on the individual height and age scales, thus providing an intersecting point on the height plus age scale. The second connecting line is drawn from the point registered for weight through the point registered on the height plus age scale and extended to intersect the vertical scale labeled standard heart size.

The nomograph for computing per cent deviation from standard heart size utilizes an "N" shaped diagram composed of three scales labeled observed heart size, per cent deviation, and standard heart size.

The observed heart size and the previously computed standard heart size are registered on the appropriate scales. The line drawn between these two points intersects the oblique line to provide registration of per cent deviation from standard heart size.

This nomograph procedure is illustrated in Figure 5.

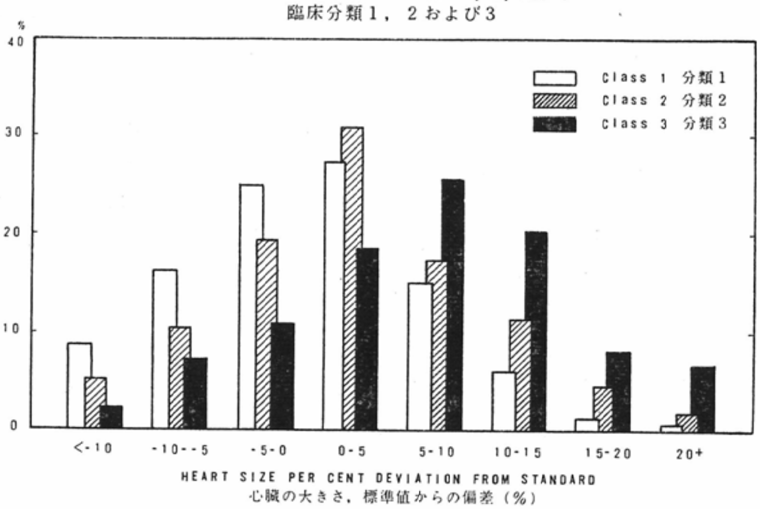
FIGURE 5 PROCEDURES FOR USING HEART NOMOGRAPH
図5 心臓の大きさ計算図表の使用法




## HEART SIZE RELATED TO HYPERTENSION AND HEART DISEASE

The use of heart size data is illustrated in Figure 6 where the range of cardiac enlargement is related to hypertension and overt heart disease.

FIGURE 6 DISTRIBUTION OF RELATIVE HEART SIZE
図6 相対的心臓の大きさの分布
CLINICAL CLASSIFICATIONS 1, 2, AND 3
臨床分類1, 2および3




The association of cardiac enlargement with hypertension and heart disease is found in subjects of all ages, as shown in Table 3, and prevalence appears to become greater with advancing age

TABLE 3 PREVALENCE OF HYPERTENSION AND HEART DISEASE BY RELATIVE HEART SIZE, AGE, AND SEX

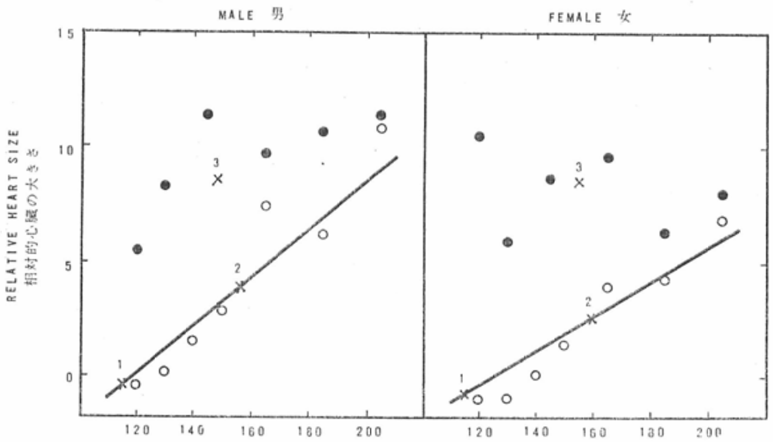
表3 高血圧症および心臓疾患の頻度；相対的心臓の大きさ，年齢および性別

| SEX 性 | AGE 年齢 | PREVALENCE OF HYPERTENSION† 高血圧症の例数 | | | PREVALENCE OF HEART DISEASE‡ 心臓疾患の例数 | | |
|---|---|---|---|---|---|---|---|
| | | RELATIVE HEART SIZE 相対的心臓の大きさ | | | RELATIVE HEART SIZE 相対的心臓の大きさ | | |
| | | <5% | 5-10% | 10%+ | <5% | 5-10% | 10%+ |
| MALE 男 | 10-29 | 11 | 18 | 36 | 2 | 5 | 14 |
| | 30-49 | 22 | 33 | 36 | 5 | 9 | 11 |
| | 50-69 | 48 | 62 | 85 | 11 | 13 | 32 |
| FEMALE 女 | 10-29 | 3 | 7 | 11 | 1 | 4 | 7 |
| | 30-49 | 18 | 21 | 41 | 2 | 9 | 21 |
| | 50-69 | 49 | 66 | 84 | 10 | 32 | 39 |

†Blood pressure higher than 140/90.
血圧が140／90以上の症例

Figure 7 shows the relationship of heart size and blood pressure for subjects with and without overt heart disease.

FIGURE 7 RELATION BETWEEN RELATIVE HEART SIZE AND BLOOD PRESSURE
図7 相対的心臓の大きさと血圧との関係




SYSTOLIC PRESSURE
収縮期血圧

○ Classes 1, 2 without overt heart disease.
分類1，2 明白な心臓疾患のないもの
● Class 3 with overt heart disease.
分類3 明白な心臓疾患のあるもの
× Mean value in each group.
各分類における平均値

For subjects without heart disease, heart size increases linearly with blood pressure. However, for subjects with overt heart disease the points are located above the straight line in Figure 7, indicating there are at least two factors associated with heart enlargement ; one, high blood pressure ; another something specific to overt heart disease.

## COMPARISON WITH OTHER DATA

Heart sizes reported for various populations were compared, although differences in deriving the standards do not allow precise comparison.

Table 4 appears to suggest larger heart sizes in normal Japanese than in the United

States population.

TABLE 4 COMPARISON OF HEART SIZE DATA REPORTED FOR VARIOUS POPULATIONS: TRANSVERSE DIAMETER FOR SPECIFIED WEIGHT AND HEIGHT CATEGORIES

表4 各種の人口集団について報告された心臓の大きさの資料の比較; 特定の体重および身長区分に対する横径

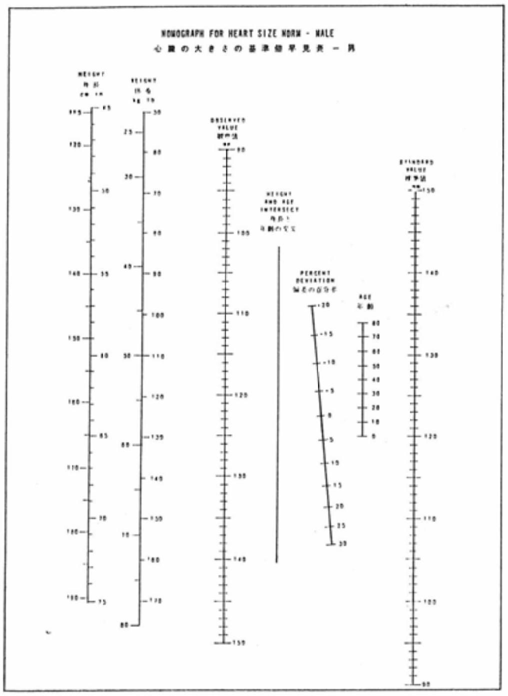
| WEIGHT 体重 | HEIGHT 身長 | JAPANESE POPULATION 日本の母集団 | | | | | UNITED STATES POPULATION 米国の母集団 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PRESENT STUDY 今回の研究 | | | | YOSHITOSHI 吉利 | HODGE, EYSTER | | UNGERLEIDER |
| | | AGE 年齢 40 | | AGE 年齢 60 | | AGE AND SEX UNSPECIFIED 年齢および性別非特定 | AGE 年齢 40 | AGE 年齢 60 | AGE AND SEX UNSPECIFIED 年齢および性別非特定 |
| | | MALE 男 | FEMALE 女 | MALE 男 | FEMALE 女 | | SEX UNSPECIFIED 性別非特定 | | |
| Pound | Inch | mm | mm | mm | mm | mm | mm | mm | mm |
| 100 | 58 | 123 | 120 | 128 | 125 | 116 | 109 | 111 | 112 |
| | 62 | 118 | 115 | 123 | 121 | 112 | 107 | 109 | 108 |
| | 64 | 113 | 111 | 118 | 116 | 108 | 105 | 107 | 105 |
| 120 | 58 | 134 | 129 | 138 | 134 | 127 | 116 | 118 | 122 |
| | 62 | 129 | 125 | 133 | 130 | 123 | 114 | 116 | 118 |
| | 64 | 124 | 120 | 128 | 125 | 118 | 112 | 114 | 115 |
| 140 | 58 | 144 | 138 | 149 | 144 | 137 | 124 | 126 | 132 |
| | 62 | 139 | 134 | 144 | 139 | 132 | 122 | 124 | 128 |
| | 64 | 134 | 130 | 139 | 135 | 128 | 120 | 122 | 126 |

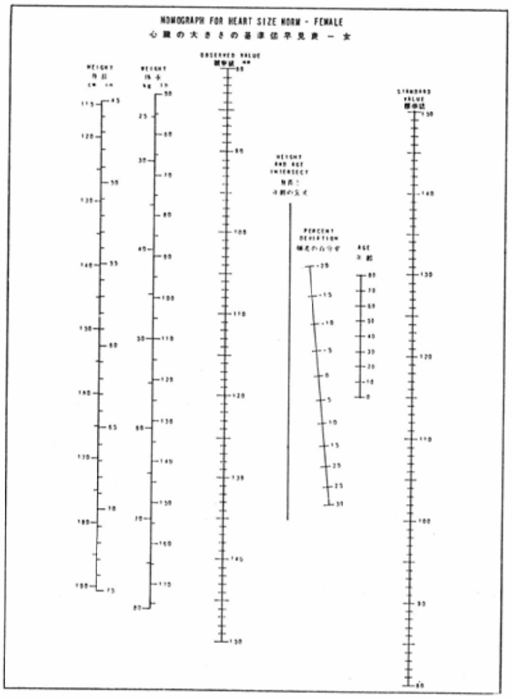

## SUMMARY

Utilizing the information obtained from the detailed clinical examinations of subjects seen at the Atomic Bomb Casualty Commission, standard heart size determinations in the Hiroshima population are provided. A formula has been devised to express the normal transverse cardiac diameter, obtained from the routine posteroanterior chest roentgenogram, in relation to weight, height, and age. The analysis was made for each sex separately. Values computed by using this formula are regarded as standard heart size. Deviations from the standard are interpreted as individual variability in the normal group, with a standard deviation of 9 mm. When this standard was applied to abnormal subjects, a high correlation between the relative heart size and the blood pressure or the presence of overt heart disease was evident. For this reason, the relative heart size for this standard should prove useful, together with other related factors, in the diagnosis and investigation of cardiovascular disease.

A nomograph has been devised for practical use. A copy of this nomograph is available from the Editorial Department, ABCC, Hiroshima.

## NOMOGRAPH FOR HEART SIZE NORM
## 心臓の大きさの基準値計算図表




## REFERENCES

1. Danzer CS : Cardiothoracic ratio ; an index of cardiac enlargement. Amer J Med Sci 157 : 513, 1919
2. Hodges PC, Eyster JAE : Estimation of cardiac area in man. Amer J Roentgenol 12 : 252–65, 1924
3. Hodges FJ, Eyster JAE : Estimation of transverse cardiac diameter in man. AMA Arch Inter Med 37 : 707–14, 1926
4. Ungerleider HE, Clark CP : A study of the transverse diameter of the heart silhouette with prediction table based on the teleoroentgenogram. Amer Heart J 17 : 92–102, 1939
5. Yoshitoshi M : Teleoroentgenography for transverse diameter of heart and its relation with body build in Japanese. Hoken Igaku–J Life Insur Med 55 : 14–17, 1957
6. Transverse Heart Diameter, Inter–office memorandum of ABCC to Dr. Pryde from R. L. Simon, 11 Jan 55
7. Hollingsworth JW, Beebe GW : Adult health study ; provisional research plan, ABCC TR 09–60

## SUPPLEMENTAL BIBLIOGRAPHY

1, Bainton JH : The transverse diameter of the heart. Amer Heart J 7 : 331–41, 1932
2. Newcomer E, Newcomer NB : Heart measurements. Radiology 27 : 521–32, 1936.
3. Ungerleider HE, Gubner R : Evaluation of heart size measurements. Amer Heart J 24 : 494–510. 1942
4. Comeau WJ, White PD : A critical analysis of standard methods of estimating heart size from roentgen measurements. Amer J Roentgenol 47 : 665–77, 1942
5. Packard JM, Strutner LA, et al : Electrocardiographic standards for healthy persons, 10–19 years of age ; heart size in adolescents. Research Project N M 140211. Subtask 13, Report No. 3, US Nav Sch Aviat Med 1957