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VITAL and HEALTH STATISTICS

DATA FROM THE NATIONAL HEALTH SURVEY

Heart Disease in Adults

United States - 1960 - 1962

A description of the examination and diagnostic procedures with major findings by age, sex, and race.

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HEART DISEASE IN ADULTS

Tavia Gordon, *Division of Health Examination Statistics*

The National Health Survey uses three methods for obtaining information about the health of the U.S. population. The first is a household interview in which persons are asked to give information relating to their health or to the health of other household members. The second is the collection of data from available health records. The third is direct examination. The Health Examination Survey was organized to use the third procedure, drawing samples of the population of the United States and, by medical examination and with various tests and measurements, undertaking to characterize the population under study.

The initial enterprise of the Health Examination Survey was the examination of a nationwide probability sample of 7,710 persons aged 18-79 years. Its purpose was to obtain information on the prevalence of cardiovascular disease, arthritis, diabetes and certain other chronic diseases, on dental health, and on the distribution of a number of anthropometric and sensory characteristics. Altogether, 6,672 persons were examined during the course of the Survey which was begun in October 1959 and completed in December 1962. Sample persons received a standard examination, lasting about 2 hours, performed by medical and other staff members of the Survey in specially designed mobile clinics.

This is one of a series of reports describing and evaluating the plan, conduct, and findings of the first cycle of the Health Examination Survey. The description of the general plan[1] and of the sample population and response[2] has been published. These provide general background for all reports of findings. In this report the cardiovascular examination is outlined and those parts of the examination relating to the diagnosis of heart disease are discussed. An account is given of the method of evaluating the findings and of the procedures used in arriving at diagnoses. The prevalence of heart disease in adults is summarized, for total heart disease and for specific diagnoses.

THE CARDIOVASCULAR EVALUATION

The cardiovascular evaluation included the following:

1. A medical history
2. A cardiovascular examination performed by a fellow or first-year resident in internal medicine with
   a. Three measurements of blood pressure
   b. Examination of the ocular fundi with an ophthalmoscope
   c. Examination of the neck for venous engorgement
   d. Inspection and palpation of the peripheral arteries
   e. Examination of the extremities for evidence of edema
   f. Examination of the heart by auscultation and palpation for thrills, heart sounds, or murmurs
   g. Other observations which might contribute to differential diagnosis, such as a set of serological tests for syphilis and evidences of thyroid enlargement, congenital malformations, physical impairments, and residuals of cerebrovascular accidents.

3. A 12-lead electrocardiogram
4. A chest X-ray—14 by 17 inches in size, taken at a 6-foot distance

The Medical History

The cardiovascular examination began with a self-administered medical history. After a brief interview by a receptionist, the examinee was asked to complete a medical history form. The receptionist remained available to provide the examinee with any assistance necessary. Included among the questions were some concerning cardiovascular symptoms or disease. These are shown in Appendix I. The examinee was then offered a drink which included 50 grams of glucose, unless he was under treatment for diabetes, and after completing the self-administered history was asked a few additional questions by the receptionist. These included questions about physical handicaps, major health problems, and operations and were designed to elicit relevant medical information that had not appeared in response to the more specific questions on the history. The receptionist, at the same time, reviewed the history both for completeness and for consistency and queried the examinee further where any deficiencies were evident.

The examining physician reviewed the medical history before beginning the physical examination. He attempted to correct any incompleteness or inconsistency remaining in the record and where the examinee had been uncertain in his answer attempted to arrive at a definite "yes" or "no" by further questioning. In some cases he could not. For most of the cardiovascular questions the physician was instructed to ask for further information if an answer of "yes" or "?" had been checked, or if the examinee had indicated that he did not know the answer. A series of standard probes were used (Appendix I) and the answers to these were recorded. When these probes were completed the physician was free to further question the examinee until he was satisfied that he had all the relevant information that could be obtained in a single session.

Among the cardiovascular questions two were of especial importance for the diagnosis of heart disease—questions 21 and 22 (Appendix I). These dealt with chest pain and heart pain. It was on the basis of the response to these questions and the associated probes that a diagnosis of angina pectoris was made. Responses to the other cardiovascular questions on the medical history form were also of assistance in, although not sufficient in themselves for, heart disease diagnosis.

The Cardiac Examination

After reviewing the medical history, the physician began the physical examination. Included in this was a standardized examination of the heart, undertaken without exercise. The precordium was palpated for thrills with the examinee first sitting upright, then leaning forward. This was first done with the examinee breathing normally and then repeated with the examinee holding his breath in expiration. Auscultation was done with a stethoscope, using both the bell and the diaphragm, and proceeded from the apex upward along the left sternal border and then to the pulmonic and aortic areas. It was done with the examinee upright, first breathing normally and then holding his breath in expiration. Next, palpation and auscultation were repeated with the examinee supine. Finally, he rolled over on his left side and was examined with the bell and palpated for thrills.

Findings from this examination were recorded on a standard form (Appendix II). If a murmur was noted it was described in specific terms, as to intensity, time, pitch, quality, and duration.[3] Intensity was graded on a five-point scale, from very faint (grade 1) to very loud (grade 5).

Blood Pressure Measurement

Three blood pressure measurements were made, the first just after the physician met the examinee; the second midway in the examination, after completing the auscultation of the heart in the sitting position; and the third at the end of the examination. Blood pressures were taken while the examinee was sitting on the examining table. The nurse placed the middle of the cuff over the bulge in the upper left arm. The cuff was left on the arm between the first and second measurements, removed after the second, and

returned for the third. The physician held the arm at the level of the atrium, with the nurse holding the Baumanometer at the physician's eye level. Using the bell of his stethoscope, the physician noted the pressure when the sound first was heard, when it first became muffled, and when it disappeared. All three measurements were recorded. The point at which the Korotkov sounds disappeared was taken as the diastolic pressure. If the sounds did not disappear, the point of muffling, if distinctly heard, was used. Since the Baumanometer is scaled in intervals of 2 mm., measurements were so recorded. Some results from this examination have already been reported.[4,5]

Other Parts of the Examination

For the chest X-ray, a posterior-anterior view was taken at a 6-foot distance and recorded on a 14 by 17 inch film. The exposure was taken in inspiration but was not timed for a fixed phase of the heart cycle. The electrocardiogram was obtained by a Twin Viso machine (model 60-1300). Twelve leads were recorded: I, II, III, AVR, AVL, AVF, V_1-V_6.

The other aspects of the cardiovascular examination, while not leading to the diagnosis of heart disease as such, were helpful either in evaluating the signs of heart disease or in determining a specific etiology. Thus, the presence of congenital abnormalities might contribute to the differential diagnosis of congenital heart disease. The finding of a positive serological test for syphilis was required in order to make a diagnosis of syphilitic heart disease.

Comparison With Clinical Examination

The uniform, single-visit examination used for the Health Examination Survey differed in both objectives and procedures from the usual clinical examination. In clinical practice the objectives are evaluation and medical management of the individual patient. Usually the patient is being studied because of some complaint for which he has sought medical advice. If the diagnosis or treatment seems obvious on clinical grounds, the workup may be minimal. On the other hand, if the diagnostic clues are equivocal, there may be an extended series of tests and consultations and the patient may be under observation for an appreciable period before diagnosis. Diagnosis may be modified by the patient's response to treatment, by his subsequent clinical history, or by new findings. There is, in short, a variable diagnostic workup and an extended opportunity to confirm or reject the original impressions.

On the other hand, the purpose of the Health Examination Survey is to characterize a population group. The cardiovascular examination was designed to provide reliable diagnostic information insofar as such information could be obtained during a single visit. Since there was no responsibility for patient care, persons with medical complaints need not be diagnosed as having disease if the findings were equivocal or nonspecific. Since persons did not present themselves for medical care but because they were members of a population sample, the absence of complaints gave no assurance that there was no disease. Therefore, a standardized examination was given to every examinee.

Prior to beginning the first cycle of the Health Examination Survey, a special study was undertaken under the direction of Dr. Jeremiah Stamler.[6] Its purposes were to design a single-visit cardiovascular examination which would yield diagnoses in accord with current survey practice, to compare diagnoses obtained by this examination with diagnoses obtained for the same individuals by a replicate of this examination, and to compare diagnoses made by the single-visit examination with diagnoses arrived at in clinical practice. The single-visit examination developed for this study was later adopted, with minor modifications, by the Health Examination Survey for use in its examination of adults.

While there is a distinct contrast between the standardized single-visit examination and a clinical examination, the study did not find large differences between the two in diagnostic results. The chief discrepancies were with respect to coronary heart disease. The diagnosis of angina pectoris was more common on the single-visit examination than on the clinical, whereas minor electrocardiographic abnormalities were more

likely to lead to a diagnosis of coronary heart disease on the clinical examination than on the single-visit examination.

HEART DISEASE DIAGNOSIS

Several intermediate steps were involved in progressing from examination findings to heart disease diagnoses. The first step was interpreting the chest X-ray film and the electrocardiographic tracing. The second was constructing a set of diagnostic criteria. The third was developing a procedure for translating the findings from the examination and the interpretation of the X-ray and electrocardiogram into specific diagnoses. How these steps were taken for the Health Examination Survey is discussed in the following sections.

Interpretation of the X-ray and Electrocardiogram

Both the electrocardiogram and the chest X-ray were interpreted independently by several specialists. These interpretations were made without any other information about the examinee.

The electrocardiogram was read independently by three cardiologists according to criteria agreed upon in advance. These criteria are specified in Appendix III, which also contains a reproduction of the precoded form on which the findings were entered. For all major findings allowance was made for designating any electrocardiographic abnormality observed by the electrocardiographic reader even though the specified criteria for that abnormality were not satisfied. After completion, the three independent determinations were compared. Where they all agreed, the unanimous decision was used for subsequent diagnosis. In the event that there was any disagreement, the three met with Dr. Michael A. Corrado, who served as coordinator for this work, and together they came to a final decision. This final decision was the one used in such cases.

The evaluation of the chest X-ray was a somewhat more complicated undertaking. Initially, arrangements were made to have the X-ray films interpreted by radiologists specializing in pulmonary disease. In addition to noting evidence of pulmonary disease, the "pulmonary readers" were requested to record evidence of distinct cardiovascular abnormality. As had been anticipated, this led to an estimate of the prevalence of cardiovascular abnormalities which was much lower than is ordinarily found in cardiovascular surveys. Another group of radiologists was therefore employed to reexamine the films for evidence of cardiovascular abnormality. These "cardiovascular readers" were chosen on the basis of standards set by Dr. Lloyd E. Hawes, radiologist for the Framingham Heart Study. A set of films from the Health Examination Survey was read first by him and then by a number of different radiologists. Three were found to employ about the same standards as Dr. Hawes and were chosen to read the Health Examination Survey films for cardiovascular abnormalities. Each was given a random third of the films to read. The forms used in recording the radiological findings for both the "pulmonary readers" and the "cardiovascular readers" are reproduced in Appendix IV.

The reading procedure was designed as follows. A finding of general cardiac enlargement or left ventricular hypertrophy, definite or possible, was considered "positive." All films were read by two pulmonary readers and one cardiovascular reader. The determination of the two pulmonary readers provided a preliminary evaluation. If both considered the film "positive" a decision of enlargement was made whatever the findings of the cardiovascular reader. If they disagreed and the cardiovascular reader considered the film positive, the decision was that enlargement was present; otherwise a second cardiovascular reader interpreted the film and his decision was final. If the two pulmonary readers considered the film "negative" and the cardiovascular reader agreed with them, the decision was that no enlargement was present; otherwise a second cardiovascular reader examined the film and his decision was binding. All decisions were made independently and no reconciliation of differences was undertaken.

The rationale for this procedure is too complicated to be discussed at this point. It is partly explained in Appendix IV. The effect was to produce reading results which conformed well, both in level of abnormalities found and in

attributions to specific individuals, with the standards of the Framingham Heart Study.

Classification and Criteria

After extensive consultation the Health Examination Survey arrived at the following diagnostic categories and criteria for hypertension and heart disease. Ultimately, they were derived from definitions of the New York Heart Association[3] but were modified to fit the circumstances of population surveys in general and of the Health Examination Survey in particular.[7,8]

Hypertension

Hypertension.—160 mm. hg. or over systolic or 95 mm. hg. or over diastolic

Borderline hypertension.—Below 160 mm. hg. systolic and below 95 mm. hg. diastolic, but not simultaneously below both 140 and 90 mm. hg.

Normotension.—Below both 140 mm. hg. systolic and 90 mm. hg. diastolic

(When aortic insufficiency is present or the heart rate is under 60, hypertension or borderline hypertension must be defined by the diastolic pressure.)

Hypertensive Heart Disease

Definite.—One of the following:

1. Hypertension plus left bundle branch block or left ventricular hypertrophy (LVH) by ECG. (By voltage criteria when 35 years of age or over. If under 35 years left ventricular or subendocardial ischemia must be present in addition to LVH by voltage criteria. No person under 35 had hypertension or borderline hypertension with this combination of ECG findings.)
2. Hypertension plus LVH or general cardiac enlargement (GCE) by X-ray.
3. A history of hypertension currently on medication for hypertension, and LVH or GCE by X-ray and/or LVH by ECG.

Suspect.—One of the following:

1. Borderline hypertension plus LVH by ECG and/or LVH or GCE by X-ray.
2. Borderline hypertension plus LVH or GCE by X-ray.

Rheumatic Heart Disease

Definite.—One of the following:

1. Any diastolic murmur in the absence of evidence of a congenital or syphilitic etiology.
2. If there is no history of rheumatic fever or chorea, a grade 4 pansystolic murmur at the apex in the absence of other evidence of congenital heart disease.
3. History of rheumatic fever or chorea and a grade 3 pansystolic murmur at the apex.

No Suspect Category

Syphilitic Heart Disease

Definite.—Positive serology and a diastolic murmur at the base.

No Suspect Category

Coronary Heart Disease

Definite.—One of the following:

1. Myocardial infarction (MI) on ECG and/or definite angina (judgment of examining physician). Angina will not be ascribed to coronary heart disease if aortic stenosis or syphilitic heart disease is present.
2. History of myocardial infarction in judgment of examining physician and either left ventricular ischemia on the ECG or myocardial infarction on ECG outside criteria.

Suspect.—One of the following:

1. History of myocardial infarction in judgment of examining physician with no evidence of myocardial infarction or left ventricular ischemia on the ECG.
2. Suspect angina (judgment of examining physician).

Congenital Heart Disease

Individual case review—no suspect category

Other Heart Disease

Definite.—One of the following:

Medical examination

1. Aortic stenosis (a systolic ejection murmur accompanied by a thrill at the base with diminished or absent A_2 in the absence of other etiology).

ECG findings

2. Left bundle branch block
3. Complete heart block
4. Atrial fibrillation
5. LVH including left ventricular ischemia or subendocardial ischemia

Suspect.—One of the following:

X-ray findings

1. Cardiomegaly (LVH or GCE)

ECG findings

2. Right bundle branch block (complete)
3. Partial A-V block
4. Atrial flutter
5. Right ventricular hypertrophy
6. Isolated left ventricular ischemia

There are some omissions from this list. Because sample persons had to visit the mobile center for examination two manifestations of heart disease were automatically omitted. The first were acute clinical episodes. The second were episodes which run a rapid fatal course—in particular, coronary heart disease first manifesting itself as "sudden death." Moreover, past manifestations which left only equivocal evidence were also undiagnosed.

In addition, the Survey chose to ignore two important clinical manifestations of heart disease. It was thought that the examination was not adequate for diagnosing cases of congestive heart failure. To be sure, most such cases were diagnosed as some form of heart disease, anyhow, because of other findings in the examination, but a few cases did elude diagnosis. Cor pulmonale was also omitted, again because it was decided that the examination was inadequate for differential diagnosis. Again a few cases of heart disease were not diagnosed because of this omission.

In diagnosing rheumatic, congenital, and syphilitic heart disease no provision was made for a category of suspect disease, chiefly because such diagnoses depend on quite subtle differentiations of heart sounds and murmurs. It was thought that without verification of the examining physician's impressions it would be unwise to place great weight on such evidence; therefore the Survey considered it preferable to omit suspect categories for these diseases.

Diagnosis

After all the findings were available, the final step was to arrive at a diagnosis. Even in favorable circumstances this is a difficult process to standardize. In the Health Examination Survey, it was more difficult than usual. There were 62 different examining physicians. To rely on their consistent use of the same diagnostic standards and criteria was clearly impossible. What is more, they did not have available the specialist judgments on the electrocardiographic tracing and the chest X-ray or the findings from the serological tests for syphilis. Thus, though the examining physician was requested to enter his diagnostic impressions, these were used only as indicators; the final diagnoses were made by the permanent staff of the Survey, with consultant help in difficult cases.

The first step in this procedure was to supply a set of rules suitable for diagnosis by computer, which would convert the coded information from the medical record and from the interpretation of the X-ray film and the electrocardiogram into a diagnostic decision. An example of the computer output is given in Appendix V. Some of these decisions were then subject to review. For the first few hundred cases all computer diagnoses were reviewed by Dr. Alice M. Waterhouse, medical advisor to the National Center for Health Statistics. These reviews made it evident that many diagnostic decisions did not require a special medical review and the classes of cases subject to review were finally narrowed to the following:

1. Cases with significant murmurs.
2. Cases with a diagnosis of angina pectoris.
3. Cases where the diagnosis depended on a

history of hypertension or a history of myocardial infarction.

4. Cases with electrocardiographic findings of myocardial infarction outside of criteria or of left ventricular ischemia, where a diagnosis of definite coronary heart disease had not been made.
5. Cases diagnosed as having heart disease by the examining physician but not by the computer.

This omitted from review those cases with a clear and definite diagnosis of heart disease on the available evidence and those cases where there was no possibility of diagnosing heart disease from the available evidence.

In most cases where the computer diagnosis was reviewed, the diagnostic decision made by the computer was unaltered. In a few instances, however, there was a diagnostic change on the basis of review. Where a review decision seemed to require specialist judgment the case was referred to Dr. Abraham Kagan of the Framingham Heart Program for a final decision. The discussion of the details of these decisions is not feasible, but in general equivocal evidence of heart disease was treated as nondiagnostic, although it was recognized that some of these cases would warrant medical supervision.

The review procedure did more than arrive at final diagnoses. It also submitted the diagnostic criteria to repeated scrutiny. In the balance they appear to be both reasonable and conservative.

MAJOR FINDINGS

Of the 111.1 million adults in the United States, some 14.6 million had definite heart disease and nearly the same number had suspect heart disease. Of every 100 persons aged 18-79 years, 13.2 had definite heart disease while an additional 11.7 had suspect heart disease (table A).

Among the specific forms of the disease, the one most commonly encountered was hypertensive heart disease. More than 10 million adults had definite hypertensive heart disease; nearly 4.8 million had suspect hypertensive heart disease. Numerically, coronary heart disease was next in importance, with 3.1 million definite and 2.4 million suspect cases. Other forms of heart disease accounted for substantially fewer cases.

Sex

Definite heart disease was more prevalent in women than in men, while suspect heart disease was more prevalent in men than in women (tables 1 and B). The relationship varied with the diagnosis. Women were more likely to have definite hypertensive heart disease; men were more likely to have definite coronary heart disease or heart

Table A. Prevalence of definite and suspect heart disease in adults, by heart disease diagnosis: United States, 1960-62

Heart disease diagnosis	Definite heart disease	Suspect heart disease	Definite heart disease	Suspect heart disease
	Number of adults in thousands		Percent of all adults	
Total	14,621	12,979	13.2	11.7
Hypertensive	10,499	4,759	9.5	4.3
Coronary	3,125	2,410	2.8	2.2
Rheumatic	1,270	...	1.1	...
Congenital	244	...	0.2	...
Syphilitic	147	...	0.1	...
Other	292	7,330	0.3	6.6

NOTE: Counts for "Other" exclude persons with any of the specified heart diseases. Counts for the specified heart diseases, on the other hand, are not exclusive. The criteria do not provide for "possible" categories of rheumatic, congenital, or syphilitic heart disease.

Table B. Prevalence of definite and suspect heart disease in men and women, by heart disease diagnosis: United States, 1960-62

Heart disease diagnosis	Men	Women	Men	Women
Definite heart disease	Number of adults in thousands		Percent of all adults	
Total	6,652	7,970	12.6	13.7
Hypertensive	4,050	6,449	7.7	11.1
Coronary	1,945	1,180	3.7	2.0
Rheumatic	608	662	1.2	1.1
Congenital	160	84	0.3	0.1
Syphilitic	91	57	0.2	0.1
Other	128	164	0.2	0.3
Suspect heart disease				
Total	7,315	5,663	13.9	9.7
Hypertensive	2,518	1,914	4.8	3.3
Coronary	1,136	1,274	2.2	2.2
Other	4,122	3,208	7.8	5.5

NOTE: Counts for "Other" exclude persons with any of the specified heart diseases. Counts for specified heart diseases, on the other hand, are not exclusive. The criteria do not provide for "possible" categories of rheumatic, congenital, or syphilitic heart disease.

disease of congenital or syphilitic origin. On the other hand, suspect hypertensive heart disease was more common in men than in women, while suspect coronary disease was more common in women than in men. The significance of these differentials will not be discussed in this report.

Race

Heart disease was more common in Negro than in white adults (tables 2 and C). (Comparison of racial differences is limited to findings for white and Negro persons since the sample was too small to permit adequate representation of other nonwhite races.) Some 24.4 per 100 Negro adults had definite heart disease as contrasted with 12.0 per 100 white adults. For suspect heart disease, the prevalence rates were 14.8 and 11.3 per hundred, respectively. This racial difference, evidenced by both men and women, arose from the marked racial contrast in the prevalence of hypertensive heart disease. For definite hypertensive heart disease, the prevalence was nearly 3 times as great for Negro men as for white and 2.2 times as great for Negro as for white women. A similar, but much smaller, difference was noted for suspect hypertensive heart disease. With other heart disease categories, where prevalence rates were lower, it is difficult to be sure whether there was a racial difference in the prevalence of disease. For coronary and rheumatic heart disease, specifically, there is no evidence from this Survey of a racial difference in prevalence.

Age

The prevalence of heart disease rose sharply with age. In the age group 18-24 years, less than 2 percent had definite heart disease. By age 75-79 years, 39 percent of the men and 46 percent of the women had definite heart disease (table 1). A similar, although less steep, gradient with age was observed for suspect heart disease.

Table C. Prevalence of definite and suspect heart disease in white and Negro adults, by heart disease diagnosis: United States, 1960-62

Heart disease diagnosis	White	Negro
	Percent of specified race	
Definite heart disease		
Total	12.0	24.4
Hypertensive	8.2	20.8
Coronary	2.9	2.6
Rheumatic	1.1	1.7
Congenital	0.2	0.2
Syphilitic	0.1	0.7
Other	0.3	0.2
Suspect heart disease		
Total	11.3	14.8
Hypertensive	3.9	4.9
Coronary	2.2	2.6
Other	6.4	8.3

NOTE: Counts for "Other" exclude persons with any of the specified heart diseases. Counts for the specified heart diseases, on the other hand, are not exclusive. The criteria do not provide for "possible" categories of rheumatic, congenital, or syphilitic heart disease.

The majority of all persons in the age group 75-79 years had heart disease of some form, with more persons manifesting definite than suspect evidence of such disease. Heart disease was more common in men than in women until age 55 years and more common in women at older ages. In other words, heart disease prevalence rose with age more rapidly for women than for men.

The tendency for heart disease prevalence to increase sharply with age can be observed in both definite and suspect hypertensive and coronary heart disease (tables 3 and 4, figs. 1, 2, and 3). The curves exhibiting prevalence by age tended to be steeper for women than for men in definite hypertensive heart disease and suspect coronary heart disease. For definite coronary heart disease the curves for men and women are closely parallel, while for suspect hypertensive heart disease a sex difference is moot.

The prevalence of rheumatic heart disease also increased with age (table 5, fig. 4). For syphilitic and congenital heart diseases there were too few sample cases for any judgments to be made about differentials by age, sex, or race.

Multiple Diagnosis

In a substantial number of cases a diagnosis of heart disease, while appearing under one rubric, could have been made on more than one basis. Thus, the weight of evidence of heart disease is really greater than has been indicated up to this point. At the same time the relative frequency of multiple heart disease findings complicates the discussion considerably. Among persons with suspect hypertensive heart disease, for example, are some with only marginal evidence of heart disease and others with very definite evidence of heart disease, perhaps with a grossly enlarged heart and distinct electrocardiographic abnormality, but with only marginal evidence of a hypertensive etiology. This is equally true of other diagnostic categories. The following examples will make this clearer.

Of the persons with definite hypertensive heart disease fully 89 percent would be considered to have heart disease even in the absence of hypertension (table D). Some 16 percent had coexisting coronary heart disease or some other specific form of heart disease. About 7 percent more would be considered to have definite heart disease on the basis of their electrocardiograms and for another 64 percent a finding of heart enlargement on X-ray would, by itself, have led to a diagnosis of suspect heart disease. For suspect hypertensive heart disease the comparable percentages are equally impressive. Some 14 percent had another specific heart disease, another 2 percent had definite heart disease on the basis of their electrocardiogram, while 69 percent more would be considered to have suspect heart disease on the basis of evidence of heart enlargement by X-ray.

With coronary heart disease the situation is similar (table E). About 41 percent of all definite cases of coronary heart disease had coexisting hypertensive heart disease or some other specific heart disease and another 15 percent had some other evidence of heart disease. For suspect

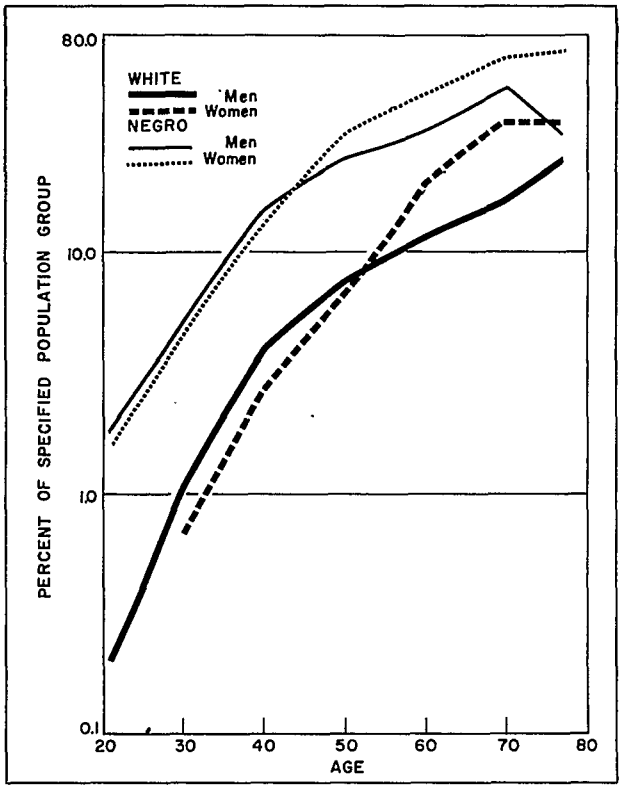

Figure 1. Prevalence of definite hypertensive heart disease for white and Negro adults, by age and sex.

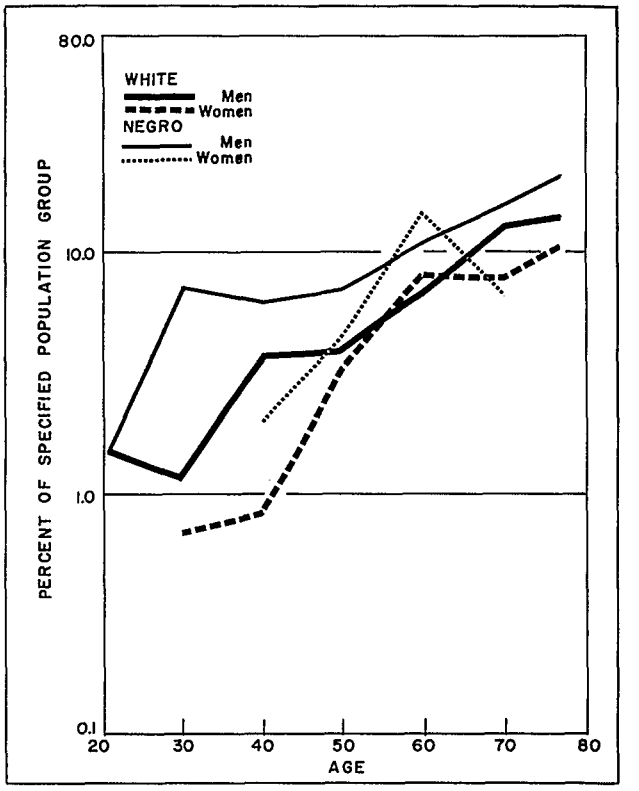

Figure 2. Prevalence of suspect hypertensive heart disease for white and Negro adults, by age and sex.

NOTE: Because of the small sample size, rates for the Negro population are subject to very high sampling errors.

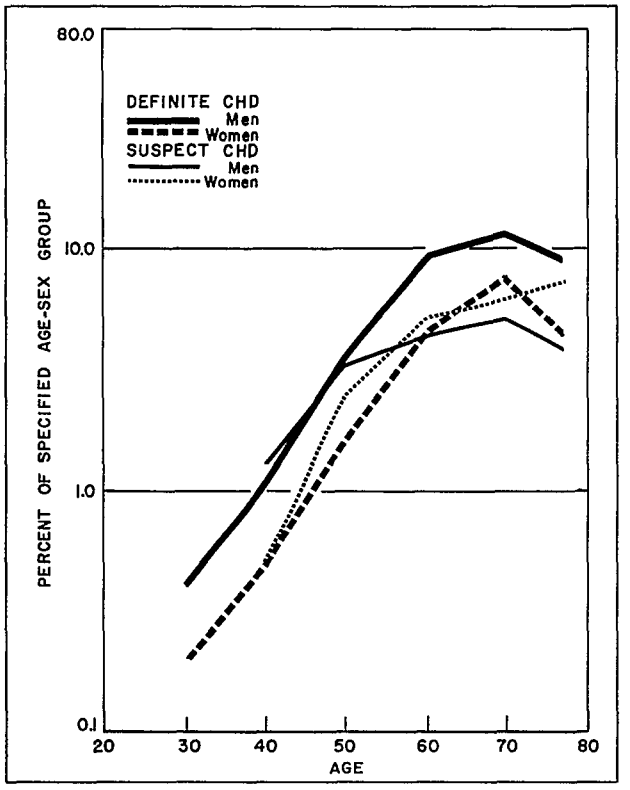

Figure 3. Prevalence of definite and suspect coronary heart disease, by age and sex.

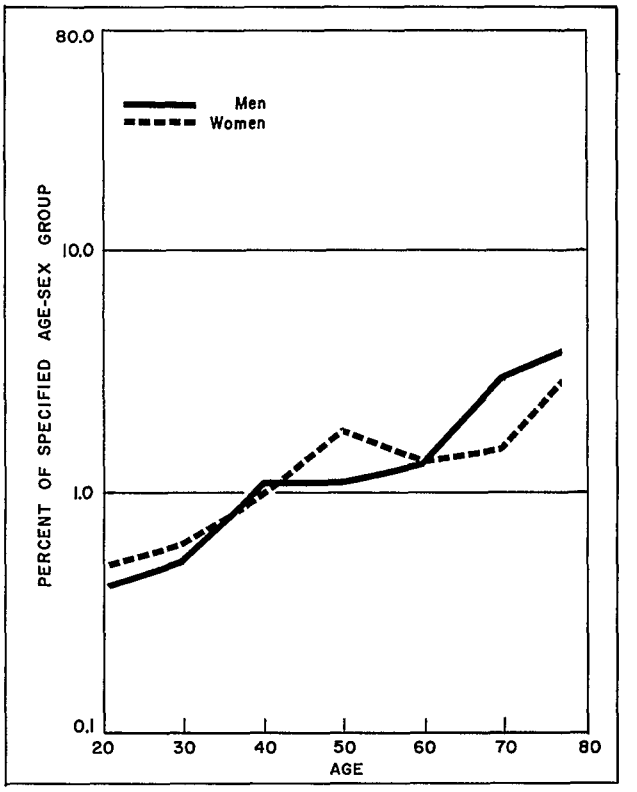

Figure 4. Prevalence of definite and suspect rheumatic heart disease, by age and sex.

Table D. Prevalence of definite and suspect hypertensive heart disease in adults with and without other heart disease: United States, 1960-62

Other heart disease diagnosis	Hypertensive heart disease diagnosis	
	Definite	Suspect
	Number of adults in thousands	
Total	10,499	4,759
None	1,205	724
Coronary heart disease		
Definite	917	337
Suspect	623	178
Other specified heart disease	149	138
Heart disease, other	7,605	3,382

NOTE: The category "Other specified heart disease" consists of rheumatic, congenital, or syphilitic heart disease. Counts are exclusive. Categories are listed in order of descending priority.

Table E. Prevalence of definite and suspect coronary heart disease in adults with and without other heart disease: United States, 1960-62

Other heart disease diagnosis	Coronary heart disease diagnosis	
	Definite	Suspect
	Number of adults in thousands	
Total	3,125	2,410
None	1,361	1,308
Hypertensive heart disease		
Definite	917	623
Suspect	337	178
Other specified heart disease	30	47
Heart disease, other	480	254

NOTE: The category "Other specified heart disease" consists of rheumatic, congenital, or syphilitic heart disease. Counts are exclusive. Categories are listed in order of descending priority.

coronary heart disease 35 percent of the persons had another specific heart disease and 11 percent more had some other evidence of heart disease.

Furthermore, an appreciable number of cases of hypertensive heart disease were manifest on both the X-ray and the electrocardiogram (fully 21 percent of all definite cases and 11 percent of all suspect cases). Multiple evidence of coronary heart disease also was common.

In short, heart disease is very often a complex, multifaceted disease entity, inadequately displayed by the rubrics in current use.

Other Heart Disease

Some examination findings, while clearly indicating heart disease, did not satisfy the criteria for hypertensive, coronary, rheumatic, congenital, or syphilitic heart disease. These were incorporated into a miscellaneous category "Other heart disease"; those persons who had such findings but none of the specified heart diseases were so categorized. This category, then, unlike the others, was used only if a person could not be categorized as having heart disease on other grounds.

Two kinds of evidence were considered indicators of definite "Other heart disease." The first was aortic stenosis. The second were certain electrocardiographic findings, the most common of which were left bundle branch block and atrial fibrillation. It was rare that either of these indicators was found in persons who did not have heart disease defined on some other basis. In fact, a total of only 271,000 adults was estimated to have definite "Other heart disease," most of these on the basis of the electrocardiogram.

Suspect "Other heart disease" was diagnosed if none of the specified heart diseases were diagnosed and definite "Other heart disease" was not present but if heart enlargement was noted on the X-ray. Heart enlargement without a defined etiology was very common: it is estimated that

6,910,000 adults had this finding using the Survey standards. Electrocardiographic findings indicating suspect "Other heart disease" were much less common. Most cases diagnosed on these grounds had either right bundle branch block or left ventricular ischemia, with the cases being evenly divided between these two categories. As with other findings included in "Other heart disease," left ventricular ischemia was much more commonly found with other evidence of specific heart disease than it was as an isolated finding.

Heart Findings

Up to this point the discussion has focused on persons with cardiac findings satisfying the diagnostic criteria of this Survey. Between such persons and persons who clearly and certainly gave no evidence of heart disease was a group of persons with possibly serious but nondiagnostic heart findings. If they were under a physician's care it is probable that some of these would be designated as having heart disease. At the very least, they would be reexamined at regular intervals or submitted to additional diagnostic tests.

Two kinds of findings may be mentioned (table F). The first was a miscellaneous set of electrocardiographic findings. These range from nonspecific T-wave abnormalities to electrocardiographic tracings which fall just short of the rather severe Survey criteria for myocardial infarction. Fully 6.4 percent of all adults had such findings in the absence of diagnosed heart disease. The second was a significant systolic murmur, which another 2.8 percent had. Altogether 9.2 percent of all persons had at least one of these findings but were not diagnosed as having heart disease.

Table F. Number of adults with specified cardiac findings but without diagnosed heart disease: United States, 1960-62

	Number of adults in thousands
Electrocardiographic findings	
Myocardial infarction outside of criteria	163
Left ventricular hypertrophy	2,644
Subendocardial ischemia[1,2]	567
Nonspecific T-wave abnormalities[1,3]	1,857
Incomplete right bundle branch block or I-V block	503
Tachycardia or abnormal nodal rhythm	185
Miscellaneous abnormalities of the Q or P waves	383
Left axis deviation with specified history[4]	793
First degree A-V block with specified history[5]	161
Physical examination findings	
Significant systolic murmur	3,476

[1]Inside or outside criteria.
[2]With or without digitalis effect.
[3]Includes left ventricular ischemia outside criteria.
[4]Chest pain, heart pain, high blood pressure, or heart trouble.
[5]Rheumatic fever, chorea, high blood pressure, or heart trouble.
NOTE: Counts are not exclusive.

SUMMARY

There were about 14 million adults in the United States with definite heart disease and nearly the same number with suspect heart disease. The most common form of heart disease was hypertensive.

Definite heart disease was more frequent among women, and suspect heart disease was more frequent among men.

Hypertensive heart disease was more common in Negro than in white adults.

The prevalence of heart disease rose steeply with age. This age trend was evident for hypertensive, coronary, and rheumatic heart disease, although the rate of rise varied with the diagnosis. Altogether, less than 2 percent of persons in the age group 18-24 years had definite heart disease, while 39 percent of all men aged 75-79 years and 46 percent of all women in this age group had definite heart disease.

A large number of persons with heart disease had more than one manifestation of the disease. A large number of persons without diagnosed heart disease had possibly serious cardiac findings.

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DETAILED TABLES

Table 1. Prevalence of definite and suspect heart disease in men and women, by age: United States, 1960-62

Age	Definite heart disease			Suspect heart disease		
	Both sexes	Men	Women	Both sexes	Men	Women
	Percent of specified age-sex group					
Total-18-79 years	13.2	12.6	13.7	11.7	13.9	9.7
18-24 years	1.2	1.4	1.1	4.0	6.4	2.0
25-34 years	2.4	2.9	2.0	4.9	6.6	3.3
35-44 years	6.7	7.4	6.1	8.8	11.4	6.4
45-54 years	13.2	13.8	12.5	15.3	18.3	12.4
55-64 years	25.3	24.2	26.2	19.4	18.5	20.1
65-74 years	39.9	33.2	45.2	20.7	25.3	17.1
75-79 years	42.3	38.8	45.8	25.2	27.1	23.3

Table 2. Prevalence of definite and suspect heart disease for white and Negro adults, by age and sex: United States, 1960-62

Age	Men		Women	
	White	Negro	White	Negro
	Percent of specified population group			
Definite heart disease				
Total-18-79 years	11.5	23.8	12.5	24.8
18-24 years	1.4	1.9	0.8	3.2
25-34 years	2.5	7.9	1.4	6.8
35-44 years	6.1	18.1	4.9	14.0
45-54 years	11.3	33.0	9.6	36.6
55-64 years	22.5	41.6	23.7	52.2
65-74 years	31.3	56.9	43.5	70.1
75-79 years	39.3	32.3	44.8	69.5
Suspect heart disease				
Total-18-79 years	13.5	17.6	9.3	12.6
18-24 years	6.3	6.7	1.2	8.3
25-34 years	5.5	16.9	2.6	7.8
35-44 years	10.6	16.7	5.4	13.0
45-54 years	18.4	18.2	11.8	14.8
55-64 years	17.6	28.2	20.3	20.3
65-74 years	26.4	11.9	17.3	16.2
75-79 years	25.3	50.3	23.4	14.2

Table 3. Prevalence of definite and suspect hypertensive heart disease for white and Negro adults, by age and sex: United States, 1960-62

Age	Men		Women	
	White	Negro	White	Negro
	Percent of specified population group			
Definite hypertensive heart disease				
Total-18-79 years	6.5	19.1	9.8	22.2
18-24 years	0.2	1.9	-	1.6
25-34 years	1.1	5.2	0.7	4.7
35-44 years	4.0	15.2	2.7	14.0
45-54 years	7.7	24.4	6.8	31.5
55-64 years	11.7	33.1	19.5	46.4
65-74 years	16.3	50.2	37.5	66.4
75-79 years	24.0	32.3	37.1	69.5
Suspect hypertensive heart disease				
Total-18-79 years	5.0	7.6	3.3	4.7
18-24 years	1.5	1.5	-	-
25-34 years	1.2	7.3	0.7	-
35-44 years	4.0	6.2	0.8	3.6
45-54 years	4.3	10.5	3.4	5.9
55-64 years	7.3	13.8	8.5	15.0
65-74 years	13.8	-	8.4	10.3
75-79 years	15.7	21.4	10.7	14.2

Table 4. Prevalence of definite and suspect coronary heart disease for white and Negro adults, by age and sex: United States, 1960-62

Age	Men		Women	
	White	Negro	White	Negro
Definite coronary heart disease	Percent of specified population group			
Total-18-79 years	3.8	3.2	2.1	2.0
18-24 years	-	-	-	-
25-34 years	0.1	3.1	0.2	-
35-44 years	1.2	-	0.4	1.0
45-54 years	3.0	7.4	1.3	3.9
55-64 years	10.3	5.7	4.7	5.5
65-74 years	12.2	3.4	8.2	5.1
75-79 years	9.8	-	5.1	-
Suspect coronary heart disease				
Total-18-79 years	2.1	3.1	2.2	2.2
18-24 years	-	-	-	-
25-34 years	-	-	0.2	-
35-44 years	1.0	3.5	0.5	0.9
45-54 years	3.5	2.8	2.4	4.1
55-64 years	4.2	7.7	5.3	4.3
65-74 years	5.1	7.5	6.2	9.0
75-79 years	4.1	-	8.5	-

Table 5. Prevalence of rheumatic heart disease in men and women, by age: United States, 1960-62

Age	Both sexes	Men	Women
	Percent of specified age-sex group		
Total-18-79 years	1.1	1.2	1.1
18-24 years	0.5	0.4	0.5
25-34 years	0.5	0.5	0.6
35-44 years	1.1	1.1	1.0
45-54 years	1.5	1.1	1.8
55-64 years	1.3	1.3	1.3
65-74 years	2.2	3.0	1.5
75-79 years	3.3	3.8	2.9

APPENDIX I.

MEDICAL HISTORY QUESTIONS RELATED TO CARDIOVASCULAR DISEASE

(Excerpts From HES-204, Medical History-Self Administered)

1. a. In the past few years have you had any headaches? YES NO ?
   If YES b. How often? Every few days Less often
   c. Do they bother you quite a bit just a little
   Probes A,B

2. a. In the past few years have you had any nosebleeds? YES NO ?
   If YES b. How often? Every few days Less often
   c. Do they bother you quite a bit just a little
   Probe A

3. a. At any time over the past few years, have you ever noticed ringing in your ears or have you been bothered by other funny noises In your ears? YES NO ?
   If YES b. How often? Every few days Less often
   c. Do they bother you quite a bit just a little
   Probes A,B

4. a. Have you ever had spells of dizziness? YES NO ?
   If YES b. How often? Every few days Less often
   c. Do they bother you quite a bit just a little
   Probe A

5. Have you ever fainted or blacked out? YES NO ?

6. a. Have you ever had a stroke? YES NO ?
   If YES b. Have you had a stroke in the past 12 months? YES NO ?
   c. Have you ever seen a doctor about it? YES NO ?

7. Has any part of your body ever been paralyzed? YES NO ?

9. Was there anytime in your life when you had a lot of bad sore throats? YES NO ?

16. a. Have you ever been bothered by shortness of breath when climbing stairs? YES NO ?
   If YES b. How often? Almost everytime Less often
   c. Does it bother you quite a bit just a little
   Probes A,D

17. a. Have you ever been bothered by shortness of breath when doing physical work or exercising? YES NO ?

If YES b. How often? Almost everytime Less often

c. Does it bother you quite a bit just a little

18. a. Have you ever been bothered by shortness of breath when you were not doing physical work or exercising? YES NO ?

Probe A

If YES b. How often? Every few days Less often

c. Does it bother you quite a bit just a little

19. a. Have you ever been bothered by shortness of breath when you are excited or upset about something? YES NO ?

If YES b. How often? Almost everytime Less often

c. Does it bother you quite a bit just a little

20. a. Have you ever waked up at night because you were short of breath? YES NO ?

Probe A

If YES b. How often? Every few nights Less often

c. Does it bother you quite a bit just a little

21. a. In the past few years, have you ever had any pain, discomfort, or tightness in your chest? YES NO ?

Probes A,B

IF YES, please answer questions b through j below.

b. How often? Every few days Less often

c. Does it bother you quite a bit just a little

d. Where does it bother you? (Check every place it bothers you.)

Front Back Right side Middle Left side

Somewhere else State where _____

e. Does it usually stay in one place move around ?

f. How long does the pain usually last?

Just a few minutes Few minutes to an hour More than an hour

g. Does it usually come When you take a lot of exercise or

when you are quiet or

is there no difference

h. Does it usually come when you are upset or

doesn't this make any difference

j. Do you take any pills or medicine for it? YES NO ?

22. a. In the past few years, have you ever had any pain, discomfort, or trouble in or around your heart? YES NO ?

IF YES, please answer questions b through j below.

b. How often? Every few days Less often

c. Does it bother you quite a bit just a little

d. Where does it bother you? (Check every place it bothers you.)

Front Back Right side Middle Left side Probes A,B

Somewhere else State where _____

e. Does it usually stay in one place move around ?

f. How long does the pain usually last?

Just a few minutes Few minutes to an hour More than an hour

g. Does it usually come When you take a lot of exercise or when you are quiet or is there no difference

h. Does it usually come when you are upset or doesn't this make any difference

j. Do you take any pills or medicine for it? YES NO ?

23. a. Sometimes, our hearts "act funny" (odd) like missing a beat, or beating real fast, or seem to turn over. Have you ever noticed your heart do anything like that? YES NO ? Probes A,B

If YES b. How often? Every few days Less often

c. Does it bother you quite a bit just a little

24. a. Have you ever been bothered by your heart beating hard? YES NO ?

If YES b. How often? Every few days Less often Probes A,B

c. Does this bother you quite a bit just a little

25. a. Are your ankles ever swollen at bedtime? YES NO ? Probe A

If YES b. Is the swelling gone by morning? YES NO ?

26. a. When you walk, do you have pains or cramps in your legs? YES NO ?

If YES b. How often? Every few days Less often Probe A

c. Does it bother you quite a bit just a little

62. a. Has a doctor ever said you had rheumatic fever (inflammatory rheumatism) YES NO

If YES b. Have you had it in the past 12 months? YES NO ?

c. Are you taking any pills or medicine for it? YES NO

If YES d. What is it? _____

63. Has a doctor ever said you had chorea or St. Vitus' Dance? YES NO

Probe C

65. a. Has a doctor ever told you that you have hardening of the arteries? YES NO

If YES b. Have you had this condition in the past 12 months? YES NO ?

66. a. Have you ever had any reason to think you may have high blood pressure? YES NO ?

If YES or ? b. Did a doctor tell you it was high blood pressure? YES NO

Probe C

c. How long ago did you first start having it?

1 year | 1-5 years | over 5 years

d. Have you had it in the past 12 months? YES NO ?

e. Do you take any pills or medicine for it? YES NO ?

If YES f. Give name of the medicine_____

67. a. Have you ever had any reason to think you may have heart trouble? YES NO ?

If YES or ? b. Did a doctor tell you that you had heart trouble? YES NO

Probe C

If YES, what did he call it?_____

c. How long ago did you first start having it?

1 year | 1-5 years | over 5 years

d. Have you had it in the past 12 months? YES NO ?

e. Do you take any pills or medicine for it? YES NO ?

If YES f. Give name of the medicine_____

Probes: A. Do you have any idea what causes your_____?

B. Tell me how it feels.

C. In what way does it bother or affect you?

D. How many flights?

| These questions were used, where indicated, if the examinee answered either "yes" or "?"

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APPENDIX II.

FORMS USED IN RECORDING FINDINGS ON THE PHYSICAL EXAMINATION

Confidentiality has been assured the individual as set forth in 22 FR 1687

PHS-3034
REV. 4-61

Health Examination Survey

PHYSICAL EXAMINATION

HES-205

BLOOD PRESSURE - LEFT ARM			
TIME	SYSTOLIC	DIASTOLIC 1	DIASTOLIC 2
1.			
2.			
3.			

OCULAR FUNDI	RIGHT	LEFT	REMARKS	CODE
4. Normal				
5. Fundus not Visualized				
6. Globe Absent				
7. Increased Light Reflex				
8. Narrow Arterioles				
9. Tortuous Arterioles				
10. AV Compression				
11. Hemorrhage				
12. Exudate				
13. Venous Engorgement				
14. Papilledema				
15. Disc Abnormal				
16. Lens Opacities				
17. Iritis				
18. Other (Specify)				
19. K-W Grade [0] [1] [2] [3] [4] [5]				

EARS	RIGHT	LEFT	REMARKS	CODE
20. Normal				X
21. Drum not Visualized				
22. Malformation				
23. Exudate				
24. Perforated Drum				
25. Scarred Drum				

NECK	
26. Venous Engorgement (Upright) YES NO	

PERIPHERAL ARTERIES - Inspection and Palpation

27. All Normal ☐

RIGHT SIDE	NORMAL	SCLEROTIC	TORTUOUS	NOT DONE*	CODE
28. Superficial Temporal					
29. Brachial					
30. Radial					
LEFT SIDE	**NORMAL**	**SCLEROTIC**	**TORTUOUS**	**NOT DONE***	**CODE**
31. Superficial Temporal					
32. Brachial					
33. Radial					

*NOT DONE (Specify which item number and why not done) _____

QUALITY OF ARTERIAL PULSATIONS						
34. All Normal ☐						
RIGHT SIDE	NORMAL	BOUNDING	DIMINISHED	NOT PALPABLE	NOT DONE*	CODE
35. Radial						
36. Dorsalis Pedis						
37. Post-tibial						
LEFT SIDE	NORMAL	BOUNDING	DIMINISHED	NOT PALPABLE	NOT DONE*	CODE
38. Radial						
39. Dorsalis Pedis						
40. Post-tibial						

LOWER EXTREMITIES	RIGHT	LEFT	REMARKS	CODE
41. Normal				
42. Not Done*				
43. Varicosities				
44. Dependent Edema				
45. Ulcers				

*NOT DONE (Specify which item number and why not done)

HEART

46. Thrills None ☐

IF present, specify: Location _____

Timing _____

47. Apical Impulse Not Felt ☐

	At or inside	Outside			
MCL					
Interspace	3	4	5	6	7

48. Heart Sounds

Normal ☐

	Accentuated	Diminished
A_2	☐	☐
P_2	☐	☐
M_1	☐	☐

Third Heart Sound ☐ Splitting of second sound abnormal ☐

Other (Specify) _____

49. Murmurs If* present, specify (in order): location, intensity (grades I through V), pitch, quality, duration, timing, transmission, and whether significant or non-significant.

Systolic None ☐ _____

Diastolic None ☐ _____

MUSCULOSKELETAL SYSTEM

50. Arthritis and Rheumatism No Positive Findings ☐

If positive findings are present, fill out **Summary of Joint Involvement** on next page.

SUMMARY OF JOINT INVOLVEMENT

Joints	MANIFESTATIONS					
	Tender	Swelling	Deformity	Limitation	Other[1]	Code
51. Shoulder						
52. Elbow						
53. Wrist						
54. Metacarpo-phalangeal						
55. Proximal-inter-phalangeal						
56. Distal-inter-phalangeal						
57. Hip						
58. Knee						
59. Ankle						
60. Feet						
61. Cervical spine						
62. Lumbar spine						
63. Other*						

Record positive findings as R for right, L for left, RL for both, except for spine (items 61 and 62) which should be check marked.

Fingers (Items 54, 55, and 56): Record total number of joints involved on right or left.

[1] "Other" manifestations include Heberden's nodes, subcutaneous nodules, ulnar deviation, pain on motion, heat, atrophy, and funnel fist.

* "Other" joints include temporomandibular, sternoclavicular, sacroiliac, and specific joints of the feet.

ADDITIONAL FINDINGS IN THE PHYSICAL EXAMINATION	
NONE ☐	CODE
64. Head	
65. Neck	
66. Chest	
67. Extremities	
Neuromuscular System	
68. Gait	
69. Coordination	
70. Strength	
71. Tremor	

IMPAIRMENTS			
NONE ☐			
	ETIOLOGY		
	Birth	Later illness or injury	CODE
72. Cleft palate			
73. Club foot			
74. Paralysis (Specify site)			
75. Missing digits (Specify)			
76. Other (Specify)			

77. Additional Remarks	

EXAMINING PHYSICIAN'S IMPRESSION

Cardiovascular Diseases	NEGATIVE	POSITIVE	SUSPECT
Hypertension	☐	☐	☐
Peripheral arteriosclerosis	☐	☐	☐
Organic heart disease	☐	☐	☐
Angina pectoris	☐	☐	☐

If positive or suspect,

Etiology _____

Anatomy _____

Physiology _____

Functional capacity _____

Other _____

_____

Comments _____

_____

_____

Arthritis and Rheumatism

No arthritis ☐

Classical arthritis (give specific diagnosis) _____

Definite arthritis _____

Rheumatic complaints _____

Questionable complaints _____

Other Diseases and Conditions

_____

_____

_____

_____ M.D.

Signature

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APPENDIX III.

ELECTROCARDIOGRAPHIC READINGS

Criteria and Classification

The following are the criteria and classifications used in electrocardiographic (ECG) reading by the Health Examination Survey. They were developed by the cardiologists who read the ECG's. The draft version of these criteria was submitted to cardiologists experienced in reading electrocardiograms for survey purposes, and their criticisms and suggestions were taken into account in this working version.

Category	Leads	Impressions	
1. Q & QS patterns (Q must be 1 mm. or more)			
a. Q duration =\0.04 second or more	I, II, V_1-V_6 (any)	Anterior myocardial infarction	Anterior myocardial infarction
b. Q duration = 0.04 second or more	AVL	Anterior or lateral myocardial infarction	
c. QS pattern when R wave is present in adjacent precordial lead to the right	V_2-V_6 (any)	Anterior myocardial infarction	
d. QS pattern	V_1-V_4 (all)	Anteroseptal myocardial infarction	
	V_1-V_5 (all)	Anterior myocardial infarction	
	V_1-V_6 (all)	Anterolateral myocardial infarction	
e. Q duration = 0.05 second or more and a Q wave in AVF	III	Posterodiaphragmatic myocardial infarction	Posterior myocardial infarction
f. Q duration = 0.05 second or more and R = +5 mm. or more	AVF	Posterodiaphragmatic myocardial infarction	
g. Q duration = 0.04 second	II, III, and AVF (all)	Posterodiaphragmatic myocardial infarction	
2. QRS axis deviation			
a. QRS axis = -30° or more	I, II, and III	Left axis deviation	
b. QRS axis = +120° or more	I, II, and III	Right axis deviation	
3. Ventricular preponderance (hypertrophy)			
a. S (+) R = 35 mm. or more NOTE: Record associated ST- or T-wave abnormalities separately	"S" in V_1 or V_2, and "R" in V_5 or V_6	Left ventricular hypertrophy	
b. QRS duration less than 0.12 second and R = 5 mm. or more and R/S = 1.0 or more and transition zone (decreasing R/S) left of V_1	V_1	Right ventricular hypertrophy	
4. ST junction and segment (T-P interval is baseline)			
a. ST junction depression 1 mm. or more	I, II, AVL, AVF, V_1-V_6 (any)	Subendocardial ischemia	
b. ST-J depression 0.5-0.9 mm. and ST segment horizontal or downward	I, II, AVL, AVF, V_1-V_6 (any)	Subendocardial ischemia and/or digitalis effect	
c. No ST-J depression as much as 0.5 mm. but ST segment sloping down and reaching 0.5 mm. or more below baseline	I, II, AVL, AVF, V_1-V_6 (any)		

Category	Leads	Impressions
4. ST junction and segment—Continued		
d. ST segment elevation, any of		
2 mm. or more	I, II, III, V_5, V_6 (any)	
3 mm. or more	V_1-V_4 (any)	
e. ST segment elevation and ST contour upward (convex), with elevation		
2 mm. or more	I, II, III, V_5, V_6 (any)	Current of injury
3 mm. or more	V_1-V_4 (any)	
f. ST segment elevation and concave, with elevation		
2 mm. or more	I, II, III, V_5, V_6 (any)	
3 mm. or more	V_1-V_4 (any)	
5. T wave		
a. T = -.5 mm. or more and QRS mainly upright	I, II, III, AVL, AVF, V_2-V_6 (any)	
b. T wave flat or small diphasic (± 1 mm.) and when QRS mainly upright	I, II, V_4-V_6 (any)	Nonspecific T-wave abnormality
and R = + 5 mm. or more	AVL, AVF (either)	
c. T = -1 to -.5 mm.	I, II, AVL, V_2-V_6 (any)	Left ventricular ischemia
when R = (+) 5 mm. or more	AVL	
when QRS mainly upright	AVF	
6. A-V conduction		
a. Complete A-V block (permanent or intermittent)	Any	Complete heart block
b. Partial (varying) A-V block	Any	Partial A-V block
c. P-R interval over 0.21 second (any heart rate)	I, II, III (any)	First degree heart block
d. Accelerated conduction	Any	Wolff-Parkinson-White syndrome
7. Ventricular conduction		
a. QRS duration 0.12 second or more and R peak duration 0.06 second or more (in absence of infarct criteria, category 1, above)	I, II, III (any) I, AVL, V_5, V_6 (any)	Left bundle branch block
b. R prime greater than R and QRS duration over 0.12 second	V_1	Right bundle branch block
c. R prime greater than R and QRS duration not over 0.12 second and not less than 0.10 second	V_1	Incomplete right bundle branch block
d. QRS of 0.10 second or more, but without LBBB or RBBB	I, II, III (any)	Intraventricular block

Category	Leads	Impression
8. Arrhythmias		
a. 3 or more premature ventricular contractions in sequence	Any	Ventricular tachycardia
b. Atrial fibrillation or flutter	Any	Atrial fibrillation or flutter
c. Atrial (over 120/minute), nodal or supraventricular (over 100/minute) tachycardia	Any	Atrial, nodal, or supraventricular tachycardia
d. Nodal rhythm (up to 100/minute) PR interval less than 0.11 second with either a positive or negative P wave or absent P or P following QRS	Any	Nodal rhythm
9. Low QRS, high T		
a. Total R or S amplitude in leads I plus II plus III equals less than 15 mm.	I, II, III (all)	Low QRS voltage
b. T wave over 12 mm.	Any	High T voltage
10. Premature beats and miscellaneous		
a. Premature atrial, nodal, or ventricular systoles	Any	Premature atrial, nodal, or ventricular systoles
Rare (up to 3 in 40 complexes)		
Frequent (4 or more in 40 complexes)		
b. Miscellaneous items not mentioned elsewhere		
1. QT interval >0.42, at any rate	Any	Prolonged QT
2. P waves notched, or peaked (3 mm.), or prolonged (>0.12 second)	Any	P-wave abnormality
3. Q duration of 0.03-0.04 second (but not diagnostic of posterior myocardial infarction)	III and AVF (both)	Other Q-wave abnormality

NOTE: In each category the ECG readers were allowed to designate abnormalities outside of criteria. For some categories such findings were fairly common.

The general ECG reading procedure is described in the main body of this report.

Three exceptions to this procedure were accepted. (1) When a case was reviewed the full documentation was considered. If the ECG was found to have an abnormality which had been overlooked in the routine reading, this abnormality was taken into account in the diagnosis; similarly ECG readings that were found not to meet the criteria were discounted on review. This led to very few changes. (2) All cases of MI outside criteria were reviewed by Dr. Abraham Kagan of the Framingham Heart Study. One was found to meet the criteria and the diagnosis was changed accordingly. A number of other cases were found to nearly meet the criteria. In ordinary usage they would be considered diagnostic of MI but it was decided not to alter the criteria to include them. (3) The voltage criteria used in the finding of LVH (S in V_1 or V_2 plus R in V_5 or V_6, whichever is greater) made it possible to obtain this finding by having clerks measure the ECG's. S in V_1 and R in V_5 were measured on all ECG's. It was found on the basis of a sample of electrocardiograms that the S wave was almost always greater in lead V_1 than lead V_2 and the R wave was almost always greater in lead V_5 than lead V_6, so measurements were confined to leads V_1 and V_5. If their sum was 35 mm. or more and the person was 35 years or older, this was considered evidence of LVH for purposes of diagnosing hypertensive heart disease. A review of a sample of these cases indicated that the measurement was sometimes in error but it was assumed that other ECG's were undermeasured and hence that there was a counterbalancing error. The measurement added a fairly large number of cases. Of persons 35 years or older having definite or borderline hypertension, 111 had LVH by measurement but not by the readings of the cardiologists. All of these cases were automatically diagnosed as having hypertensive heart disease. Actually in 70 cases the ECG finding simply constituted supplementary evidence of hypertensive heart disease since there was also evidence of heart enlargement on the X-ray,

and in only 7 of these cases was the diagnosis changed from suspect to definite hypertensive heart disease as a consequence of the ECG measurement. In the remaining 41 cases, however, a new diagnosis of hypertensive heart disease resulted—in 23 cases definite, and in 18 suspect. The net effect of the ECG measurement was to raise the prevalence of hypertensive heart disease by approximately 9 percent.

The distributions of LVH findings by the readers for persons 35 years and over against the combined sum of the S in V_1 and the R in V_5 were as follow:

Voltage S (V_1) + R (V_5)	Number of electrocardiograms		
	Total	LVH finding	No LVH finding
Under 35 mm-----	3,903	45	3,858
35 mm-----------	62	8	54
36 mm-----------	53	11	42
37 mm-----------	37	11	26
38 mm-----------	35	13	22
39 mm-----------	33	16	17
40 mm-----------	22	10	12
41 mm-----------	22	13	9
42 mm-----------	27	22	5
43 mm-----------	18	15	3
44 mm-----------	14	13	1
45+ mm----------	80	75	5

This table includes all sample persons, whatever their blood pressure.

If a person had normal blood pressure, no account was taken in this report of discrepancies between the electrocardiographic readings and the measurements for LVH. Had this been done, the number of persons considered to have had significant but nondiagnostic cardiac findings would have been increased by about 10 percent.

The level of agreement between readers in designating major electrocardiographic findings was generally very high. Some examples are given below. Needless to say, agreement is no assurance of validity, LVH being a case in point. For most findings, however, it seems reasonable to assume that relatively few cases were missed in the ECG reading.

Final determination	Number of readers agreeing with final determination on their original reading			
	Total	3	2	1
Myocardial infarction[1]-	100	67	13	20
Left ventricular hypertrophy----------	397	342	29	26
Right ventricular hypertrophy[1]----------	7	5	2	-
Subendocardial ischemia[1,2] ----------	135	102	23	10
Nonspecific T wave[1]----	207	147	39	21
Left ventricular ischemia[1]----------	83	67	5	11
Left bundle branch block----------	25	25	-	-
Right bundle branch block----------	29	26	2	1
I-V block----------	50	26	10	14
Atrial fibrillation----	20	20	-	-
Abnormal nodal rhythm--	14	11	1	2

[1]Inside or outside criteria.
[2]With or without digitalis effect.

Some of these categories are fairly broad and if they were broken into their specific components the level of agreement would be less than indicated here. For example, all three readers might agree that the electrocardiogram showed evidence of a myocardial infarction but disagree on the location of the infarct or on whether the finding was inside or outside the criteria.

In addition, there were instances where one or more of the readers reported a finding which was not agreed to in the final review. The number of such cases of "false positives" was as follows:

Myocardial infarction---------	25
Left ventricular hypertrophy---	33
Right ventricular hypertrophy--	1
Subendocardial ischemia ------	46
Nonspecific T wave----------	41
Left ventricular ischemia-----	28
Left bundle branch block------	3
Right bundle branch block-----	6
I-V block----------	19
Atrial fibrillation----------	-
Abnormal nodal rhythm-------	1

ECG Code Sheet

PHS-3762 ECG CODE SHEET (Clinical)
REV. 12-61 HES-212 Deck 30

CASE NUMBER (1-5)	READER (6)	
RATE (7-9)	PR (10-11)	QRS (12-13)

CODE: 1--Abnormal
2--Abnormal--Outside criteria
X--All normal
Y--Unsatisfactory ECG } Column 14
9--No ECG

14	15	16	17	18	19
Ant MI	Post MI	LAD	RAD	LVH	RVH

ST S or J: 20 Sub. Isch. | 21 Sub. Isch. / digitalis | 22 Current of Injury

T Wave: 23 Non-Specific | 24 LV Isch.

AV Cond.: 25 Complete Block | 26 Partial Block | 27 1st degree Block | 28 WPW

Vent. Cond.: 29 LBBB | 30 RBBB | 31 Inc. RBBB | 32 I-V Block

Arrhythmias: 33 Vent. Tach. | 34 Aur. Fib. | 35 Aur., Nod., Supra-Vent. Tach. | 36 Vent. Rhythm | 37 Nodal Rythm

38	39	40	41	42
Low QRS	High T	Rare Premature	Frequent Systole	*(Circle one)* A1 V2 N3

43 Misc. | REMARKS

APPENDIX IV.

INTERPRETATION OF CHEST X-RAY

Form Used in Pulmonary Reading

PHS-3739
4-61

NATIONAL HEALTH SURVEY CHEST X-RAY INTERPRETATION

X-RAY NUMBER	READER	DATE	CHECK HERE IF FILM IS UNSATISFACTORY ☐

PULMONARY PATHOLOGY

NONE	EXISTENCE OF LESION *(Check one)*	IF LESION EXISTS, STATE MOST LIKELY ETIOLOGY
☐	☐ Definite ☐ Indefinite	

CARDIOVASCULAR PATHOLOGY

NONE	HEART ENLARGEMENT *(Check one)*	OTHER CVD *(Check one)*
☐	☐ Definite ☐ Borderline	☐ Definite ☐ Borderline

IF OTHER CVD, PLEASE SPECIFY

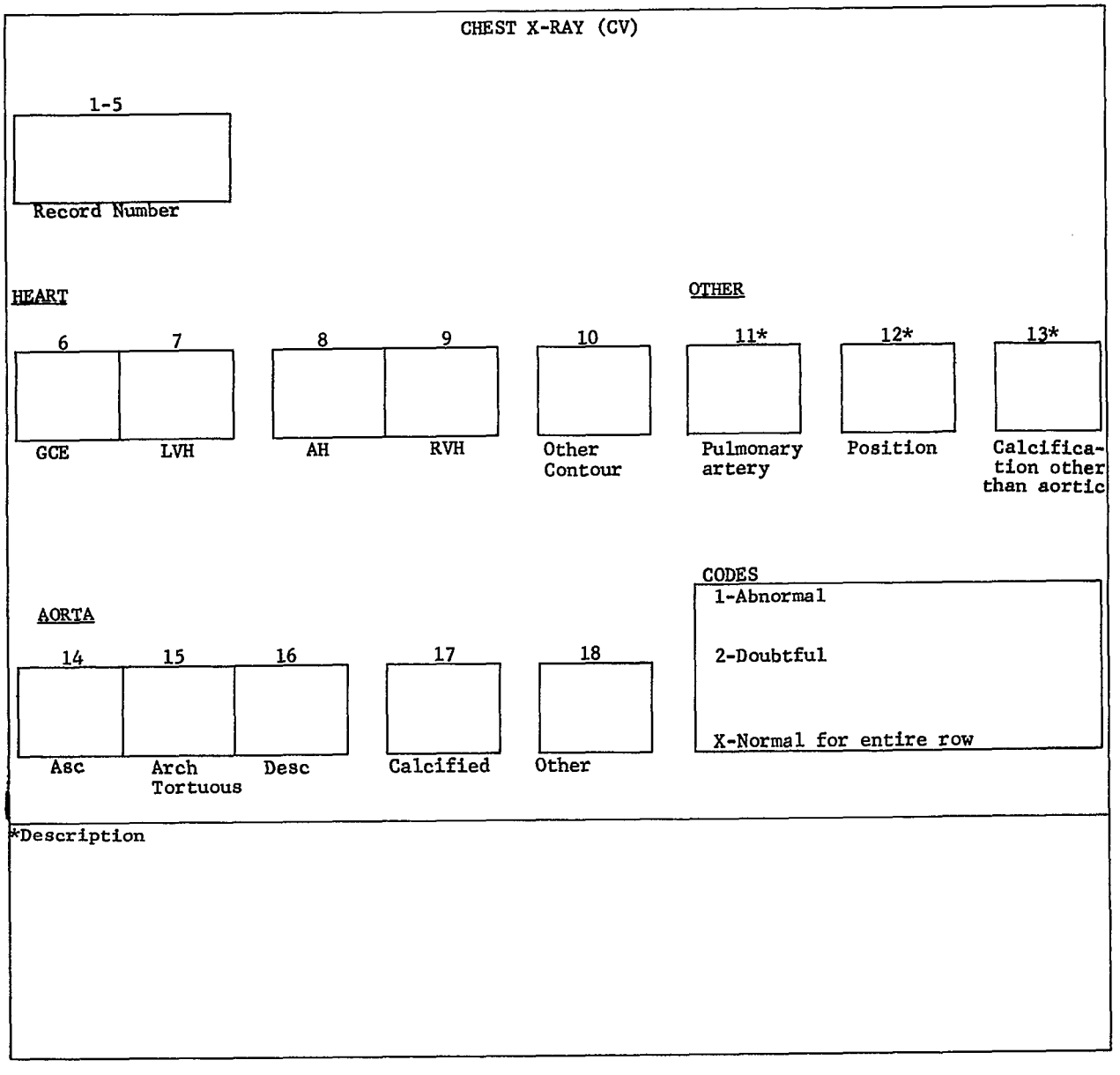
PLEASE SPECIFY BELOW ANY OTHER SIGNIFICANT PATHOLOGY

Instructions for interpreting cardiovascular pathology

Heart enlargement: Borderline enlargement is defined as 10 to 20 percent larger than normal. If enlargement was not generalized specify the hypertrophied chamber.

Other cardiovascular pathology is to be specified as follows: Calcification of the ascending aorta, calcification of the aortic knob, calcification of other portions of the aorta, abnormality of shape of aorta (specify), increased pulmonary vascularity.

Form Used in Cardiovascular Reading



Pulmonary Readers

Initially, the X-ray films were interpreted by three radiologists with a special interest in pulmonary disease. While their primary concern was with evidence of pulmonary pathology, abnormalities of the heart or vessels were also noted. So far as the diagnosis of heart disease was concerned, the two findings of special concern were those of generalized cardiac enlargement (GCE) and those of chamber enlargement, especially left ventricular hypertrophy (LVH). Borderline GCE was defined as present if the heart was 10 to 20 percent larger than normal; larger hearts were considered to have definite GCE. No criteria were given for LVH.

In the following discussion a reading is considered positive if a finding of GCE or LVH, definite or borderline, was made. In order to determine how frequently a film with evidence of GCE was missed by the pulmonary readers, a series of 190 films were measured by the method of Hilbish and Morgan,[9] and the heart size as measured was compared with the findings of the pulmonary readers.

Heart size (in percent of normal)	Number of films	Reader 1	Reader 2	Reader 3
		Number of positive readings		
Total------	190	56	42	22
Under 105------	134	17	10	1
105-109--------	20	10	9	3
110-114--------	9	6	3	1
115-119--------	6	5	5	2
120+-----------	14	13	13	11
Could not measure-------	7	5	2	4

There were 29 films found to be 10 percent or more enlarged on measurement. Reader 1 read 24 of these as positive, reader 2 read 21 as positive, and reader 3 read 14 as positive. The findings of readers 1 and 2 were consistent with the criteria for GCE. Reader 3 seemed to be following a different rule, generally recording enlargement when it was 20 percent or greater but seldom if it was 10-19 percent. The positive findings reported for the smaller hearts are not inconsistent with the rules, since the films may have exhibited abnormalities of shape indicative of cardiac hypertrophy.

Next, it was determined in what way, if any, the cardiovascular readings of the pulmonary readers differed from readings by radiologists who specialize in cardiovascular reading. To answer this it was necessary to obtain a set of cardiovascular reading standards, or, in more concrete terms, to have a set of films read by a standard radiologist. Dr. Lloyd E. Hawes, radiologist for the Framingham Heart Program, was chosen. In other words, Framingham practice in X-ray reading was the standard chosen.

Dr. Hawes was given a set of 192 Survey films which had been selected to include a high proportion of positives. He found 96 of these "positive"; the number of positive readings by the three pulmonary readers were 56, 42, and 22, respectively. Thus, even the two highest counts were substantially below the level of readings by Dr. Hawes.

Cardiovascular Readers

It was evident that to make the cardiovascular findings of the Survey comparable with those of the Framingham Heart Program another group of readers would have to be used to read the X-ray films for cardiovascular abnormalities. It was felt that training radiologists to conform to standards was beyond the resources of the Survey; it was decided, instead, to choose radiologists who conformed naturally and without instruction to Dr. Hawes' standards.

A series of radiologists were asked to read the standard set of films. The four who conformed most closely to Dr. Hawes' readings compared with him as follows:

Reading by		Reader			
Hawes	Other reader	A	B	C	D
		Number of films			
Total----------		185	192	192	183
Agreement					
positive	positive	68	84	73	54
negative	negative	64	56	80	86
Disagreement					
positive	negative	24	12	23	37
negative	positive	29	40	16	6

In terms of reading levels the four readers read the following percentage of films as positive.

Dr. Hawes----------	50.0
Reader A----------	52.4
Reader B----------	64.6
Reader C----------	46.4
Reader D----------	32.8

(Although it later turned out that reader D could not participate in the cardiovascular readings, his readings on the standard films are included in some of the subsequent analysis.)

The procedure used in the cardiovascular readings allowed for a distinction between generalized heart enlargement and left ventricular hypertrophy and for a designation of findings as abnormal or doubtful. These distinctions were ignored in the final determinations because the readers clearly had no common standards for such details. This is shown in the following tables.

Percent of positive findings designated doubtful:

Dr. Hawes	32.3
Reader A	18.6
Reader B	1.6
Reader C	44.7
Reader D	15.0

Percent of positive findings designated as generalized enlargement:

Dr. Hawes	41.7
Reader A	14.4
Reader B	38.7
Reader C	55.9
Reader D	6.7

Since the cardiovascular reading was to proceed without training the readers or reconciling their differences, it was felt advisable to assimilate all positive findings to one class. In the case of one reader (reader C), possible findings were actually assimilated to negative, since the threshold between possible and definite in his case seemed to correspond to the threshold between negative and possible for the other cardiovascular readers.

Final Evaluation

The procedure adopted for using both the pulmonary and the cardiovascular readings to arrive at a final evaluation of heart abnormalities on the X-ray was essentially *ad hoc* but can be justified by both the standardization experience and the Survey findings. The readings made during the standardization process were used only as an aid in selecting readers. The films were re-read routinely for their final evaluation.

The evaluation technique adopted has been described in the text. The combination of possible findings by the pulmonary and cardiovascular readers is summarized:

Final evaluation code	Pulmonary reader		Cardiovascular reader	
	1	2	1	2
0	Negative	Negative	Negative	...
1	Positive	Positive	Positive	...
2	Positive	Positive	Negative	...
3	Positive or negative	Negative or positive	Positive	...
4	Positive or negative	Negative or positive	Negative	Positive
5	Negative	Negative	Positive	Positive
6	Positive or negative	Negative or positive	Negative	Negative
7	Negative	Negative	Positive	Negative

NOTE: Codes 1-5 are considered positive, all others negative.

There were 183 films which were interpreted by Dr. Hawes and readers A, B, and D. The distribution of films according to the findings of these four readers and the final evaluation code is shown:

Final evaluation code	Number of films according to the number of positive initial readings					
	Total	0	1	2	3	4
Total	183	46	31	30	31	45
0	63	34	15	7	5	2
1	32	-	-	2	5	25
2	1	-	-	-	-	1
3	23	1	-	3	10	9
4	5	-	1	1	-	3
5	31	2	7	9	9	4
6	1	-	1	-	-	-
7	27	9	7	8	2	1

(Of the four only A and B subsequently engaged in routine reading for the Survey.) There were 92 films with positive codes 1-5. The average number of positive readings by the four readers (A, B, C, and D) was 91. Dr. Hawes found 91 films positive. All three counts were practically the same.

The preceding table can be summarized in terms of the percentage of the initial readings positive for each code.

Final evaluation code	Percent positive
Total	49.7
0	20.6
1	93.0
2	*
3	78.3
4	*
5	54.8
6	*
7	30.6

One final piece of evidence may be considered. It is well recognized that heart enlargement—whether generalized or confined to the left ventricle—is highly correlated with blood pressure. The following table shows the percentage of films coded to each of the specified codes which came from persons having hypertension.

Final evaluation code	Number of films	Percent with hypertension	
		Definite	Borderline
0	4,461	9.1	11.4
1	272	54.0	18.8
2	17	*	*
3	343	33.8	22.2
4	61	16.4	24.6
5	506	35.8	20.0
6	73	11.0	19.2
7	661	19.4	22.1
Missing	278	6.1	5.4

Since both heart enlargement and hypertension become more common with age these percentages exaggerate the correlation between the two findings. Nonetheless, they do generally tend to support the evaluation procedure used.

A comment is in order with respect to the "missing" films. Some 278 examinees had no X-ray or, in a few instances, had a film taken which was too poor to be interpreted. The large majority of these persons were women of childbearing age. It was the Survey policy not to X-ray a woman where there was evidence suggesting pregnancy. Persons with missing films were distributed by age and sex as follows:

	Number
Men	34
Women	244
18-24 years	102
25-34 years	80
35-44 years	41
45-79 years	21

The missing films were treated as negative in this report. Judging from the small number of persons with missing X-rays who had hypertension (15 definite, 17 borderline) this decision seems reasonable. It is unlikely that treating the missing X-rays as negative resulted in an appreciable understatement of heart disease prevalence. Some of these persons were diagnosed as having heart disease even without the evidence of the X-ray, but even if this were not the case there would seem to be no alternative to the procedure chosen.

Finally, some note should be made of the unusual nature of the X-ray evaluation procedure. The use of a screening procedure which picks up all suspicious findings initially and then, at a second stage of evaluation, applies more stringent rules to the cases selected is not uncommon. The Survey procedure was the reverse. The initial (pulmonary) screening was the more conservative, the final (cardiovascular) reading the less conservative. Actually the contrast between the two readings is greater than appears from the standard films. Since these films included an unusually large proportion of very large hearts, there would be more agreement on them than on a purely random sample of the population. The contrast for the Survey films as a whole was much greater, the cardiovascular readers finding 27.9 percent positive on their initial reading, the pulmonary 8.2 percent.

Why, then, were the pulmonary readings used? There were three reasons. First, they were already largely available at the time the cardiovascular standards were finally chosen. Second, they were relevant; clearly heart enlargement found on the pulmonary readings was meaningful in terms of the cardiovascular standards. Third, it was possible by using them to devise a more economical and secure cardiovascular reading system than would otherwise have been possible. While it is not suggested that the procedure used was the optimum one, it seems to have worked quite satisfactorily.

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APPENDIX V.

DIAGNOSTIC REVIEW

The procedure used in case review has been described in the text. Briefly, every case was first diagnosed by the computer. The key information was then printed out and this machine record served as a convenient summary of the case record, as well as a place for entering decisions made in a subsequent review, if there were such a review.

There were two important points at which the physician's judgment was seldom modified by review. These were the diagnosis of angina pectoris and the evaluation of a murmur. Findings of angina pectoris were reviewed, chiefly to verify the coding of the physician's judgment. The description of a significant murmur was reviewed to see if it was consistent with the physician's evaluation of it.

The question arises as to what was done when a physician's findings at these points appeared to diverge from the usual. This became a serious question on two occasions.

At one stand both examining physicians reported an unusually large number of cases of angina pectoris. Since both physicians had conducted examinations at other stands and at these had found an average amount of angina pectoris, it was felt that their judgments had to be accepted where they found an unusual amount. Their descriptions of angina pectoris were reviewed and where the wording indicated less certainty than appeared in the coded diagnosis, the coding was altered to conform. It is likely that the review of cases from this stand was more critical than usual, but in principle it was the same as the review of similar cases from other stands. Having admitted most of the cases from this stand, it is nonetheless suspected that the chest pain described for these cases was frequently not due to coronary heart disease but arose from some other cause.

The other set of unusual findings was a large number of murmurs considered diagnostic of rheumatic heart disease that was reported by one examining physician. On the average, slightly less than two cases of rheumatic heart disease were reported by other physicians for each 160 persons examined. This physician reported 19. Since he examined persons at two stands and since the other examining physician at each of these stands (a different one at each) reported only the usual number of cases of rheumatic heart disease, the prevalence of rheumatic heart disease among his examinees could hardly be attributed to the populations examined. Three choices seemed open. (1) To select a subsample of the rheumatic heart disease cases reported by this physician, controlling to the usual prevalence reported in the Survey. (2) To ignore the population examined by this physician for the purpose of computing rheumatic heart disease prevalence. (3) To accept the cases as reported. Of the three alternatives the first appeared the best and the third the worst. In effect, a random selection of cases was made by controlling to the usual prevalence, with a probability of selection by age and sex proportional to the distribution of rheumatic heart disease by age and sex as reported by the other examining physicians. This obviously was a choice among evils.

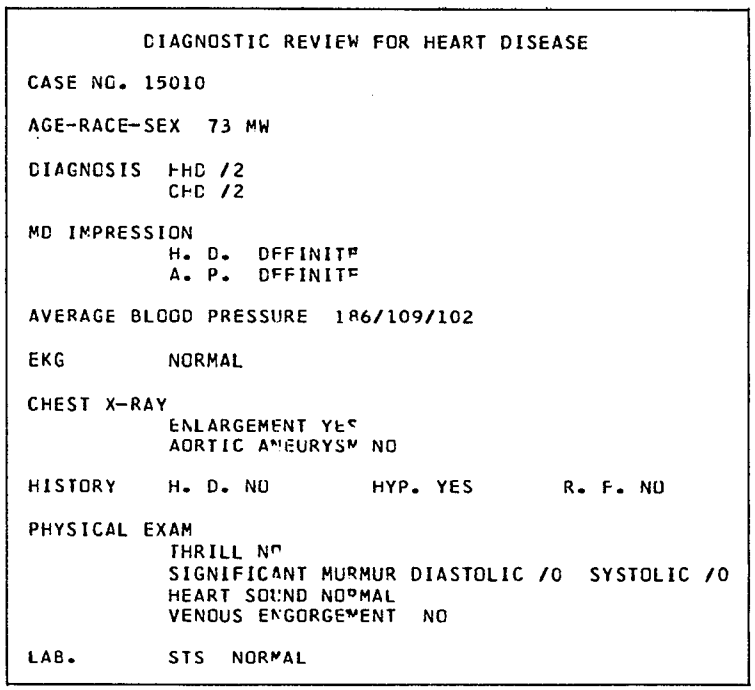
The review procedure was altered and became more efficient as staff experience accumulated. In the last seven stands reviewed, there were 1,116 cases. Of these 181 were reviewed. In 23 cases a change was made in the computer diagnosis as a result of the review.

One set of review cases warrants special notice. These are the cases in which the impression of the examining physician was that heart disease was present but the computer did not diagnose heart disease. In the review of cases from the last seven stands 36 of the 181 cases reviewed fell in this category. Inspection of the case records revealed that the physician arrived at his diagnostic impression in one of two ways. Either he interpreted the electrocardiogram as abnormal when the Survey readers did not, or he placed more diagnostic weight on findings from the physical examination, such as significant systolic murmurs, than the Survey criteria allowed.

It would be misleading, however, to emphasize the diagnostic "misses" by the examining physician and ignore the "hits." In fact, 80 percent of all cases

where the examining physician recorded a diagnostic impression of definite heart disease and 59 percent of all cases with a diagnostic impression of suspect heart disease were ultimately diagnosed as heart disease. Another 14 percent and 23 percent, respectively, were found to have either significant electrocardiographic abnormalities or a significant systolic murmur.

Finally, it ought to be noted that the physician's diagnostic impression is not the same thing as a final diagnosis. It was arrived at without having available the readings of the electrocardiogram and the chest X-ray by the Survey's specialists and indeed without an opportunity to inspect the X-ray itself. Thus, there was a certain class of heart disease cases which the examining physician could not identify in his diagnostic impression; consequently the physician's diagnostic impression led to a substantially smaller count of heart disease than did the final Survey diagnoses—458 definite and 545 suspect cases as against 855 and 745 cases, respectively.



DIAGNOSTIC REVIEW FOR HEART DISEASE

CASE NO. 15010

AGE-RACE-SEX 73 MW

DIAGNOSIS RHD /2
CHD /2

MD IMPRESSION
H. D. DEFINITE
A. P. DEFINITE

AVERAGE BLOOD PRESSURE 186/109/102

EKG NORMAL

CHEST X-RAY
ENLARGEMENT YES
AORTIC ANEURYSM NO

HISTORY H. D. NO HYP. YES R. F. NO

PHYSICAL EXAM
THRILL NO
SIGNIFICANT MURMUR DIASTOLIC /0 SYSTOLIC /0
HEART SOUND NORMAL
VENOUS ENGORGEMENT NO

LAB. STS NORMAL

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APPENDIX VI.

STATISTICAL NOTES

The Survey Design

The Health Examination Survey is designed as a highly stratified multistage sampling of the civilian, noninstitutional population, aged 18-79 years, of the conterminous United States. The first stage of the plan is a sample of the 42 primary sampling units (PSU's) from 1,900 geographic units into which the United States has been divided. A PSU is a county, two or three contiguous counties, or a standard metropolitan statistical area. Later stages result in the random selection of clusters of about four persons from a small neighborhood within the PSU. The total sample included 7,710 persons in the 42 PSU's in 29 different States. The detailed structure of the design and the conduct of the Survey have been described in previous reports.[1, 2]

Reliability in Probability Surveys

The methodological strength of the Survey derives especially from its use of scientific probability sampling techniques and of highly standardized and closely controlled measurement processes. This does not imply that statistics from the Survey are exact or without error. Data presented are imperfect for three important reasons: (1) results are subject to sampling error, (2) the actual conduct of a survey never agrees perfectly with the design, and (3) the measurement process itself is inexact, even when standardized and controlled. The faithfulness with which the study design was carried out has been analyzed in a previous report.[2]

Of the total of 7,710 sample persons, 86 percent or 6,672 were examined. Analysis indicates that the examined persons are a highly representative sample of the adult civilian, noninstitutional population of the United States. Imputation for the nonrespondents was accomplished by attributing to nonexamined persons the characteristics of comparable examined persons. The specific procedure used[2] consisted of inflating the sampling weight for each examined person to compensate for nonexamined sample persons at the same stand and of the same age-sex group.

While it is impossible to be certain that the prevalence of heart disease was the same in the examined and the nonexamined groups, the available evidence indicates that it was. One source of information on this question is a special inquiry sent to the physicians of nonexamined persons and to the physicians of a matching set of examined persons. The heart disease prevalence reported for the examined and for the nonexamined groups was in close agreement. For further details on this subject see *Vital and Health Statistics*, Series 11, No. 1.

Sampling and Measurement Error

In this report and its appendices, several references have been made to efforts to evaluate both bias and variability of the measurement techniques. The probability design of the Survey makes possible the calculation of sampling errors. Traditionally the role of the sampling error has been the determination of how imprecise the survey results may be because they come from a sample rather than from measurement of all elements in the universe.

The task of presenting sampling errors for a study of the type of the Health Examination Survey is complicated by at least three factors. (1) Measurement error and "pure" sampling error are confounded in the data;

Table I. Standard error of estimated prevalence of specified heart disease for white and Negro adults in specified age groups, by sex: United States, 1960-62

Age	Men		Women	
	White	Negro	White	Negro
	Percent of specified population group			
Definite hypertensive heart disease				
18-79 years	0.4	2.3	0.6	2.2
25-34 years	*	*	*	*
45-54 years	1.5	4.9	1.0	3.2
75-79 years	4.8	6.5	4.1	7.0
Suspect hypertensive heart disease				
18-79 years	0.5	1.3	0.3	0.7
25-34 years	0.3	*	0.2	*
45-54 years	1.2	*	1.0	*
75-79 years	4.4	*	3.2	*

it is not easy to find a procedure which will either completely include both or treat one or the other separately. (2) The survey design and estimation procedure are complex and accordingly require computationally involved techniques for calculation of variances. (3) Thousands of statistics come from the survey, many for subclasses of the population for which there are small numbers of sample cases. Estimates of sampling error are obtained from the sample data and are themselves subject to sampling error, which may be large when the number of cases in a cell is small, or even occasionally when the number of cases is substantial.

In the present report, estimates of approximate sampling variability for selected statistics are presented in tables I and II. These estimates have been prepared by a replication technique which yields overall variability through observation of variability among random subsamples of the total sample. The method reflects both "pure" sampling variance and a part of measurement variance.

In accordance with usual practice, a 68 percent confidence interval may be considered the range within one standard error of the tabulated statistic and a 95 percent confidence interval the range within two standard errors.

An overestimate of the standard error of a difference $d = x - y$ of two statistics x and y is given by the formula $s_d = \left[V_x^2 + V_y^2\right]^{\frac{1}{2}}$, where V_x^2 and V_y^2 are variances respectively of x and y, or the squares of the standard errors shown in tables I and II. For example, the prevalence of definite hypertensive heart disease (HHD) is $x = 8.2$ percent for white adults and $y = 20.8$ percent for Negro (table C), while from table I variances are found to be $V_x^2 = 0.16$ percent and $V_y^2 = 5.29$ percent. The formula yields the estimate of the standard error of the difference ($d = 12.6$ percent) as $s_d = 2.33$ percent. Thus, as the observed difference is more than three times its sampling error, it can be concluded that the prevalence of definite HHD is higher among Negro adults than among white.

Small Numbers

In some tables magnitudes are shown for cells for which sample size is so small that the sampling error may be several times as great as the statistic itself. Obviously in such instances the statistic has no meaning in itself except to indicate that the true quantity is small. Such numbers, if shown, have been included to convey an impression of the overall story of the table.

Tests of Significance

As shown above, the difference in the prevalence of definite HHD between Negro and white adults was submitted to a formal test of significance and found to be significantly different from zero. This difference could have been examined in other ways. It might have been more meaningful, for instance, to ask whether the prevalence for Negro adults was higher than (rather than "different from") the prevalence for white adults. There

Table II. Standard error of estimated prevalence of specified heart disease diagnoses for white and Negro adults in specified age groups, by sex: United States, 1960-62

Race	Men	Women
	Percent of specified population group	
Definite coronary heart disease		
White	0.5	0.3
Negro	1.1	0.7
Suspect coronary heart disease		
White	0.3	0.3
Negro	0.6	0.3
Rheumatic heart disease		
Total	0.3	0.3

is much evidence indicating this, and the test for a one-sided hypothesis is more powerful than the test for a two-sided hypothesis. Alternatively, the question might have been, "Is the prevalence higher for Negro adults than for white adults if age is held constant?" Conceivably, the age-sex-specific means could be identical for the two groups but a larger proportion of older people in one group could lead to an overall higher prevalence for that group.

This last version of the hypothesis can be tested directly from table 3, with the use of a table for the binomial variable. The prevalence of definite HHD is higher for Negro adults in every age-sex group. The chances of 14 heads out of 14 tosses of a true coin are 0.00006.

Demographic Terms

Age.—The age recorded for each person is the age at last birthday.

Race.—Race is recorded as "White," "Negro," or "Other." "Other" includes American Indian, Chinese, Japanese, and so forth. Mexican persons are included with "White" unless definitely known to be Indian or other nonwhite race.

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