PROGRAMS AND COLLECTION PROCEDURES

Series 1
Number 10a

Plan and Operation of the Health and Nutrition Examination Survey

United States-1971-1973

A description of a national health and nutrition examination survey of a probability sample of the U.S. population 1-74 years of age:

Part A-Development, plan, and operation.

Part B-Data collection forms of the survey.

DHEW Publication No. (PHS) 79-1310

U.S. DEPARTMENT OF HEALTH, EDUCATION,AND WELFARE
Public Health Service
Office of Health Research, Statistics, and Technology
National Center for Health Statistics
Hyattsville, Md. February 1973

NATIONAL CENTER FOR HEALTH STATISTICS

COOPERATION OF THE BUREAU OF THE CENSUS

In accordance with specifications established by the National Health Survey, the Bureau of the Census, under a contractual agreement, participated in the design and selection of the sample, and carried out the first stage of the field interviewing and certain parts of the statistical processing.

Library of Congress* Catalog *Curd Number 72-600207

PREFACE

This report presents a detailed description of the Health and Nutrition Examination Survey (HANES). It is intended primarily to serve as a necessary foundation for understanding and use in conjunction with the substantive findings to be published later in preliminary reports and in *Vital and Health Statistics,* Series 11, of the National Center for Health Statistics (NCHS). It will also provide background information for succeeding surveys of this nature and serve as a guide or aid to others in the planning of similar health or nutrition surveys.

In the planning and operation of HANES, valuable assistance was received from many individuals and groups. Space does not permit the recognition of all who participated in the planning, development, and conduct of the many and varied aspects of the survey. Their assistance is gratefully acknowledged, however, and an apology is offered for those omitted. Mention should be made of the important role played by the U.S. Bureau of the Census. Under a contractual arrangement, the Bureau of the Census participated in certain aspects of the sample selection, in the conduct of initial household interviews, and in most of the processing of the data. The special role of a task force designated to formulate a general plan for HANES and chaired by Mr. Earl Bryant, Office of Statistical Methods, NCHS, is described in the text. Also requiring special mention is the role of the Center for Disease Control (CDC), Health Services and Mental Health Administration. In addition to the advice and assistance provided in the planning operation, particularly by past and present members of the Nutrition Program and by the Division of Laboratories, Dr. David Sencer, Director, CDC, established a Nutrition Laboratory where, under a reimbursable arrangement, essentially all of the laboratory work for the HANES program is carried out in a highly standardized manner under the direction of Dr. Hipolito Nino.

The overall responsibility for planning the program was that of Mr. Arthur J. McDowell, Director, Division of Health Examination Statistics (DHES). The primary responsibility for recommending the content of and developing the procedures for the various parts of the detailed component for the examination was that of Dr. Arnold Engel, Medical Advisor for the adult programs of DHES. His counterpart with respect to responsibility for the nutrition component of the examination was Dr. Frank W. Lowenstein, Medical Nutrition Advisor,, DHES. Dr. James E. Kelly, Dental Advisor, NCHS, and Dr. Lawrence E. Van Kirk, Jr., Dental Advisor, DHES, had similar responsibilities with respect to the dental component. Other members of the DHES staff who had responsibility in specific areas were Dr. Harold Dupuy, Psychological Advisor, Drs. John V. Federico and Lanie E. Eagleton, formerly Medical Advisors, Miss Jean Roberts, Chief, Medical Statistics Branch, and Mr. Sidney Abraham, Chief, Nutrition Statistics Branch.

CONTENTS

Part A

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PLAN AND OPERATION OF THE HEALTH AND NUTRITION EXAMINATION SURVEY

Henry W. Miller, *Division of Health Examination Statis tics*

INTRODUCTION

The National Health Survey Act of 1956 provides for the establishment and continuation of a National Health Survey to obtain information about the health status of the population in the United States, including the services received for or because of health conditions. The responsibility for the development and conduct of that program is placed with the National Center for Health Statistics (NCHS), a research-oriented statistical organization within the Health Services and Mental Health Administration (HSMHA) of the Department of Health, Education, and Welfare. Three separate and distinct programs are employed by NCHS in meeting the objectives of the Act-a household health interview survey, a family of surveys of health resources, and a health examination survey?

Between the passage of the 1956 Act and 1969, numerous studies related to nutrition were conducted by various sources which revealed that within certain areas of the United States and within certain age and income groups malnutrition and undernutrition were stark realities. The most recently completed of these studies was the National Nutrition Survey authorized by Congress with the stated objective to

> **". . . determine the prevalence and location of serious hunger and malnutrition and resulting health problems in low income populations in (ten) selected States representing different geographic regions of the U.S. and to make recommendations for dealing with such conditions."**

The preliminary results of that survey, the various programs being carried out by a number of Federal agencies to combat domestic hunger and nutrition problems, and the need for data on the magnitude and distributions of these problems in the total U.S. population prompted the Department of Health, Education, and Welfare in 1969 to establish a continuing national nutrition surveillance system under the authority of the 1956 Act for the purposes of measuring the nutritional status of the U.S. population and monitoring the changes over time. The task of developing a plan to carry out the new program was assigned to NCHS.

ROLE OF THE NCHS TASK FORCE

Charge to the Task Force

A task force was selected by NCHS of staff members representing a variety of disciplines to formulate a scientifically sound plan to collect, analyze; and disseminate the data required by the Department. The charge to the task force was to develop a plan specifically to attain the following goals :

> **"1. The development and implementation of a survey design which will permit the use of health data as an objective test of programs to improve nutritional status."**

"2. A continuing monitoring of national nutritional status and related health problems so that the evaluation of trends and progress over time will be possible and so that we will have a better basis for allocation of scarce program resources."

The task force sought the advice of administrators of programs related to nutrition and of practicing nutritionists on specific topics vital to the efficient design of a plan to attain these goals. A work paper developed by members of the task force which posed specific questions and also proposed alternative logistical approaches in implementing the survey was submitted to experts in the field of nutrition. Circulation of the work paper to the Regional Medical Program Services Advisory Committee on Nutrition and Health and to the Intergovernment-Agency Advisory Panel for the National Nutrition Surveillance System elicited a variety of responses; interested individuals who attended The White House Conference on Food, Nutrition, and Health also submitted their opinions.

The experts concluded that nutritional status could not be measured and interpreted by a few simple indexes; a person's nutritional status is a complex interrelationship of clinical observations, biochemical assessments, anthropometric measurements,. sociological and psychological evaluations, and dietary intake or patterns. Hence the ***modus operandi*** employed to measure nutritional status would require a staff of highly trained professional teams and operating conditions conducive to accurate scientific measurement procedures. Opinions on the specific tests required and procedures to be followed varied among the consultants, but the sentiment prevailed that standard measurements and procedures should be developed and maintained and that continual efforts should be made to improve techniques and the overall quality of the data.

Some differences of opinion arose concerning whether nutritional status should be estimated for the entire population or, alternatively, for only those segments that are considered to have high risk of poor nutrition. Two major reasons for measuring the whole population's nutritional status are (1) that a lack of knowledge presently exists concerning the nature and magnitude of nutritional problems in the various segments of the U.S. population; and (2) that a base must be established with which to compare specific segments of the population to determine if a group is relatively disadvantaged and/or in need of special programs. This concept of relative advantage or disadvantage is important within and between time periods.

The consultants stressed that although plans should be made to measure the nutritional status of the whole population special attention should be focused on high-risk groups such as preschool children, women of childbearing ages, pregnant and lactating women, the aged, and the low-income group in general.

Recommendations

The principal points and recommendations of the plan developed by the task force which were approved by the Department and later implemented in whole or in part in the survey were as follows:

"1. The National Nutrition Surveillance Survey (NNSS) will be a continuing national probability sample survey to provide baseline distributional and trend data on the nutritional status of the one year of age and over, noninstitutional population of the United States, emphasizing those segments of the population classified as at or below the poverty level, and, to the extent possible, consistent with resources and sample design limitations, women of childbearing ages, pre-school and young school children, and the aged. Special emphasis implies that these groups will be sampled at rates substantially higher than their proportionate representation in the general population. This survey will produce national estimates on the nature and magnitude of nutritional problems in the specified population; for some groups, estimates would be available for broad geographic regions. The national data will provide planners at the national level with a rational basis for allocating scarce resources among the programs designed to combat nutritional deficiencies and related health problems. Trend information available from the survey will indicate the degree to which national goals are met. A survey of this nature will also produce data that relate general health and nutritional variables making it possible to study relationships between certain health conditions such as obesity, atherosclerosis, and dental caries, on the one hand, and measurements of nutritional status, on the other."

"2. The Department had proposed that the NNSS be established under the authority of the National Health Survey Act of 1956. For this and for other reasons, the task force recommended that it "be made an integral part of the National Health Survey Program through

amalgamation with the existing Health Examination Survey (HES). The interrelationship of nutrition and health strongly suggests that the objectives of the two surveys are similar and compatible. The operational advantages associated with the amalgamation make this choice of instrument logical . . ."

"3. The health survey formed by the amalgamation of the HES and the NNSS will incorporate the general objectives of the HES, with the objective of the NNSS to estimate the nutritional status of the noninstitutional, civilian, one year of age and over, U.S. population. During the first cycle of the combined surveys, the objective of the HES program, Cycle IV, is to identify health care needs of the adult population of the U.S. as perceived by the HES sample subjects and as scientifically determined by specified examinations of selected body systems, and to relate both of these to the health care actually received. The NNSS measurement of nutritional status will consist of a clinical assessment by a physician, a number of biochemical tests on blood and (perhaps) urine, anthropometric measurements, and other measures of nutritional status. . . ."

"4. The HES-NNSS will be a continuing national probability sample survey with a two year cycle consisting of two annual rounds. That is, each annual sample would be representative of the population and additive to other annual samples. The sample selection procedure will be designed to ensure that the low income population is sampled at a rate several times its proportionate representation in the general U.S. population. . . ."

"5. The combined survey will employ four mobile examination centers staffed by specially trained teams of examiners including physicians, nurses, dentists, nutritionists, and technicians. HES headquarters staff, appropriately supplemented for the new program, will provide expertise on nutritional and medical evaluation and planning. . . ."

In addition to the preceding items, the task force also recommended the collection of certain data through questionnaires: a household questionnaire to obtain general demographic data, a general medical history questionnaire, and a food programs questionnaire to identify families and specific family members who participate in food assistance programs.

BACKGROUND OF HES

Basic Characteristics

As stated previously, the Health Examination Survey (HES) is one of the three different programs employed by NCHS to accomplish the objectives of the National Health Survey. It collects data by drawing samples of the civilian, noninstitutionalized population of the United States and, by means of medical and dental examinations and various tests and measurements, undertakes to characterize the population under study. This is the most accurate way to obtain definite diagnostic data on the prevalence of certain medically defined illnesses. It is the only way to obtain information on unrecognized and undiagnosed conditions-in some cases, even nonsymptomatic conditions, It is also the only way to obtain distributions of the population by a variety of physical, physiological, and psychological measurements.

In addition to the data collected by the examining, measuring, and testing procedures, a wide range of other data are collected concerning each of the sample persons examined. Therefore, it is not only possible to study the many potential relationships of the examination findings to one another but also to investigate the relationships of the examination findings to demographic or socioeconomic factors.

Any information obtained from the survey that permits the identification of an examinee is held in strict confidence and, with the exception of clinical and other examination findings that the examinee authorizes to be sent to his physician, dentist, or other source of medical care, is used only by persons engaged in the survey for the purposes of the survey.

The overall plan of the Health Examination Survey has been to conduct successive, separate programs in specific age segments of the civilian, noninstitutionalized U.S. population by means of medical and dental examinations, tests, and measurements. These successive programs, referred to as "cycles," have had a specific age segment for the target population and have been concerned with certain specified health aspects of that subpopulation.

All HES cycles have made use of a nationwide probability sample of the population. This method makes it possible to obtain the desired information efficiently and in such a manner that the statistical reliability of results is determinable. These factors, together with the fact that the examination and measurement processes are highly standardized and closely controlled, enable the results of the surveys to describe the entire population of the United States on the basis of relatively small samples.

The approach to each cycle has been necessarily multidisciplinary in nature. Each has drawn on and combined the talents of statisticians, physicians of various specialties, dentists, psychologists, nurses, educators, sociologists, management specialists, and others. In addition, each cycle has involved interagency collaboration: The U.S. Bureau of the Census has participated in several phases of the surveys; and other Federal agencies (such as the National Institutes of Health, the Office of Education, and the Children's Bureau) as well as non-Government agencies (such as schools of public health, medical research centers, and survey research agencies) have also advised and assisted the surveys.

The data collected are from national samples of the civilian, noninstitutionalized population. The size of the sample permits some analysis of the data by broad geographic region, population density groups, or other major subgroups of the total sample, but it does not permit analysis by smaller breakdowns, such as by State. The data are analyzed and the findings are made available to interested persons primarily through the publication of reports prepared in a form usable by large numbers of consumers of health statistics. The reports are limited to objective, scientific presentation of the particular findings, including estimated levels of prevalence and relevant discussion of various observed relationships. They do not include discussion of program implications of the findings, nor do they present value judgments concerning their implications to public health. The principal reports are published by the National Center for Health Statistics in ***Vital and Health Statistics,*** Series 2 and 11.

Past HES Programs

During the period from 1959 to 1970, three separate survey programs or cycles were conducted. Cycle I, conducted between November 1959 and December 1962, was directed toward the civilian, noninstitutionalized U.S. population between the ages of 18 and 79 years, inclusive. The examination was focused on certain chronic diseases, cardiovascular diseases, arthritis and rheumatism, and diabetes. Also included were a dental examination, tests for visual and auditory acuity, X-rays, electrocardiographic tracings, blood chemistry tests, and numerous body measurements. The sample size of Cycle I was 7,710 persons, of which 6,672 (86.5 percent) were examined. Details of the plan of that program are described in an earlier report.* Reports of various methodological studies[3-11] and of the findings[12-49] are also available.

The target population of the second cycle of the HES consisted of children aged 6 through 11 years. That cycle became operational in July 1963 and was concluded in December 1965. The examination was focused primarily on various parameters of growth and development, but it also screened for heart disease, congenital abnormalities, ENT abnormalities, and neuromusculoskeletal abnormalities. The size of the sample was 7,417, of which 7,119 (96.0 percent) were examined. A detailed report of the plan, operation, and response results of that cycle[50] as well as several methodological reports [51-56] and reports of findings[57-81] have been published.

The third cycle, conducted between March 1966 and March 1970, was concerned with youths 12-17 years of age, inclusive. As in Cycle II, the focus was on growth and development. A unique feature of the survey was that the same sample areas and housing units of Cycle II were used again. Thus, many of the Cycle II sample children were also examined in Cycle III, providing valuable longitudinal data. Of the total sample size of 7,518 youths, 6,773 (90.1 percent) were examined. Of those examined, 2,271 were examined in both cycles. A report of the plan and operation of that cycle[82] and several methodological reports[83-85] have been published. Reports of the findings are becoming available and will increase rapidly now that initial analyses of the data from the second cycle are virtually completed.

PLANNING FOR THE HEALTH AND NUTRITION EXAMINATION SURVEY

General

The decision to amalgamate HES and NNSS into one dual-purpose survey and to distinguish it from the previous HES cycle concept led to its informal renaming as the Health and Nutrition

Examination Survey (HANES). The planning for the two components of HANES did not occur simultaneously, although obviously in the later stages the two pieces had to be merged into a single workable plan. Prior to. the development or suggestion that the HES program be responsible for carrying out a nutrition survey, preliminary planning had already begun for HES Cycle IV. It can be judged from the beginning and concluding dates of the three HES cycles discussed in the preceding section that the operation of HES has had to proceed simultaneously on three different 'levels-planning, collection, and analysis.

There are a number of reasons for this three-level concept of operation, but a principal one is to avoid complete dismantling and rebuilding of the field organization between examining phases of successive cycles. It also avoids the loss of highly trained field and headquarters personnel whose skills are unique and difficult to replace. Thus, while data were being collected in HES Cycle III, analysis was being made of Cycle II data. At the same time, plans and preparation were being made for Cycle IV, so that upon completion of Cycle III, data collection could begin immediately in the new cycle.

The planning which had taken place for Cycle IV came to center around the problems of current and unmet health care needs of the U.S. adult population in response to the widespread interest in that aspect of health services. The target population was to be adults, with heavier sampling of older persons and minority groups. Although Cycle I had also studied a sample of adults, it was planned that the content would include some major areas of interest not included in the earlier cycle. Areas under consideration were diseases of the pulmonary and urinary systems, thyroid diseases, dermatology, determination of bone mineral density, various antibody levels, tests of psychological functioning, and additional blood chemistries. Repetition of certain Cycle I examination procedures using modified techniques and obtaining additional specific data was also considered; for example, data on hearing as a byproduct of a speech discrimination test, data on the cardiovascular system obtained by electrocardiograms recorded directly onto magnetic tape, newer methods for obtaining blood pressures, and data on vision from the measurement of intraocular tension and from testing with lenses for acuity correction.

Development of HANES General Objectives

The specifications around which the general objectives of HANES were developed were based primarily upon the principal points and recommendations of the NCHS task force with some modifications, as follows:

1. Each cycle of HANES would cover approximately a Z-year period based on a sample of about 30,000 persons aged 1 through 74 years. (Recommendations of the task force had been for the age range 2-84 years; however, because of the problem of response associated with the age group 75-84 years and the expected small number of such persons that would fall into the sample, the upper limit was reduced to 74 years.)
2. All sample persons would receive a specifically designed nutrition examination, with a one-fifth subsample of those aged 25-74 years also receiving a more detailed examination based upon the HES component.
3. The sample would be more heavily weighted on the low-income groups, the older age groups, preschool children, and women of childbearing age.
4. Three mobile examination centers would be used. (This number was reduced from that of an earlier plan for four for budgetary reasons.)
5. The examination time for persons receiving the nutrition examination should- be under 2 hours; for persons receiving the detailed examination, under 4 hours.
6. The nutrition component would consist of a general physical examination; dermatological, ophthalmological, and dental examinations; body measurements; biochemical assessments; and dietary intake measures.
7. The HES (detailed) component would carry out the general objectives of HES, with emphasis on health care needs. The data collection period would encompass two HANES cycles because of a smaller yield of examinees due to subsampling.

8. Demographic, health history, health care needs, and dietary data and' data on participation in food programs would be obtained through the use of questionnaires.

Development of Some Specific Areas of the Detailed Component

As stated earlier, much of the preliminary planning for the detailed component had already been performed in preparing for HES Cycle IV. It was decided that the central purpose should remain as planned-to obtain data concerning the current and unmet health care needs of persons in the age group 25-74 years. It was considered that these data could best be obtained by ascertaining the health needs as self-perceived by the individuals examined, and as professionally and scientifically determined by the survey's examination and tests. Information obtained through the use of questionnaires would include data on what health care has been received; and even though the examination would provide some indications of the health care needed, it would not identify specifically the entire range of unmet medical needs. Besides identifying health needs, some account would be taken of the importance of these needs by considering what effect they have had or will have on the individual's functioning. The resultant data on health needs would provide an enormous amount of information, heretofore unavailable, that could be studied in relation to the health care that had been, is being, or should be received. It would not, however, provide any total systems-analysis-type assessment of the present overall functioning of the medical care system.

It was recognized that the detailed examination component could not cover all aspects of an individual's health. The approach used was to select a number of index conditions that could be targets of a single, time-limited examination and that could be related to the symptoms and individually felt health needs of the sample person. These target conditions were chosen to provide needed prevalence information on conditions related to some of the commonest symptoms experienced by patients. Thus, the interview and questionnaire data would yield information concerning the sample person's experiencing the following seven sets of symptoms or complaints: shortness of breath, joint pain, chest pain, skin problems, dental difficulties,, trouble with hearing, and visual disturbance. In addition, the sample person would be asked about any other kinds of symptoms, complaints, or health troubles he may have. Through the detailed examination it would be possible to establish the presence of chronic pulmonary disease; chronic disabling arthritis of the hip, knee, and other joints; specific dermatological disease; dental and oral conditions; cardiovascular disease (including peripheral vascular disease) ; thyroid abnormality; auditory acuity; correctable level of visual acuity; as well as the presence of ocular hypertension and other ocular conditions. The above concept is displayed as providing the information to enter the cells of the matrix shown in figure 1.

As a result of having to reshape the detailed component for HANES, it was necessary to drop certain elements planned for HES Cycle IV. The most important of these elements was the almost total elimination from the first HANES program of any significant separate psychological examination. It was decided to proceed with further developmental work in this area over the

Self-perceived needs and action	Health needs from HANES examination and test		
	a No pathology found	b Pathology noted but no treatment needed	c Pathology found, treatment indicated
1. No problem or relevant complaint	√	√	X
2. Condition not seen as needing any medical attention	√	√	X
3. Condition seen as needing medical attention but not under treatment			X
4. Condition under treatment by M.D., D.D.S., etc.		√	√

NOTE: Index conditions for the matrix.—Cardiovascular disease; chronic respiratory disease; disabling arthritis of hip, back, knee; dental and oral conditions; dermatological disease; ophthalmologic conditions (including visual acuity); hearing loss; psychological problem.

KEY:
√ = No unmet need
X = Unmet need

Figure 1. Conceptualization of the Health and Nutrition Examination Survey approach to measurement of unmet health needs.

next 2 years in order to carry out necessary validation, calibration, and developmental work on the full battery of instruments developed by the psychological advisor and on other possible modifications of a psychological battery. In this work it was planned to collaborate with persons in the National Institute of Mental Health and with selected outside experts. One instrument, developed from a small portion of the proposed battery, was to be used in HANES. The final form developed for use in the detailed portion of the survey was the General Well-Being Questionnaire. The questionnaire is intended to fill several purposes: to serve as an indicator of overall adjustment; to provide subscales of adjustment, such as emotional stability and control, depressive mood, worry or concern about health, and tension; to collect information on psychological services needed and prevalence of use of some services; and to serve as a "moderator variable" or control in the statistical assessment of unmet medical needs.

Considerable interest in further national and regional information on hearing sensitivity to pure tone and to speech among adults had been indicated by the staffs of the National Institute of Neurological Diseases and Stroke (NINDS) and the National Bureau of Standards, by members of the American Academy of Ophthalmology and Otolaryngology, and by other experts in related fields. Data were needed in the development of standards for bone conduction thresholds and for more precise determination of the relationship of bone to air-conduction thresholds and to speech discrimination. These would provide a more valid base or normal standard than is now available for use in the diagnosis of specific conditions and for assessing the functional implication of hearing impairment. It was later decided, however, that the speech-testing portion be postponed until the second HANES program because of difficulties in preparing a reliable, valid test on tape that could be administered within certain allowable time limits of the examination and because necessary pretesting requirements, could not be satisfactorily completed in time for implementation into the first HANES program.

In planning the specific components of the audiometry testing, including the instrumentation and methods to be used, the following experts were consulted individually and in ad hoc meetings: Dr. Eldon L. Eagles, Associate Director, NINDS; Dr. Hallowell Davis, Central Institute for the Deaf; Dr. Ralph Naunton and Dr. Stanley Zerlin, University of Chicago; Dr. John W. Black, Ohio State University; Dr. Paul LaBenz, NINDS; Dr. Leo Doerfler, University of Pittsburgh; Dr. Edith L. R. Corliss and Mrs. Pearl Weissler, National Bureau of Standards; Dr. Hayes Newby and Dr. Donald Causey, University of Maryland; Dr. Sadanand Singh, Howard University; and Mr. Kenneth Stewart, University of Pittsburgh.

A specific protocol for air- and bone-conduction testing for use in the survey was developed by Dr. LaBenz, who also advised on all aspects of this part of the examination and trained the audiometric technicians. Initial training of the HANES examiners was given by Dr. Mark Doudna, University of Maryland. The field protocol related to the instrumentation and acoustical environment, including the weekly field calibration of the instrument used, the monthly environmental noise surveys, and the daily physical checks of the instruments,* was developed by Mr. Kenneth Stewart, in charge of the Acoustics Laboratories, University of Pittsburgh, who also advised on all related aspects during the survey.

The vision examination of adults in HES Cycle I had consisted of testing with and without glasses for near and distance visual acuity. In addition, there had been a limited funduscopic. examination of the eyes, but primarily for the determination of hypertension. In the planning for HES Cycle IV, it was recommended that a glaucoma screening procedure, probably involving tonometry (Schiøtz-Sklar) and visual field testing, be added to the examination. With the increased interest in more definitive information on visual problems and eye conditions among the general population, however, Dr. Carl Kupfer, Director, National Eye Institute (NEI), 'proposed collaboration and provision for logistical and technical backing for a much more ambitious program. NEI was particularly interested in determining the prevalence and distribution of specific eye diseases and related conditions throughout the United States for use in setting goals and priorities for future emphasis in the field of ophthalmology. Consist-

ent with the overall objectives of the survey, an evaluation of treatment needs was incorporated into the examination.

Two ophthalmologists from NEI, Drs. James P. Ganley and Arthur F. Garcia, developed the examination form and standardized protocol for the ophthalmic examination and were responsible for training and recruiting the examining ophthalmologists.

The main impetus for inclusion of an extensive dermatology component for HES Cycle IV came from within the profession itself through the National Program for Dermatology. The examination protocol, including an assessment of treatment needs, was worked out by Dr. Marie-Louise Johnson, Division of Dermatology, Dartmouth Medical School, and Director of the Data Collection Unit for the National Program. She also assumed responsibility for recruiting and training the examining dermatologists required to carry out this highly specialized part of the examination.

Because of the considerable interest expressed by representatives of the American Heart Association, the National Heart and Lung Institute, several areas of the Health Services and Mental Health Administration, and others, it was determined that Cycle IV should include plans to obtain data for the determination of the total prevalence and the distribution of cardiovascular disease, primarily hypertension and heart disease. Although collection of such data had been a major part 0f the Cycle I adult survey program, it was felt that there was a need for further and more up-to-date information in this area, particularly with respect to the extent of need for medical care and normative electrocardiographic data.

The Cycle I survey of adults did not include an evaluation of pulmonary function. Since chronic pulmonary disease is second only to heart disease as a cause of disability in the adult population, it was recommended that the prevalence and distribution of this disease be determined. For this purpose, a large battery of tests was considered originally in the Cycle IV planning. Tests considered included spirometry, single-breath carbon monoxide tests for pulmonary diffusion, PA and lateral X-rays of the chest to determine lung volume by a planimeter method, the body box or plethysmograph, and an oscillatory method of determining respiratory resistance. In the pilot work on these various tests, it was determined that the body box and the oscillatory method were unsuitable under the operational conditions of the survey.

Specific body-size measurements were to be included for a variety of reasons: the measurements would provide a minimum of information to be compared with some similar measurements taken in Cycle I, height and weight data to be related to pulmonary function, and other measurements to correlate with joint disease.

The arthritis examination of Cycle I had included determinations of the prevalence of rheumatoid arthritis and osteoarthritis based primarily on X-rays of the hands and feet. It was decided in the Cycle IV planning that, in keeping with the overall objectives, more emphasis should be placed on the determination of the amount of disability and on evaluating the medical care that had been received or was needed. Arthritis of the hip, knee, and lower back was to be stressed since they are the cause of much disability from this disease. Two X-rays were to be taken, one of the hips and sacroiliac region, and the other of the knees. In addition, the range of motion of the hips and knees was to be determined by using goniometers. Developmental work was performed to determine the necessary modifications of X-ray equipment and settings required to produce the proper quality of hip X-ray for a measurement of leg length at 6 feet instead of the usual 3 feet. This measurement was to be obtained to provide more information on its relationship to unilateral osteoarthritis of the hip and the possible alleviation of disability from this condition.

Much of the work in the development of an arthritis history and of the content of the examination was performed in collaboration with Dr. John Decker, Chief, Arthritis and Rheumatism Branch, National Institute of Arthritis and Metabolic Diseases (NIAMD).

Osteoporosis, a fairly common condition, especially in postmenopausal women, was one of the other skeletal conditions considered for inclusion in Cycle IV. The initial choice for measuring bone density was the photon absorption method of Cameron. This method, although quite accurate, required the use of a radioisotope as a radiation source. After thorough

investigation, however, it was found that arrangements for State and national licensing for radioisotopes posed extremely difficult barriers to the use of this method. On the recommendation of Dr. G. Donald Whedon, Director, NIAMD, it was decided to use X-ray densitometry instead. The X-ray to be used was one of the hand-wrist with the density determined on the fifth finger and the radius. A contract was arranged with Dr. George Vose of Texas Woman's University to process the X-ray films. Bone density was to be determined by a microdensitometer coupled to a computer.

Previous cycles had included some biochemical and hematological determinations, e.g., cholesterol, uric acid, protein-bound iodine, hemoglobin, and serologic tests for syphilis. The final selection of all tests to be included in the detailed component of the examination was not made until the tests required for the nutrition component had been considered since many of the tests could serve both.

In the selection of tests for the total HANES, a large number of individual hematologists, biochemists, nutritionists, and clinical pathologists were consulted. Particularly involved were the committee of clinical pathologists of the National Academy of Sciences and the laboratory division of the Center for Disease Control (CDC). The final selection of tests to be included in HANES was based not only upon meeting the requirements of the two components but also upon other criteria. These criteria were that the test be in.general widespread use, adaptable to shipping over long distances, that the number of abnormal values expected in a general population would not be extremely small, and that a period of fasting would not'be required before taking a sample of blood from the examinee. Some recommended tests that met the above criteria, such as tests for immunoglobulins, had to be eliminated because of cost.

The hematological determinations finally decided upon for all sample persons were hematocrit, hemoglobin, red cell count, white cell count, and sedimentation rate. The nutritional biochemistry component would be performed on appropriate specimens of serum or plasma and would consist of determinations for vitamins A and C, magnesium, serum iron, iron-binding capacity, serum folates, total protein and albumin, and cholesterol. In addition, further biochemical determinations were to be made on blood samples from examinees in the detailed component. These were: total bilirubin, SGOT, alkaline phosphatase, uric acid, calcium, phosphorus, a T-3 index by resin uptake, a T-4 by column, and serum antibody titers for polio I, II, and III, measles, rubella, diphtheria, tetanus, and amebiasis. Also, a differential white cell count was to be made on blood smears of detailed examinees.

In addition to providing advice and assistance in the planning operation, the CDC, Dr. David Sencer, Director, established a Nutrition Laboratory where, under a reimbursable arrangement, essentially all the HANES laboratory work would be performed. CDC was also instrumental in developing procedures for obtaining and shipping the specimens and quality control procedures to be used in the field.

A casual urine specimen for testing pH, albumin, glucose, and hematuria using reagent strips was included in Cycle IV plans. The same specimen would be acidified, frozen, and sent to CDC for determinations of creatinine, thiamine, riboflavin, and iodine. The last three would be related to creatinine (thiamine per gram of creatinine). In addition, collection of a timed urine specimen was seriously considered for the purpose of a creatinine clearance test, but later pilot work demonstrated that this procedure was too difficult to administer in conjunction with other parts of the proposed examination.

Examples of other procedures that had been considered for inclusion in Cycle IV but that were not finally included in later pilot testing were the use of a special X-ray procedure to demonstrate coronary artery calcification, ballistocardiogram for evaluating cardiac function, use of ultrasound to determine liver size, semiautomated procedures for taking blood pressure, and the use of tonography for glaucoma evaluation. Factors such as cost and difficulty of adaptation to field operation, including time for administration and stage of development among other considerations, were instrumental in their exclusion.

In keeping with the overall objective of HES Cycle IV, health care needs, it was planned to include in the dental examination an assessment of the needs for dental care. The assessment was

to be accomplished by having the examining dentist apply his clinical judgment above the customary index assessments of oral health and arrive at an estimate of unmet treatment needs. A large portion of the proposed dental examination would also provide data for comparison with that of Cycle I.

A final phase of planning for the dental examination resulted in the inclusion of an enamel biopsy procedure. This newly developed procedure is a simple and rapid technique for removing a microscopic layer of enamel from a small area of a tooth for laboratory analysis for fluoride content. The result expressed in parts per million serves as an estimate of the individual's exposure to and absorption of fluoride. Besides the obvious interest in this finding from the large national sample, comparisons will be made with the number of cavities and fillings on selected surfaces where it is thought that fluoride has its most striking impact.

Early plans for HES Cycle IV led to construction of a rather detailed medical history questionnaire that was to be complemented by seven supplements designed to elicit additional information on positive responses related to certain target chronic diseases. With the inclusion of the nutrition component, drastic cuts in both the number and size of the questionnaires produced a package that consisted of the Medical History Questionnaire, ages 12-74, and the General Medical History Supplement, ages 25-74, to be completed by all of the detailed examination subset of sample persons, along with a possible three supplements-Supplement A, Arthritis; Supplement B, Respiratory; and Supplement C, Cardiovascular-to be completed only as indicated by positive response to screening questions on the General Medical History Supplement. These forms were the result of extremely widespread consultation in connection with the planning of the content of the detailed examination. They drew extensively on the experience of other surveys including, for example, the respiratory studies carried out by the British Council on Medical Research. Specific advice on matters of direct concern to them came from a number of institutes within the National Institutes of Health (e.g., NIAMD), from various outside professional groups, and from some individual experts in the areas. The development and consultation work was carried out largely by the medical staff within the advisory group of the Division of Health Examination Statistics (DHES).

The Health Care Needs Questionnaire was also constructed to obtain information on the individual's perception of his own health care needs along with information concerning actions related to obtaining health care. Medical-advisors within DHES worked closely with experts at the School of Public Health at Johns Hopkins University Medical School in developing the questionnaire. Consultation with staff members of the Medical Sciences Division of the National Academy of Sciences-National Research Council provided corroboration of the approach used. Members of other divisions within NCHS, notably the Health Interview Statistics Division and the Health Resources Statistics Division, were very helpful in advising on questionnaire wording.

The household questionnaire developed for Cycle IV had to undergo very little change except for the addition of several questions regarding housing facilities. This questionnaire, which was developed jointly by members of the DHES staff and the Bureau of the Census personnel, is the basic source document for demographic and socioeconomic data of the population sample and also serves in the final stage of sample selection. In addition to information on the age, race, and sex of all household members, a variety of other data is obtained—family income, marital status, ethnic background, education, work status, occupation and industry, and a series of questions concerning housing characteristics.

Development of Specific Areas of the Nutrition Component

As in planning for the detailed component of HANES, the final content of the nutrition component was made only after extensive consultation with many agencies and individuals. Personnel of CDC provided very valuable advice and assistance, particularly in the development of the nature of the blood analyses to be performed and in planning for the necessary facilities for the extensive laboratory work. To take maximum benefit of the experience of the

Ten-State Nutrition Survey, several especially knowledgeable individuals on the staff of the Nutrition Program within CDC who had played an active role in that earlier survey, along with other staff members from the Nutrition Program, participated with NCHS staff in a work conference directed specifically to the problem of planning HANES. A number of consultations were held with personnel of the U.S. Department of Agriculture, in both the Agricultural Research Service and the Food and Nutrition Service, who provided valuable input and expert help, as did nutrition specialists within the Maternal and Child Health Service and the Indian Health Service of HSMHA. Assistance was also provided by the Office of Economic Opportunity, the Office of Education, and the Food and Drug Administration, to list but a few of the major contributors.

The Food Programs Questionnaire, developed in collaboration with the Department of Agriculture, was designed to elicit information about family participation in food stamp and commodity programs and the participation of young sample persons in school lunch, breakfast, and milk programs. Data from the questionnaire will be related to the various examination findings as well as to the hematological and blood chemistry results. Information about participation in food programs such as school lunch programs will be related to dietary adequacy of participants.

The medical, dental, and nutrition advisors within DHES played an important role in the development of the medical history questionnaires for the nutrition component. Many of the outside consultants and experts in the area were asked to and did review drafts of the forms. Because of the wide age span (l-74) of the population being surveyed, three different questionnaires were developed relative to three different age segments-l-5, 6-l 1, and 12-74. The first two questionnaires, while essentially alike, differ in content primarily because of the factors of question-recall validity and prevalence. The questionnaire for age group 12-74 is oriented more toward information associated with the dental and medical conditions that are more prevalent in that age group.

One of the three essential parts in obtaining a full nutritional profile of individuals or groups is some assessment of food intake. While food consumption data alone are not a valid measure of nutrition, such data help to interpret clinical and biochemical findings. Information about dietary intakes is useful also for such purposes as characterizing food preparation practices, identifying sources of nutrients, and determining the types of food consumed at different seasons and in different geographic locations.

Although a variety of methods have been developed during the past 40 years to estimate food intakes as part of nutritional status or epidemiological studies, a number of practical considerations influenced the selection of the 24-hour recall and food frequency methods over other methods for HANES. Principal among these considerations were the nature of the data-collecting process and simplicity of the two methods, the fact that data would be analyzed by groups and not by individuals, the limitations of interviewing time, the availability of staff and training facilities, and the recruitment potential for interviewers. In addition, the 24-hour recall method and 7-day food record have been compared by several researchers who concluded that for estimating the intakes of population groups, the two methods tend to be interchangeable.

Because of the large sample size (30,000), it is anticipated that subgroups, such as age, sex, income, education, family size, health status, and geographic area, will be large enough for analysis to indicate groups of persons where it is obvious that steps need to be taken to improve their diets.

Another necessary part in assessing the current nutritional status of an individual is a clinical appraisal that includes general assessment by a trained physician looking especially for stigmata of malnutrition and includes taking certain anthropometric measurements. The clinical examination was prepared by the Nutrition Advisor to DHES in conformance with accepted criteria for such examinations. The assessment consists essentially of an inspection by the physician of the head and neck for the presence or absence of various signs which are found associated with possible nutritional deficiencies. In addition, it was considered essential that the neck be inspected and palpated for any visible or palpable enlargement of the thyroid gland; that the abdomen be inspected and palpated, and the

liver size be determined by percussion in all persons over 25; that the deep tendon reflexes be checked; that the musculoskeletal system be observed for any marked deformities due to possible rickets; and that there be an inspection and palpation of the skin for possible signs suggesting nutritional problems.

It was felt that while height and weight were the most simple measurements for assessing nutritional status, the information derived from them would be rather crude. Additional measurements were needed for more refined and accurate information on nutritional status in relation to body build and composition. Among the large variety of measurements considered, eight were finally selected in addition to height and weight. These were triceps and subscapular skinfolds to provide a measure of the presence or absence of obesity; triceps skinfold that, when subtracted from the upper arm girth, provides an approximate measure of muscle mass; elbow and bitrochanteric breadth to provide more information on body build, particularly on the bony structure; sitting height to provide a comparison of trunk length in various age-sex groups of different ethnic and socioeconomic backgrounds; and head and chest circumferences of children 1 to 7 years of age only, as a source of useful information through their interrelation as possible indicators of early protein-calorie deficiency in that age group.

The dental examination planned for the detailed component was expanded in several ways to meet the objectives of the nutrition component. Among these were a more detailed assessment of the gums for manifestations of systemic nutritional deficiencies and diseases, and a series of questions about chewing foods to determine the relationship between dietary intake and dental conditions.

Pilot Testing

The first of the pilot test operations was performed in Georgetown, Delaware, from April 27 through May 23, 1970, immediately following the completion of Cycle III. The main emphasis of this test was on the detailed examination component of the survey, which had been in the planning stages for 2 years. Testing was intended to determine, among other things, the feasibility and acceptability of new examination procedures such as goniometry, pulmonary function tests, tuberculin testing, knee X-rays, thyroid grading, and examination recording forms. Other equally important portions of the survey evaluated in this work were questionnaires, interviewing techniques, administrative areas, and the time factors involved in all aspects of the work. A total of 70 persons aged 25-74 were examined during the Delaware work.

Much was learned from the first test. Many revisions were required in the coding and sequencing of the questionnaires, and a general appraisal was made of the reliability and relevance of items contained in the questionnaires. Problems associated with interviewing were identified, and the amount of time required for household interviewing was obtained. In the examination portion, the procedures that were tried proved feasible and workable with few exceptions. Examples of the exceptions include evaluation of the two types of thyroid grading which had to be deferred until further testing could be performed because of the small number of persons with enlarged thyroid glands. A new piece of equipment to measure respiratory resistance presented difficulties in obtaining valid readings. Further trials were also indicated in the area of tuberculin skin testing.

Further pretest work followed at the Research Triangle Park, North Carolina, between June 10 and October 6, 1970. With the exception of a small number of persons, all participants were recruited from Government offices in the Research Triangle Park area. A total of 428 persons were examined. As in Delaware, this pretest work was focused on the detailed component of the survey. With approval from the Office of Management and Budget for the nutrition component which occurred during the last days of the test work at this location, it was possible to examine 25 individuals using the procedures and forms developed for that portion of the survey. These examinations were very important since the examinees were children in the age group 1-6 years, and they provided experience for the first time in the history of the Health Examination Survey with examinees of this age. The detailed examination component was conducted employing certain refinements of procedures initially tried out in Delaware.

Several new procedures were tested, however, including laboratory techniques for red and white cell counts, hemoglobin, smears, and a dermatology examination. During the time of this pretest, special training in laboratory procedures was provided to the technicians by experts from the Center for Disease Control.

The third phase of the pretest work was conducted at the same location, but using a probability sample of persons from Durham County, North Carolina. Several important parts of the overall survey were tested for the-first time during this phase. The household questionnaire was one of these. This questionnaire, administered by Bureau of the Census interviewers, is the first contact with a sample household. It establishes the household composition and obtains certain demographic information about the households and the individuals who live in them. It is also essential in the selection of persons to be included in the sample. Sample selection procedures, which are complicated by the dual concept of the survey and the use of different sampling ratios for various age-sex groups, were also performed for the first time during this test.

The sample selection provided individuals for both the nutrition and detailed examination components. The examination sessions thus included both types of examinees, permitting the testing of procedures and questionnaires of the two components taken together. The examination also included several procedures not tried previously, such as the ophthalmological examination, collection of urine specimens, and the use of a lung analyzer machine. The equipment for measuring respiratory resistance continued to present difficulties in operation and was later excluded from the examination plan. One of the four medical history supplements to the detailed examination, Supplement D, Gastrointestinal, was also dropped to reduce examination time because it was relatively less important to the survey than were the others.

In addition to the examination and questionnaire portions of the survey, administrative procedures, consisting principally of record keeping, scheduling and the rescheduling of examinees with broken appointments, school contacts, and transportation of examinees, were also tested.

A total of 274 sample persons were identified for this pretest. Of these, 204 were to receive the nutrition portion and the remaining 70 the detailed examinations. At the end of operations, 71 percent of those in the nutrition component and 74 percent in the detailed component had been examined.

The fourth phase of pretest work was concluded December 17, 1970, in Winston-Salem, North Carolina. Prior to this phase, all forms and questionnaires were reviewed, and many changes were made in wording, sequence, and so forth. Questions not felt to have sufficient validity or relevance to the survey were deleted. The Bureau of the Census questionnaire also underwent some changes, primarily on the question of sources of income where less detail was required of nonpoverty persons. No substantive additions were made to any of the questionnaires or to the examination procedures. The test of visual fields in the ophthalmology examination was excluded because of problems encountered in its administration. Various sequencing procedures for more efficient examinee flow in the examination center were also tested.

During these pretests, new personnel to staff a second caravan were hired for the varying aspects of the survey (interviewers, technicians, nurses, coordinators, and administrative personnel), and the operation of these pretests was a part of their training. The nutrition interviewers used during the preceding test had been hired as a temporary arrangement pending the recruitment of permanent personnel. Permanent nutritionists were recruited in time for the last test, and extensive training in this area was given during the Winston-Salem pretest.

Following the Durham pretest, a complete package of the HANES material, including a description of the program and sample design, was distributed to the panel of advisors to the National Center for Health Statistics and others, asking for any comments they might care to make concerning the program or any of the specific procedures and forms involved. Replies were received from more than a score of these advisors, and their cornments were carefully considered and, in many cases, taken into account in the final version of the HANES plan.

The final "dress rehearsal" took place in the Baltimore metropolitan area. The date for the

opening phase, household interviewing by the Bureau of the Census, was February 8, 197 1, with examinations between March 1 and April 16. Prior to this, however, field employees participated in further formal and informal training sessions in such areas or procedures as interviewing techniques, questionnaire administration, laboratory, audiometry, dietary interviewing, and coding amounts and types of food. They also received an orientation by key staff members of NCHS and DHES. A total of 573 sample persons were included in this final test. Of these, 460 were to receive the nutrition portion only, and 113 the detailed examination. The overall examination rate was 66 percent, with 68 percent of those in the nutrition component and 56 percent in the detailed part being examined.

Summary

The following summary shows the questionnaires, procedures, and measurements of the survey, by recipient, as it proceeded through the first 35 of the total 65 primary sampling units:

Recipients	*Questionnaires*
All households in the sample	Household Questionnaire
All households containing one or more sample persons	Food Programs Questionnaire
All sample persons	General Medical History, Ages l-5 General Medical History, Ages 6-11 General Medical History, Ages 12-74 Dietary Intake, 24-Hour Recall Dietary Intake, Food Frequency
Additional for all sample persons in the detailed component	General Medical History Supplement, Ages 25-74 Supplement A, Arthritis; Supplement B, Respiratory; Supplement C, Cardiovascular. Supplements A, B, and C depend on certain positive responses in other history questionnaires Health Care Needs Questionnaire General Well-Being Questionnaire

Recipients	*Examination procedures and measurements*
All sample persons	General medical examination Dental examination Dermatological examination Ophthalmic examination Anthropometric measurements Hand-wrist X-rays (ages l-l 7 only) Laboratory determinations: Hemoglobin; Hematocrit; Red cell count; White cell count; Sedimentation rate; MCV; M C H; Serum iron; Iron binding capacity; Serum folates; Cholesterol; Glucose qualitative (urine); Albumin qualitative (urine)

Recipients	*Examination procedures and measurements*
All sample persons-Con.	MCHC; Vitamin A; Vitamin C; Magnesium; Total protein; Albumin; Occult blood qualitative (urine); Creatinine (urine); Thiamine (urine); Riboflavin (urine); Iodine (urine)
Additional for all sample persons in the detailed component	Extended medical examination X-rays of chest and major joints (hand-wrist, knee, hip) Audiometry (air and bone) Electrocardiography Goniometry Spirometry Pulmonary diffusion Tuberculin test Laboratory determinations: Bilirubin; SGOT; Alkaline phosphatase; Uric acid; Calcium; Thyroid (T-3, T-4); Phosphorus; W.B.C. differential count; Serological tests for amebiasis, measles, tetanus, diphtheria, rubella, polio

SAMPLE DESIGN

General Plan

The design of the sample, which is expected to yield approximately -30,000 sample persons for HANES, is quite similar in a number of ways to the designs used in the first three HES cycles. General descriptive reports of those designs [2,50,82] are available, as is a more detailed report of the Cycle II sample design.55 NCHS set specifications for the sample design and carried out some of the steps of drawing the sample. Other steps in the design and sample selection were performed by the Bureau of the Census under a contractual arrangement.

The primary similarity of the design to that of the HES cycles is that it is a multistage, stratified, probability sample of loose clusters of persons in land-based segments. The successive elements dealt with in the process of sampling are primary sampling unit (PSU), census enumeration district (ED), segment (a cluster of households), household, eligible person, and, finally, sample person.

The HANES design was further complicated, however, by the fact that unlike the preceding cycles it had two distinct examination components-nutrition and detailed-to be considered instead of only one. Similarly, the age range in HANES covers more than one specific age group, and emphasis is placed on the low-income groups, preschool children, women of childbearing age, and the elderly, because these are the groups liable to be affected most often by malnutrition and for which detailed information is most needed. Therefore, the design had to take into consideration the sample size requirements for the population subgroups to obtain an optimum mix for reliability of estimates.

Design Specifications

The sample design of HANES was developed essentially from a set of specifications that took

into consideration the requirements and limitations placed upon it. It was important that the requirements be consistent with survey objectives and that the limitations not be so serious as to materially distort the objectives. Specifications considered to be of primary importance were as follows:

1. The target population would be the civilian, noninstitutionalized population 1-74 years of age residing in the coterminous United States, with one exception. Because of operational difficulties experienced in Cycle I, all people residing upon any of the reservation lands set aside for the use of American Indians would be excluded.
2. For the nutrition component, broad national estimates must be made annually, with more detailed estimates published upon the completion of a 2-year cycle. For the detailed examination, broad national estimates would be based on data collected during the 2-year cycle, with more detailed estimates being made after the completion of the two successive 2-year cycles.
3. Three mobile examination centers similar to the ones used in earlier cycles of HES would be used. Thus, with appropriate modifications, the survey would be based on administrative and logistical procedures that have been developed and proved over a period of more than 10 years. A team could examine about 20 persons per day; of these, all would receive the nutrition examination, and four would receive the detailed examination. Other time limitations were a 5-day workweek, a loss of 5 weeks per year due to vacations and holidays, and a loss of 7 days per move from one examining location to another.
4. Operationally, the three caravans could visit a maximum of about 65 PSU's over a period of approximately 2 years.
5. A team must stay at least 3 weeks at a stand because of the expense of moving and the need to allow enough time in an area to give sample persons adequate time to be examined. A team cannot stay in an area longer than 6 weeks because of the requirement to finish the. survey in 2 years.
6. Because of the considerations in items 3-5 above, there would be a minimum number of 300 and a maximum number of 600 sample persons for each stand.
7. To the extent possible, the schedule of examining locations must take account of climate.
8. About 20 percent of the sample should be selected from the population classified at or below the poverty level. Other groups of special interest are preschool children, women of childbearing age, and the aged.
9. The estimates from the survey would be of two kinds: (1) distributions of the population by specified characteristics such as height, weight, blood pressure, and selected biochemical determinations; and (2) prevalence in the population of selected chronic conditions, particularly those in the arthritic, respiratory, and cardiovascular groups.
10. Maximum target tolerances for sampling variability would be set for several key statistics, permitting a general analysis by broad geographic regions, population size groups, and other major subgroups such as income, race, age, and sex.
11. Data from the 1960 Decennial Census would have to be used in the sampling procedures until 1970 data become available.

Stratification and Selection of Primary Sampling Units

The first-stage sample consists of 65 geographic areas, or PSU's. These have been selected from among approximately 1,900 PSU's into which the geographical territory of the mainland has been divided. Each PSU consists of a county or a small group of contiguous counties. For the purposes of the design of the Health Interview Survey, one of the other major NCHS data collection programs, PSU's are stratified into 357 groups, and one PSU is selected from each stratum with a probability proportional to its

size. For the design of HANES, these 35 7 strata were collapsed into 40 superstrata.

Fifteen of the superstrata contain only one very large metropolitan area of more than 2,000,000 population, and thus were chosen into the sample with certainty. The others were grouped into 25 superstrata on the basis of geographic region and population density class, as shown in table 1. Then, using a controlled selection technique to assure representation of specified State groups and of classes by rate of population change, two PSU's were chosen from each of the 25 strata with probability proportional to the PSU's 1960 population. Thus the sample contains 65 PSU's. A listing of the PSU's is given in appendix I, along with definitions of geographic region, State groups, and classes by rate of population change,.

To provide the ability to make early national estimates, PSU's were divided randomly into two parts. Thus, the survey cycle of 2 years will be conducted in two rounds. The first round involves 35 locations, including 10 of the large metropolitan areas and 25 of the smaller, noncertainty PSU's.

Table 1. Number of self-representing and nonself-representing superstrata for the Health and Nutrition Examination Survey design, by region and population density class, with average size of superstrata and definitions of population density classes

Region and population density class	Number of superstrata			Average size of superstrata, 1960 population in millions	Definitions of population density classes
	Total	Self-representing	Nonself-representing		
All regions	40	15	25	4.5	...
Northeast	13	9	4	3.4	...
Largest SMSA's	9	9	-	2.7	SMSA population greater than 2.4 million.
Other large SMSA's	1	-	1	5.2	70% or more of SMSA's population was urban.
Other SMSA's	1	-	1	6.5	Less than 70% of SMSA's population was urban.
Non-SMSA, urban	1	-	1	4.1	40% or more of the population was urban.
Non-SMSA, rural	1	-	1	4.8	Less than 40% of the population was urban.
Midwest	10	3	7	4.8	...
Largest SMSA's	3	3	-	3.5	SMSA's population greater than 3 million.
Other large SMSA's	2	-	2	4.3	90% or more of SMSA's population was urban.
Other SMSA's	2	-	2	5.3	Less than 90% of SMSA's population was urban.
Non-SMSA, urban	2	-	2	5.9	34% or more of the population was urban.
Non-SMSA, rural	1	-	1	6.2	Less than 34% of the population was urban.
South	8	-	8	5.4	...
Largest SMSA's	2	-	2	4.8	90% or more of SMSA's population was urban.
Other large SMSA's	1	-	1	5.1	
Other SMSA's	1	-	1	4.5	Less than 90% of SMSA's population was urban.
Non-SMSA, urban	2	-	2	6.0	30% or more of the population was urban.
Non-SMSA, rural	2	-	2	5.9	Less than 30% of the population was urban.
West	9	3	6	4.8	...
Largest SMSA's	3	3	-	3.2	SMSA population greater than 2.5 million.
Other large SMSA's	2	-	2	6.0	72% or more of SMSA's population was urban.
Other SMSA's	1	-	1	6.2	Less than 72% of SMSA's population was, urban.
Non-SMSA, urban	2	-	2	5.0	36% or more of the population was urban.
Non-SMSA, rural	1	-	1	5.0	Less than 36% of the population was urban.

Within PSU Design

For the first 44 HANES stands, only 1960 census data were available for the purpose of sampling within PSU's. The remaining 21 stands will use 1970 census data, resulting in a different procedure for within-PSU sampling. A principal reason for this change is that socioeconomic changes within ED's from the time of the 1960 census until the start of HANES precluded a satisfactory method to classify ED's efficiently into poverty and nonpoverty groups. This classification can now be made using the 1970 data.

For the stands using the 1960 data, ED's in each PSU were divided into segments of an expected six housing units each. In urban areas where listing units were well defined in 1960, this division was quite accurate since the sampling frame was composed of listings that resulted from the 1960 census. For ED's not covered by the listing books, area sampling was employed and, consequently, some variation in the segment size occurred. To make the sample representative of the current population of the United States, the list segments were supplemented by a sample of housing units that had been constructed since 1960.

Then a systematic sample of segments in each PSU was selected. The ED's that fell into the sample were identified and coded into two economic classes. One of the classes, identified as the "poverty stratum," was composed of "current poverty areas" that had been identified by the Bureau of the Census in 1970 (pre-1970 census) plus other ED's in the PSU with 1959 mean income less than $3,000 (based on the 1960 census). The other economic class, identified as the "nonpoverty stratum," included all other ED's not designated as belonging to the poverty stratum. A description of how the current poverty areas were determined is given in appendix I.

For those sample segments in poverty stratum ED's, all segments were retained in sample. For those sample segments in nonpoverty stratum ED's the segments were divided into eight random subsamples, and one of the subsamples was chosen to remain in sample for HANES. One advantage from sampling the nonpoverty stratum in this way related to the need to have reserve segments in case the sample of persons in a PSU is less than the specified minimum of 300.

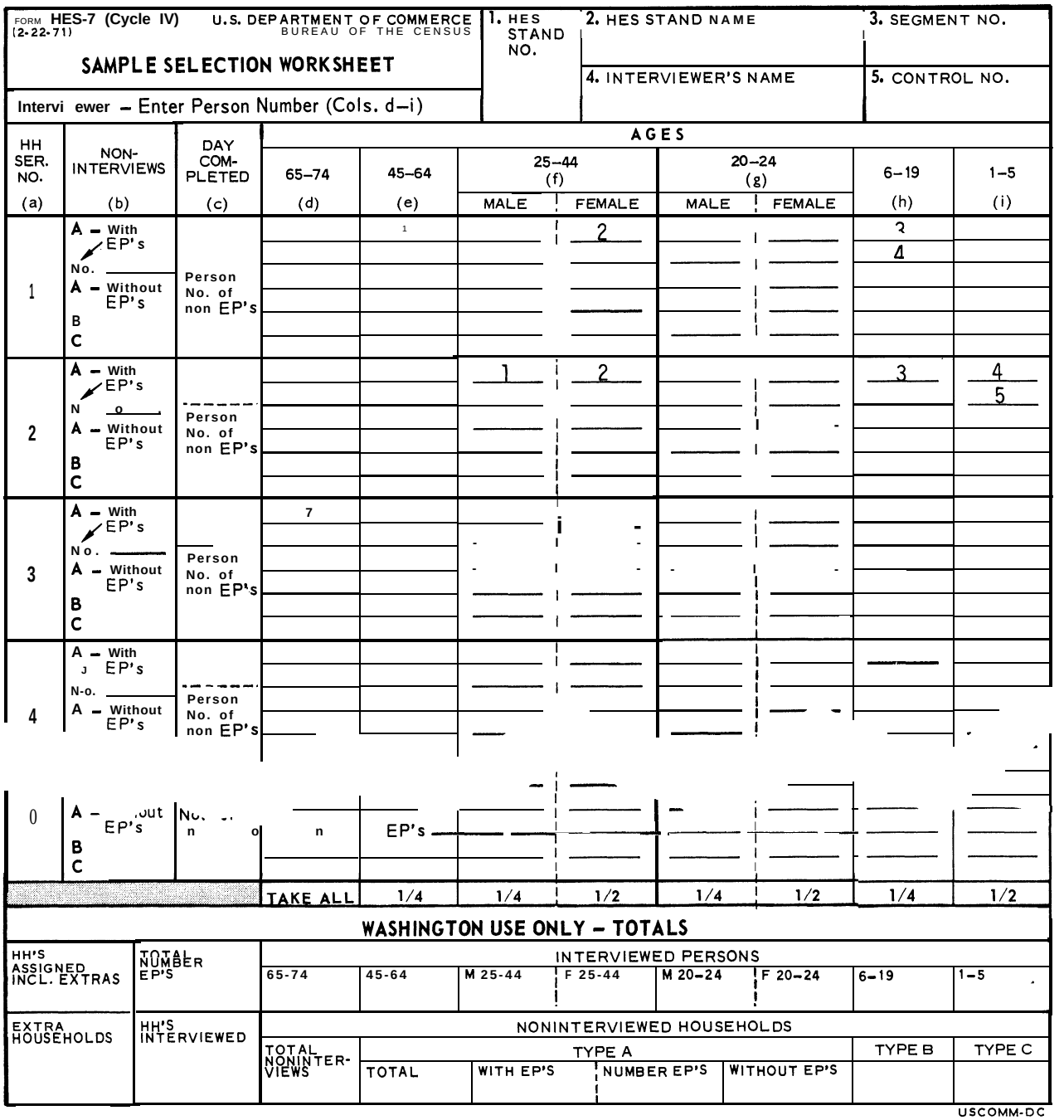
For the remaining 21 stands, 1970 census data will be used. ED's in each PSU will be divided into segments of an expected eight housing units each. As in 1960, the 1970 urban segments will be more stable in size than area segments. For each PSU using 1970 materials, ED's will first be sorted into poverty and nonpoverty strata. The proportion of persons in poverty will be used to determine the poverty and nonpoverty status of each ED. The designated proportion will vary from stand to stand. The poverty indices will be based on 1969 income (1970 census), size of family, sex of head of family, age (65 years or under) of head of family, and farm-nonfarm status. The sampling rate for selection of segments from the 21 stands will be changed from a poverty-nonpoverty ratio of 8: 1 to a ratio of 2 : 1. This change is being made as a result of a study using 1970 data by the Bureau of the Census that indicated a significant decrease in the sampling variance could be obtained by employing the 2: 1 ratio.

Then a systematic sample of segments will be drawn from each poverty-no npoverty stratum at different rates. As in using 1960 materials, reserve segments from 1970 materials will also be provided to meet the specified minimum of 300 sample persons per stand.

Selection of Sample Persons

After the sample segments have been identified, a list of all current addresses within the segment boundaries is made, and the households are interviewed to determine the age and sex of each household member, as well as other demographic and socioeconomic information required for the survey. If no one can be found at home after repeated calls or if the household members refuse to be interviewed, the interviewer tries to determine the household composition from neighbors.

To identify the sample of people to receive the nutrition examination, the household members aged l-74 in each segment are listed on the Sample Selection Worksheet as illustrated in figure 2, with each household in a segment numbered serially from 1 through *K,* the number of households in the segment. The household members are listed on the worksheet



FORM HES-7 (Cycle IV) (2-22-71) U.S. DEPARTMENT OF COMMERCE BUREAU OF THE CENSUS

SAMPLE SELECTION WORKSHEET

Interviewer – Enter Person Number (Cols. d–i)

1. HES STAND NO.
2. HES STAND NAME
3. SEGMENT NO.
4. INTERVIEWER'S NAME
5. CONTROL NO.

HH SER. NO. (a)	NON-INTERVIEWS (b)	DAY COM-PLETED (c)	AGES 65–74 (d)	45–64 (e)	25–44 (f) MALE	25–44 (f) FEMALE	20–24 (g) MALE	20–24 (g) FEMALE	6–19 (h)	1–5 (i)
1	A – With EP's No. ___ A – Without EP's B C	Person No. of non EP's		1		2			3 4	
2	A – With EP's No. ___ A – Without EP's B C	Person No. of non EP's			1	2			3	4 5
3	A – With EP's No. ___ A – Without EP's B C	Person No. of non EP's	7							
4	A – With EP's No. ___ A – Without EP's	Person No. of non EP's								
0	A – Without EP's B C	No. of non EP's								
		TAKE ALL	1/4	1/4	1/4	1/2	1/4	1/2	1/4	1/2

WASHINGTON USE ONLY – TOTALS

HH'S ASSIGNED INCL. EXTRAS	TOTAL NUMBER EP'S	INTERVIEWED PERSONS 65-74	45-64	M 25-44	F 25-44	M 20-24	F 20-24	6-19	1-5
EXTRA HOUSEHOLDS	HH'S INTERVIEWED								

NONINTERVIEWED HOUSEHOLDS	TYPE A				TYPE B	TYPE C
TOTAL NONINTER-VIEWS	TOTAL	WITH EP'S	NUMBER EP'S	WITHOUT EP'S		

USCOMM-DC

Figure 2. Sample Selection Worksheet.

in the order of that serial number. The entry made on the worksheet corresponds to the person's column number on the household questionnaire. For example, column 1 is reserved for the household head. The spouse, if any, is usually listed in column 2, while the children and other household members are listed in succeeding columns of the questionnaire.

Suppose the first three households in a segment have the following age-sex composition:

Household serial number	Column number on questionnaire					
	1	2	3	4	5	6
1	Male, age 45 years	Female, age 42 years	Female, age 13 years	Female, age 16 years		
2	Male, age 34 years	Female, age 27 years	Male, age 7 years	Female, age 5 years	Male, age 3 years	Female, age 6 months
3	Male, age 75 years	Female, age 70 years				

These household members would be recorded on the worksheet as shown in figure 2. Note that two persons are not listed; one is 75 and the other is only 6 months of age and, therefore, they are not part of the target population of persons l-74 years of age. After the Sample Selection Worksheets are put in order by segment number, a systematic random sample of each age-sex group is selected, using the sampling rates shown at the bottom of the worksheets.

There still remains one sampling operation—selection of adults to receive the detailed health examination. Overall, about 20 percent of the total sample receive the detailed health examination, producing a subsample of about 6,000 persons. This group is a subset of the nutrition sample aged 25-74, inclusive; the sampling frame is the nutrition sample designated on the Sample Selection Worksheet. The subsample is chosen systematically after a random start, using the sampling rates shown in table 2.

The sample size varies from one PSU to another, depending on the PSU population and the number of persons living in the low-income ED's. For the reason stated in the design specifications, the design provides for a probability sample of reserve segments to insure the number of expected sample persons per PSU. A deletion procedure is employed as necessary to reduce the number of sample persons per PSU to the number expected.

Table 2. Subsampling rates and expected sample size by age and sex for the detailed health examination

Age	Both sexes	Males		Females	
	Expected sample size	Rate	Expected sample size	Rate	Expected sample size
Total	6,000	...	2,850	...	3,150
25-44 years	2,000	2/5	1,000	1/5	1,000
45-64 years	2,700	3/5	1,300	3/5	1,400
65-74 years	1,300	1/4	550	1/4	750

OTHER SAMPLING ASPECTS

Sampling Features of the Examination

The sampling aspects of the survey are not restricted to choosing the sample persons and having them participate in the examination. The conduct of the examination itself has numerous sampling features that should be mentioned.

Examinations will be conducted in 65 different locations throughout the United States by three different teams of examination staff. Each team for any one location consists of a physician, dermatologist, ophthalmologist, dentist, two health technicians, laboratory technician, and two dietary interviewers. Because of normal personnel turnover and the lack of availability of dermatologists and ophthalmologists for extended periods of time over 1 month or even shorter duration, the number of different examining staff members employed through the 65 locations will be quite large. At the time of preparation of this report, it was estimated that the total number of individuals in each of the above positions for all locations would be approximately 30 physicians, 65 dermatologists, 100 ophthalmologists (for 35 stands only, see p. 30), 9 dentists, 15 health technicians, 10 laboratory technicians, and 20 dietary interviewers. Ideally, assignment of each examinee to the particular parts of the examination should be random with respect to time, place, and examiner. Operationally, such assignment is impossible. Therefore, any peculiarities in the conduct of a part or parts of the examination procedures, difficulties with equipment, or changes in the standards of the laboratories doing blood chemistry analysis may be reflected in the examination findings as a place peculiarity.

Stand Sequencing and Scheduling

As in previous cycles of HES, the scheduling of stands for HANES has been deliberately arranged so that the North is avoided in winter and the South in summer. Such scheduling is a fairly obvious operational necessity as it would be quite impractical to conduct a mobile examination survey of this kind in the Northern States in the middle of the winter. The schedule of stands for HANES is shown in table 3.

While this type of scheduling is desirable from an operational point of view, it can produce certain limitations on the examination data. Any characteristic under study which may have a seasonal variation will be difficult to interpret by geographic region. For example, to the extent that if persons in all parts of the country weigh more in winter than in summer, the mean weight of northerners would be underestimated and that of southerners overestimated. Another area of concern is the effect of season on the quality of data. For example, relatively more poor diets were reported in the spring than in other seasons in the recent U.S. Department of Agriculture Food Consumption Suwey. Possibilities such as these must be taken into account in analysis of the data. The limitations resulting from such a scheduling arrangement, however, were not considered to be too serious in either Cycle II or Cycle III. Most of the characteristics of the examination in the age group 6-17 did not exhibit any marked seasonal variation. Even in Cycle I, where the focus of the examination was on chronic conditions in the adult population, seasonal variation was not considered to be a serious problem. This would not be true if the examination, in any of the cycles, attempted to obtain estimates of conditions such as acute respiratory disorders.

An important consideration in sequencing stands is economy of operation. Efforts are made to follow the seasonal pattern described with a minimal amount of travel necessary in moving from one stand to the next by sequencing with regard to geographic proximity. Individual stand time schedules, featuring the various operational aspects involved in conducting the examinations at a particular stand, are also required in the development of the sequencing. Time allowances are based on the distance between stands and, therefore, the time required for movement of the trailers and personnel between stands, the time required for census interviewing, followup by the health examination representative (HER), trailer setup, staff setup and dry runs, staff vacation periods, and examinations. The number of days allotted for examinations is dependent upon the expected sample size at a particular stand and is deter-

Table 3. Schedule of stand operations by caravan, Health and Nutrition Examination Survey: 1971-73

Dates of field operations	Caravan I		Caravan II		Caravan III	
	Location	Stand number[1]	Location	Stand number[1]	Location	Stand number[1]
1971:						
April-May	Philadelphia, Pa.	1	Pittsburgh, Pa.	2	[2]	[2]
May-June	Albany, N.Y.	3	Mercer, Pa.	4, (2)	[2]	[2]
June-July	Boston, Mass.	5	Detroit, Mich.	6, (4)	[2]	[2]
July-August		(5)		(6)		7
August-September	Springfield, Mass.	8	Bay City, Mich.	10	Newark, N.J.	(7)
September-October	New York, N.Y.	11	La Porte, Ind.	12	Angola, Ind.	13, (7)
October-November	Cabarrus, N.C.	14, (11)	Los Angeles, Calif.	15	Savannah, Ga.	16
November-December		(14)		(15)		(16)
1972:						
January-February	West Palm Beach, Fla.	17	Tucson, Ariz.	18	San Antonio, Tex.	19
February-March	Barbour, Ala.	20	Fresno, Calif.	21	Avoyelles, La.	22, (19)
March-April	Columbia, S.C.	23, (20)	San Francisco, Calif.	24		(22)
April-May	New York, N.Y.	26, (23)	Clallum, Wash.	27, (24)	Lamar, Miss.	25
May-June		(26)	Grant, Wash.	30, (27)	St. Joseph, Mo.	28, (25)
June-July	Hartford, Conn.	29, (26)	Boone, Iowa	33	Chicago, III,	31, (28)
July-August	Sussex, Del.	32, (29)	Washington, D.C.	34		(31)
August-September	Milwaukee, Wis.	35, (32)	Oak Hill, W. Va.	39, (34)	Cleveland, Ohio	9, (31)
September-October	Omaha, Nebr.	38, (35)		(41, (39)	Knoxville, Tenn.	42, (9)
October-November	Chillicothe, Ohio	37, (38)	Dallas, Tex.	(41)		40, (42)
November-December		(37)		(41)	Natchitoches, La.	(40)
December-January						(40)
1973:[3]						
January-February	Tampa, Fla.	45	Globe, Ariz.	44	New Orleans, La.	43
February-March	Morristown, Tenn.	46, (45)	San Diego, Calif.	47	Statesboro, Ga.	
March-April		(46)		(47)		
April-May	St. Louis, Mo.	49	Minneapolis, Minn.	62, (47)	Philadelphia II, Pa.	51
May-June	Fillmore, Minn., Howard, Iowa	52	Ottertail, Minn.	59	Chemung-Tioga, N.Y.	36
June-July	Chicago II, III.	55, (52)	Fargo, N. Dak.	56	Scranton, Pa.	57
July-August		(55)	St. Joseph, Mich.	65, (56)	Providence, R.I.	54
August-September	Columbus, Ohio	58		(65)	New York V, N.Y.	63, (54)
September-October	Bedford, Pa.	61	Monterey, Cal if.	53, (65)	New York IV, N.Y.	60, (63)
October-November	Roanoke, Va.	64, (61)	Los Angeles II, Calif.	50		(60)
November-December		(64)		(50)		

[1] Stand locations are counties, cities, or towns in which the examination center is located. Sample areas from which examinees are drawn for the stand consist of the PSU's, which may include several counties. Numbers in parentheses indicate a carryover for the stand number into the last month of the month group.

[2] Not in operation.

[3] Schedule for 1973 is tentative.

mined on the basis of approximately 19 sample persons per day. Schedules for two stands for each caravan are shown in table 4.

ADVANCE ARRANGEMENTS

Professional Relations

Before the interviewing or examination procedures can be started in a sample area, advance arrangements involving professional relations, public relations, and arrangements for the logistical requirements of the survey are necessary.

T-he conduct of the survey in any specific area is the responsibility of the Public Health Service (PHS), as distinct from the State or local health authorities or others in the area. In addition to notifying various directors within the regional offices of the Department of Health, Education, and Welfare, it is the policy of the. survey to fully acquaint the State and local health authorities and the medical, dental, and osteopathic professional organizations in the States and in the communities with the HANES objectives and method of operation. Since school children are involved in the survey, the State and local

Table 4. Excerpt from HANES schedule of stands

Operation	Caravan schedule		
	Caravan I	Caravan II	Caravan III
Stand number	20	21	22
Location	Barbour, Ala.	Fresno, Calif.	Avoyelles, La.
Sample size	600	350	590
Office setup	Feb. 4, Fri.	Jan. 28, Fri.	Feb. 25, Fri.
Census interviewing	Feb. 7, Mon.	Jan. 31, Mon.	Feb. 28, Mon.
HER followup	Feb. 15, Tues.	Feb. 8, Tues.	Mar. 7, Tues.
Examination center arrival	Feb. 29, Tues.	Feb. 15, Tues.	Mar. 14, Tues.
Examination center setup	Mar. 1, Wed.	Feb. 16, Wed.	Mar. 15, Wed.
Staff setup and training	Mar. 2, Thurs.	Feb. 17, Thurs.	Mar. 16, Thurs.
Dry runs	Mar. 3, Fri.	Feb. 18, Fri.	Mar. 17, Fri.
Examinations	Mar. 4, Sat.-Apr. 18, Tues.	Feb. 19, Sat.-Mar. 17, Fri.	Mar. 18, Sat.-Apr. 29, Sat.
Dismantle-transit	Apr. 19, Wed.	Mar. 20, Mon.	May 1, Mon.
Stand number	23	24	25
Location	Columbia, S.C.	San Francisco, Calif.	Lamar, Miss.
Sample size	300	570	440
Office setup	Mar. 31, Fri.	Feb. 25, Fri.	Apr. 7, Fri.
Census interviewing	Apr. 3, Mon.	Feb. 28, Mon.	Apr. 10, Mon.
HER followup	Apr. 11, Tues.	Mar. 7, Tues.	Apr. 25, Tues.
Examination center arrival	Apr. 20, Thurs.	Mar. 20, Mon.	May 2, Tues.
Examination center setup	Apr. 21, Fri.	Mar. 21, Tues.	May 3, Wed.
Staff setup and training	Apr. 22, Sat.	Mar. 22, Wed.	May 4, Thurs.
Dry runs	Apr. 24, Mon.	Mar. 23, Thurs.	May 5, Fri.
Examinations	Apr. 25, Tues.-May 16, Tues.	Mar. 24, Fri.-May 4, Thurs.	May 6, Sat.-June 8, Thurs.
Dismantle-transit	May 17, Wed.	May 5, Fri.	June 9, Fri.

officials concerned with public schools are also informed, as are the appropriate local and diocesan officials of the parochial' schools.

A letter announcing the survey, the local areas to be sampled, and the dates of survey operations and a brochure describing the survey are mailed 3 to 4 months before examinations are scheduled to begin, to the Health, Education, and Welfare regional offices, State medical and osteopathic societies, local medical societies, and State and local health departments. A request is made of the State and local medical and osteopathic societies that an enclosed professional release be printed in their respective professional journals. The letter to local health authorities includes a request to provide HANES with a listing of local and State health agencies, clinics, and medical services to whom HANES examinees without present medical resources and requiring medical care may be referred, or to whom a report of their examination findings may be sent.

About 2 months before examinations begin, the HANES Dental Advisor consults the PHS regional dental program director for the area. Following the regional director's recommendations, telephone calls are made and then letters are sent to the State dental director, who informs the State and local dental groups about the survey plans. Occasionally, letters are sent by the HANES Dental Advisor to State and local health dental groups on the advice of the regional director.

Three to 4 weeks after the mailing of the initial letters, the local health authorities are called by telephone, and any further questions about the survey are answered. Personal visits by HANES medical and dental advisory staff are made to any health agency or society making such a request.

Public Relations

A general news release explaining the program is prepared for each sample area and is distributed to local news media. The release is timed to coincide with the start of interviewing by the Bureau. of the Census. As a result, local news-

papers at most of the locations publish items concerning the program. No special effort is made to have radio and television stations publicize the survey, but at some locations members of the staff have been interviewed by these media and film has been taken to be televised. Under no circumstances, however, are pictures or films taken of any sample examinee since this would be a breach of the promise of confidentiality.

Sample households having a mailable address (house or post office box number) are sent an "advance" post card by the Bureau of the Census several days before their personnel begin interviewing. This card informs the household members that a Bureau of the Census interviewer will be calling at their home within the next few days in connection with a survey being conducted in the area for the Public Health Service.

Logistical Arrangements

Four to 6 weeks before the start of a stand, a member of the HANES field staff, the Field Operations Manager (FOM), visits the sample area to make physicial arrangements for the mobile examination center and the administrative office, to meet personally with local health and school officials, and to initiate the many logistical actions required for the survey. Selection of a site for the Health Examination Center is extremely important to the success of the survey. The following items are considered:

1. Location of sample households and transportation arteries
2. Community attitude toward the location
3. Proximity to power, water, and sewer connections
4. Reasonable freedom from noise and/or excessive vibration
5. Availability of living accommodations for the staff within a reasonable distance
6. Adequate space to accommodate trailers and cars of staff
7. Availability of office space near the examination site for the administrative office

During this visit to the sample area, the FOM also arranges for electricity, water, sewerage, telephone, and transportation services. Any other logistical arrangements required before the arrival of the mobile examination center and the staff are also taken care of at this time. Within the time allowed, the FOM makes a courtesy visit to the local health department and contacts the superintendents of the larger school districts to explain the program.

HOUSEHOLD INTERVIEWING PROCEDURES

Census Interviewing

Trained Bureau of the Census personnel call on all housing units contained in the segments of the sample area to determine their household composition and to obtain demographic and other data if the household contains any eligible persons aged l-74 years, inclusive. They pave the way for the HES interviewers who subsequently visit the household. Each of the households should have received the advance post card from the Bureau of the Census informing them of the visit. The front of the household questionnaire, shown as appendix IIA in part B of this report, contains standard Census identification entries related to the housing unit and space for recording information on calls. On the inside of the questionnaire, questions l-3 identify all persons living in the household, according to relationship to the head of the household, age, race, and sex. If the household does not contain any persons in the age range l-74, inclusive, the interview is concluded.

If the household does contain persons eligible for inclusion in the survey, the remaining questions may 'be asked of any responsible adult member of the household. A callback is made by the Census interviewer if a responsible adult is not present initially. At the end of the interview, the interviewer leaves a thank-you letter signed by the Surgeon General. The interviewer explains that if anyone in the household is selected, a representative of the Public Health Service will be calling again within a week or so to explain the survey. The interviewer also inquires as to the best time of the day for the representative to visit the household.

The role of the Census interviewers ends after all household questionnaires have been edited by

the Census supervisor for omissions or inconsistencies and turned over to the HANES field management office.

HANES Interviewing

The FOM and the Field Management Assistant (FMA) draw the nutrition sample daily as the household questionnaires are turned over to them. The sample for the detailed examination is drawn at the end of the week. A master list is prepared giving the name, age, race, sex, and household identification of each person selected. In the event that the number of persons on the master list significantly exceeds a predesignated expected number for a particular stand, a subsampling pattern is provided to reduce the sample size to the maximum number that can be handled according to the schedule. All persons remaining on the master list then receive a sample number. Those receiving only the nutrition examination are given numbers in the 001-599 series; the detailed examinees are given numbers in the 600-799 series.

After Census interviewing is completed and the master list prepared, HANES representatives (HER's) visit all households containing sample persons. The main purpose of this visit is to get the sample person(s) to make an appointment to come in for the examination. During the interview, the HER administers one of the medical history questionnaires (appendixes IIC-IIE, part B) as appropriate for the age of the sample person, a Food Programs Questionnaire (appendix IIB, part B), and the General Medical History Supplement, Ages 25-74 (appendix IIF, part B), if the sample person is to receive the detailed examination. The HER obtai.ns written consent for the examination of anv minors and gets a written authorization to obtain additional information from the records of physicians, dentists, hospitals, schools, and State registrars. The HER indicates to the sample person that the Public Health Service will be glad to send a report of significant findings to his physician (or clinic) and dentist if he so wishes.

In the course of the interview, the HER must be able to explain the program fully and to answer many questions, such as how the sample was selected, examination content, and value of the examination to the individual. They must also be alert to signs of noncooperation and try to overcome it.

APPOINTMENT AND TRANSPORTATION PROCEDURES

The HER carries a copy of the master appointment schedule, the original of which is kept in the field management office. This schedule calls for four morning sessions (including Saturday), four afternoon sessions (including Saturday), and two evening sessions. Ten persons (two detailed examinees and eight nutrition examinees) can be seen in any one session. The HER's schedule two detailed and five nutrition examinees for the beginning of the session and three additional nutrition examinees 1% hours later. Once the sample person has agreed to come in for the examination, a convenient time is worked out, and the information is telephoned to the office from the household. The sample number for that person is then entered on the master appointment schedule.

Finally, an appointment slip is left with the sample person indicating the day and date on which he is to be examined and the time that the taxi will call. The use of a taxi, for which arrangements have already been made, is encouraged because it reduces the chance that the sample person will not appear.

Some sample persons elect to drive themselves to the examination center and be reimbursed at the rate of 10 cents a mile. If the HER's think an appointment is "shaky," they may offer to pick up the sample person themselves. At least 3 days before the date of examination, a reminder notice (a duplicate of the one left in the home) is mailed to the person. On the day before the examination, a list of names and addresses of examinees is furnished the taxi company. For those sample persons of school age, a written excuse is obtained from the parent or guardian during the interview; this excuse is given to the taxi company, HER, or sample person, depending on where and when he is being picked up.

There are always a number of persons who, for one reason or another, cancel their appointments or are not available at the time they are to be brought to the center. Those who cancel are

fairly easily rescheduled for another time. Those who fail to appear without any notice of their intention to do so or who change their minds about participating are followed up as soon as possible, preferably the same day by the same HER. Immediate followup of these persons helps to reinforce in the sample person's mind the importance placed on his participation. In many cases, the person can thus be brought to the examination center only a little later than originally scheduled.

EXAMINATION CENTER AND FIELD STAFF

As in the preceding three cycles, examinations are carried out in a specially constructed mobile examination center (MEC). For the HANES program, nine new trailers, 45 feet long and 8 feet wide,, were constructed. The individual trailers are drawn by detachable truck tractors when making moves from one area to another. Three trailers are set up side by side and connected by enclosed passageways to make each examination center. Figure 3 shows the three trailers included in each MEC and the floor plan of each. A minimum space of 50 feet by 50 feet is required to accommodate the MEC. The site on which the MEC is located must be hard surfaced and as level as possible to avoid any effect on certain examination procedures and to be accessible to the truck tractors. Heating and air-conditioning units are installed to help provide a standardized environment for conducting the examinations.

The field staff necessary to carry out the three-team operation of the survev may be considered to consist of three elements. The first element is the team of Census interviewers (usually 8 to 16 persons) and a supervisor. The second element consists of the administrative staff and HES interviewers. The administrative staff (the field operations manager and one assistant) arrive at the location and set up their office on the Friday before Census interviewing, with from four to six HER's arriving 1 week later. The total administrative staff consists of five field operations managers, five field management assistants, and 12 HER's. The administrative staff includes extra positions because their operations at a new sample area begin before examinations at a preceding area are completed. With three teams performing examinations, four and sometimes five locations are operating simultaneously. The third element is the examining staff operating within the mobile examination center, which includes a physician, a nurse, a dermatologist, an ophthalmologist, a dentist, two dietary interviewers, two health technicians, one laboratory technician, and a coordinator.

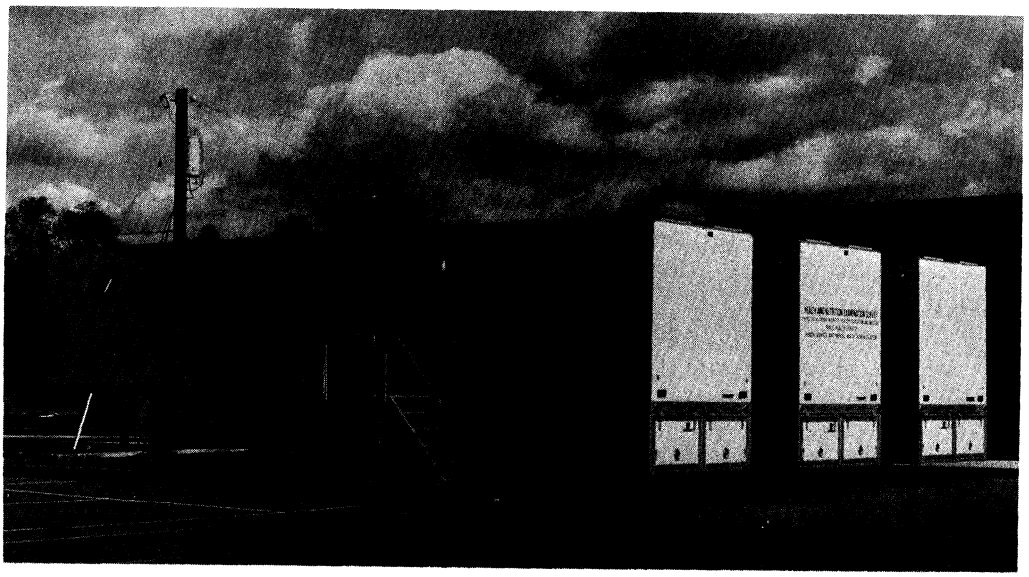
With the exception of the dermatologist and ophthalmologist, all other members of the field staff are civil service employees or commissioned officers of the Public Health Service. The dermatologist and ophthalmologist are usually senior residents who generally are employed only for a single sample area.

EXAMINATION CENTER PROCEDURES

General

As discussed earlier, the content of the examination was developed after extensive planning, consultation, and methodologic and pilot studies. Thus, it is a special examination tailored to meet the objectives and limitations of the survey and its two components and is not intended to be a complete medical examination. The fact that the examination is not a substitute for a visit to the examinee's own physician and dentist is explained to the sample person or to th.e parents or guardians of sample children. A report of medical findings for each examinee receiving the detailed examination is sent to the examinee's physician or clinic. This report includes any new significant medical, dermatological, and ophthalmological findings; data on height, weight, visual acuity, hearing levels; and the results of urinalysis, hematology, blood chemistries, and the tuberculin skin test. Enclosed with the report are a copy of the chest X-ray and a tracing and computer printout of the electrocardiogram.

Reports of medical findings of nutrition examinees are sent only if there are any new significant medical, dermatological, ophthalmological, urinalysis, hematological, or blood chemistry findings. A complete report is sent for all of these areas if the results in one or any part



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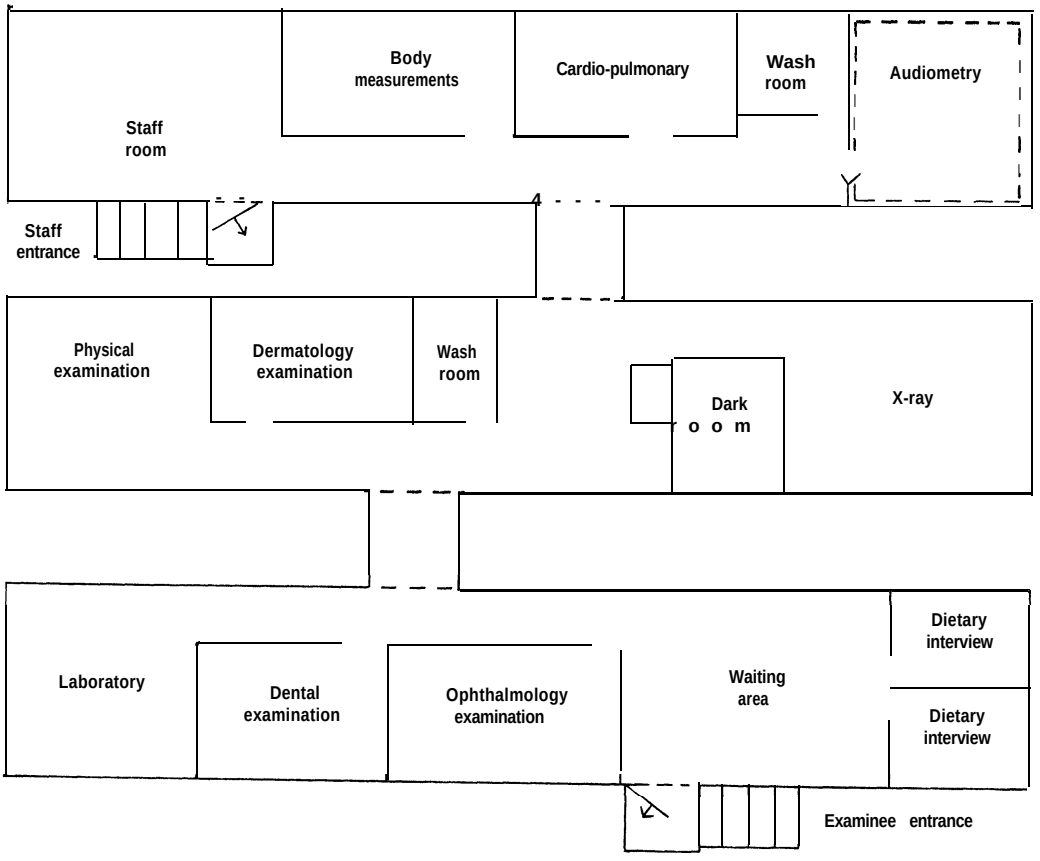

FLOOR PLAN

Figure 3. Mobile examination center.

of one, such as a biochemical test, are found to be abnormal.

Since the reports of detailed and nutrition examinees are necessarily delayed because of the processing of blood chemistries, any condition found that, in the opinion of the examining physician, requires early medical attention is reported immediately by phone to the personal physician or medical care facility identified earlier by the examinee.

A number of examinees are unable to provide the name of a regular physician or medical resource to whom they wish to have their findings reported. In such cases, the approval of the examinee is obtained during the household interview to have the findings referred to a source, such as a county health department, that had been obtained as a result of the advance professional relations described in an earlier section. 'These sources are aware of the HANES program and have been alerted to the possibility of receiving reports of findings.

Reports of dental. findings are mailed by the dentist in the field for all examinees requesting a report. Conditions that require immediate attention are handled individually, usually by phone. For an examinee who does not have a regular dentist and for whom immediate attention is required, after obtaining the patient's approval the referral service of the local dental society, the personal physician of the examinee, or other medical-dental source is informed.

All forms used in the conduct of the examination procedures as well as the questionnaires administered within the examination center are shown as appendixes IIG-IIQ in part B.

Flow of Examinees

In HANES, the wide age range of sample persons, the large number of examinees scheduled per day, and the fact that two different examinations are being carried out simultaneously, necessitate an examinee flow scheme different from those used in earlier surveys. In Cycle I, schedules were staggered, with two examinees scheduled to begin at each half-hour interval. All went through the same fixed sequence of examination elements. In Cycles II and III, six sample persons were scheduled for the beginning of each session and went through one of three fixed sequences of examination elements according to a flow chart.

The flow scheme used in HANES contains elements of both earlier systems. The usual workday consists of two sessions, with up to 10 examinations per session, eight nutrition examinees and two detailed examinees. The two detailed sample persons and five of the nutrition sample persons are scheduled for the beginning of a session. Three additional persons are scheduled 1½ hours later for the nutrition examination. Scheduling is somewhat flexible to accommodate situations when it is desirable that more than 10 persons be scheduled for a session and that persons be scheduled at times different from those normally used. This flexibility allows scheduling to be more responsive to the special problems of individual sample persons as well as to the conditions created by high or low response at a particular stand.

A primary objective of this flow system is to reduce the time examinees are in the examination center while using the examination staff in as efficient a manner as possible. The scheme gives a set of priorities by which examinees are assigned to the examination elements. However, these priorities do not require that an examinee receive one part of the examination before another if it means that he must wait for the first part because the examiner is busy. This basic scheme of assigning examinees was modified by restrictions designed to meet operational requirements such as getting blood samples to the examination center laboratory in time to complete the laboratory work before the end of a session and insuring that examinees are seen by the ophthalmologist during a certain interval of time after receiving drops to dilate the pupils of their eyes. This system also incorporates recommended and maximum times for elements of the examination. For some elements of the examination, two examiners are trained to routinely gather data. The assignment of examinees to these elements is controlled in such a way that the two examiners' data can be compared statistically.

When examinees arrive at the examination center, they are greeted by the nurse and the coordinator; the latter is a staff member with special responsibilities in the area of examinee flow and records preparation and review. As

indicated by the flow system, soon after their arrival, examinees change from their street clothes into disposable examination uniforms designed to facilitate and standardize various elements of the examination such as the physician's examinations, body measurements, and X-rays.

Physician and Nurse Examination

The general physician's examination is oriented toward gathering data on physical conditions pertinent to nutrition and certain chronic diseases, in contrast to the concept of a general clinical examination performed in the manner most familiar to the examining physician. Before beginning examinations, each new physician spends from 1 to 3 days being trained by the HANES Nutrition Medical Advisor to recognize symptoms or conditions associated with nutritional deficiencies. This training is usually performed with ongoing children and youth projects supported by the Office of Economic Opportunity and in a Maryland State hospital with patients suffering from nutritional deficiencies secondary to underlying chronic conditions such as alcoholism. Additional training is provided at the examination center with respect to the objectives of the detailed component of the physician's examination just before the start of the regular examination.

Each medical history questionnaire is reviewed by the examining physician on the day before the scheduled examination. Special attention is paid to any entries that suggest restrictions on the examinee's ability to participate in any tests or procedures, particularly the spirometry, single breath'diffusing capacity, or X-rays, and to items that may require further followup in the course of the examination.

All examinees receive a physical examination with emphasis on nutritional aspects. After monitoring the examinee's sitting blood pressure and pulse, the physician examines the ears for any abnormalities and then the head, eyes, mouth, and neck '(including the thyroid, figure 4), looking especially for lesions associated with nutritional deficiencies of vitamins A, B complex, and C, and minerals such as iodine and iron. While examining the chest (heart and lungs), an inspection is made of the chest and

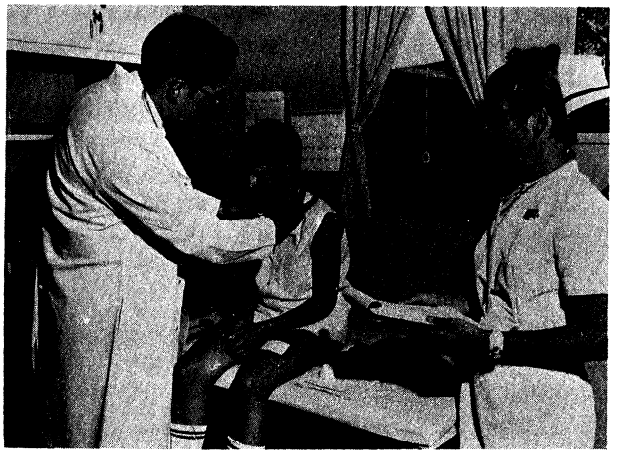

Figure 4. Physician's examination of the thyroid.

back for signs of possible deficiencies of vitamins A and D. The physician then palpates the abdomen, and in examinees over age 25, percusses the liver. The neurological and musculoskeletal systems are evaluated by testing the deep tendon reflexes and neuromuscular excitability for stigmata of thiamine or mineral deficiencies, and by palpating and inspecting the skeleton for lesions associated with vitamin D or C deficiencies. The skin of the extremities is then inspected and palpated, particularly that of the thighs and upper outer arms, for lesions that might be associated with deficiencies of vitamins A, C, B_6, or essential fatty acids. Findings are recorded in two categories, those related and those not related to nutrition. A subjective impression is recorded on the nutritional status of the examinee based on the examination and the medical history.

Venipuncture is done on all examinees by the nurse, either at the beginning of the dermatologist's examination or at some other convenient time during the course of the examination. It is performed in the dermatologist's examining area by the nurse with the assistance of the dermatologist or, in certain instances, with the assistance of the examining physician.

The examinees in the detailed component receive a more comprehensive cardiovascular evaluation and musculoskeletal examination. The cardiovascular evaluation includes a routine auscultation of the heart. If abnormal conditions are found, a tentative diagnosis is made along with an evaluation of the degree of severity and

the certainty of the diagnosis using a scale ranging from 0 to 9. In addition to the initial blood pressure reading taken at the beginning of the examination on all examinees, two more readings are taken by the nurse at the end of the physician's examination-one with the examinee supine, and the other immediately after with the examinee sitting on the edge of the examination table. The musculoskeletal examination involves the recording of findings of abnormalities and various manifestations of the knees, hips, shoulders, elbows, wrists, phalanges, ankles, feet, and back.

Detailed examinees also receive an examination of the ears, nares, reticuloendothelial system, an arterial evaluation, and a tuberculin skin test. The ear examination is of special interest because of its relevance to the audiometric data. It consists of a general inspection of the external ear, and a routine otoscopic examination of the external auditory canals and tympanic membranes. The tuberculin skin test, which is administered by the nurse, is read by her or another specially trained staff member between 48 and 72 hours later by having the examinee return to the examination center or by visiting his home. The test will be discontinued after the 35th HANES stand because of the burden imposed on the examinee and the field staff by the necessity of a second visit.

At the end of the detailed examination by the physician, he administers appropriate supplemental medical history questionnaires as required, based on positive responses to certain items on the medical history questionnaires administered earlier in the home. These supplements are identified as Supplement A, Arthritis; Supplement B, Respiratory; and Supplement C, Cardiovascular.

Ophthalmology Examination

The ophthalmologic examination, with a few exceptions, is essentially the same for all examinees. It includes an ocular history regarding previously known eye disease or previous surgery; for examinees age 4 years and over a determination of monocular distance visual acuity with usual correction, if any, and with a pinhole test to determine correctability for those with acuity less than 20/20, prescription of present glasses, slit lamp examination (figure 5), and retinoscopy for detailed examinees only with acuity less than 20/40; applanation tonometry on examinees age 20 years and over; maxillary sinus transillumination for detailed examinees only; and examination of the pupils as well as examination of the lids, globe, conjunctiva, sclera, cornea, anterior chamber, iris, and lens. The pupils are dilated in most instances for evaluation of the vitreous and retina. Diagnoses are recorded for the six most serious eye conditions found, with an indication for each of whether it affects vision and whether treatment is being given or needed. Ophthalmologists from the National Eye Institute are responsible for verifying the resultant diagnoses and for other aspects of quality control in this area.

The ophthalmology examination will be discontinued after the first 35 HANES stands have been completed. This decision was arrived at by the National Eye Institute as a result of the problems encountered in recruiting ophthalmologists to conduct the examinations and of the insufficient number of staff within the Institute to carry out the program adequately. It is felt, however, that the data collected from the first 35 stands will provide a basis for analysis of the data for the original purposes of the examination.

Dermatology Examination

The dermatological examination is a complete clinical examination of the skin and its appendages that considers normal variations in texture

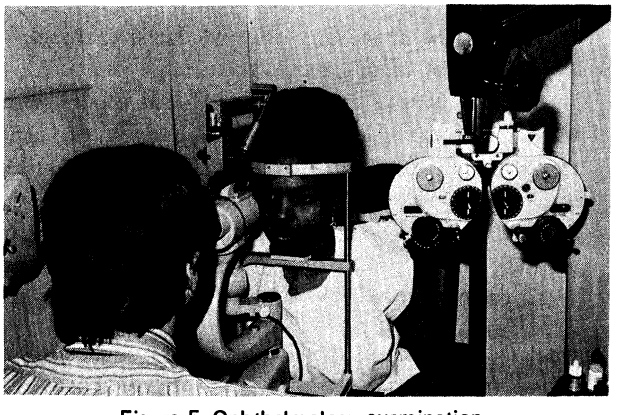

Figure 5. Ophthalmology examination.

and color, certain manifestations of aging, and all pathological changes, documenting significant diagnoses by biopsy or culture whenever possible. Estimates 'are made of actinic exposure experienced as well as actinic damage sustained, and of occupational risk from irritant and allergic contractants. For an examinee with a significant hand, foot, or generalized problem, a judgment is made about the burden to the examinee in terms of discomfort or disability, about the care sought, and about the effect expected from current best care. A lesion is photographed if there is some question about the diagnosis, if the lesion is in any way unique, or if it is to be biopsied.

Dental Examination

The dental examiners derive their findings uniformly by following a written set of objective standards in which they have been thoroughly trained. The standards are guidelines that, in effect, narrow the range of examiner variability by eliminating many of the borderline or questionable conditions that are frequently a source of disagreement. To avoid other sources that might result in systematic bias, the dentist does not dry or isolate teeth, remove oral debris and calculus, or probe any tooth surface that does not have an overt sign of decay.

The dentist dictates the condition of each tooth present to a trained recorder (health technician). The teeth are classified as sound, filled, decayed, filled-defective, and nonfunctional. Missing permanent teeth are classified under one of the following four categories: unerupted, carious extraction, accidental loss, and orthodontic extraction. When missing teeth are replaced on a fixed or partial denture, the tissue- under the replacement as well as the replacement itself, is rated. When no natural teeth remain in the jaw, the condition of the jaw and the status of the artificial replacement, when present, are recorded.

The next step of the examination is an assessment of the periodontal structures and the status of oral hygiene. The Periodontal Index is employed to assess the presence or absence of periodontal disease. By this system of classification, scores are assigned according to the extent of gingival inflammation, the presence or absence of periodontal pockets, and the firmness of a tooth in its socket. To assess oral hygiene, scores are recorded for all or any of six predesignated teeth that are present. The scores indicate the amount of debris-and the amount of calculus on selected surfaces. Fluoride and nonfluoride opacities and other conditions such as bleeding gums, diffuse marginal inflammation, swollen red papillae, and recession are also recorded.

The occlusion of all persons age 6-21 years is appraised by a series of counts and measurements. Anteroposterior position of the lower jaw in relation to the upper jaw is recorded. Counts are made of teeth in crossbite and teeth that are malaligned. Measurements are made in the anterior area of the jaws of overjet, mandibular protrusion, overbite, and openbite.

An enamel biopsy is taken on persons who have a natural upper incisor present with a front surface free of cavities and fillings. The enamel sample is "polished off" from an area about one-eighth of an inch in diameter and to a depth of approximately .0002 inch. This is about as much enamel as is removed during a routine prophylaxis by a dentist or dental hygienist. The sample is analyzed to determine the fluoride content of the tooth from which it was removed. The result, expressed in parts per million, will be compared with the number of cavities and fillings on selected tooth surfaces to assess the relationship between fluoride content and the occurrence of dental caries.

The dental 'examiner, using his best clinical judgment, estimates the dental treatment required for every sample person. In so doing, he takes into consideration the status of oral hygiene and periodontal disease, the quantity and quality of past dental care, the responses to questions asked at the beginning of the examination about chewing and eating difficulties, the age of the individual, and the probable benefit of each specific treatment plan to the individual's health and nutrition. The treatment recommendation may include any procedure ranging from a simple filling to extraction of all remaining teeth and denture construction.

At the close of the examination, the dental examiner makes a brief oral report to the examinee about the status of his oral health. It is always stressed that the survey examination

should not be considered as a substitute for a regular dental checkup. A report of findings is mailed, as described in a previous section.

Dietary Interview

The dietary interview is conducted by HANES personnel with minimum qualifications of a Bachelor's degree in food and nutrition. Most, however, are registered dietitians with experience in dietary interviewing. With some exceptions, interviews are conducted in small private rooms in the MEC. A small number of persons scheduled for the detailed examination may be visited in their homes. Home visits are sometimes required if the mother or other person responsible for a child's regular feeding does not accompany him to the examination center. The 24-hour Dietary Recall Questionnaire is administered for the total day before the day of examination (figure 6). Fifty-one three-dimensional food portion models are used as a guide in conducting the interview to help the sample person to estimate the amounts of various foods consumed. This questionnaire is followed by the Dietary Frequency Questionnaire that obtains information about how often certain foods have been eaten during the preceding 3 months. Foods reported in the 24-hour Dietary Recall Questionnaires are later coded by the interviewers using nutrient information from the U.S. Department of Agriculture Handbook No. 8. Other food codes used are from the Tulane University's master dietant list, from ***Bowes and Church's Food Values of Portions Commonly Used,***[86] or from USDA House and Garden Bulletin No. 72, and commercial sources. All dietary data will be analyzed by a computer program based on nutrient data for 100-gram portions of foods.

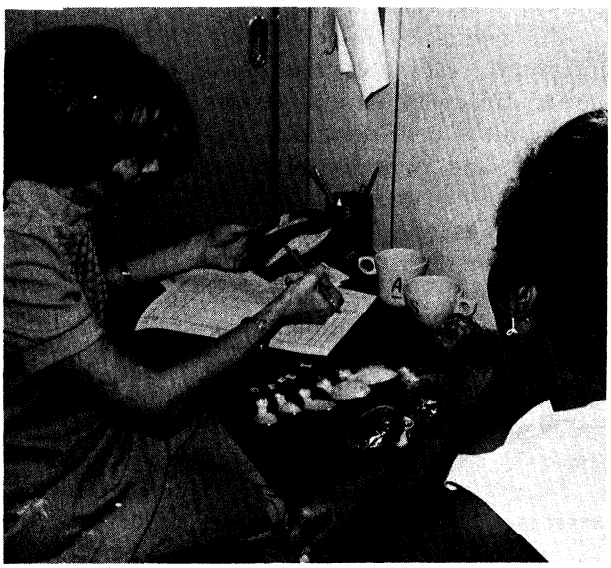

Figure 6. Dietary interview.

Following administration of the dietary questionnaires, the interviewers are also responsible for the completion of the Health Care Needs Questionnaire and the General Well Being Questionnaire for all examinees in the detailed component. While the first of these is interviewer administered, the second is intended to be essentially self-administered.

Laboratory Procedures

The laboratory technician is responsible for screening a urine specimen from each examinee for sugar, albumin, and blood; for performing the basic hematology tests; and for preparing and packaging all blood and urine samples to be sent to the CDC for analysis (figure 7). The basic hematology performed in the MEC for each examinee, if sufficient specimen is available, is hemoglobin, hematocrit, and red and white cell counts. Sedimentation rates are determined and a smear for differential W.B.C. count is also prepared. All hematology tests are performed in duplicate, and all results are recorded on a daily worksheet. All clinically borderline results are repeated immediately. Once it is ascertained that a particular result is abnormal according to CDC guidelines, it is reported directly to the HANES examining physician for any necessary followup. With the exception of the T-3 and T-4 determinations, which are performed by a private contractor, the remaining laboratory determinations, listed in an earlier section, are performed by CDC (figure 8).

Health Technician Procedures

Two technicians conduct the following parts of the examination on all examinees: measurement of height and weight, a series of body and

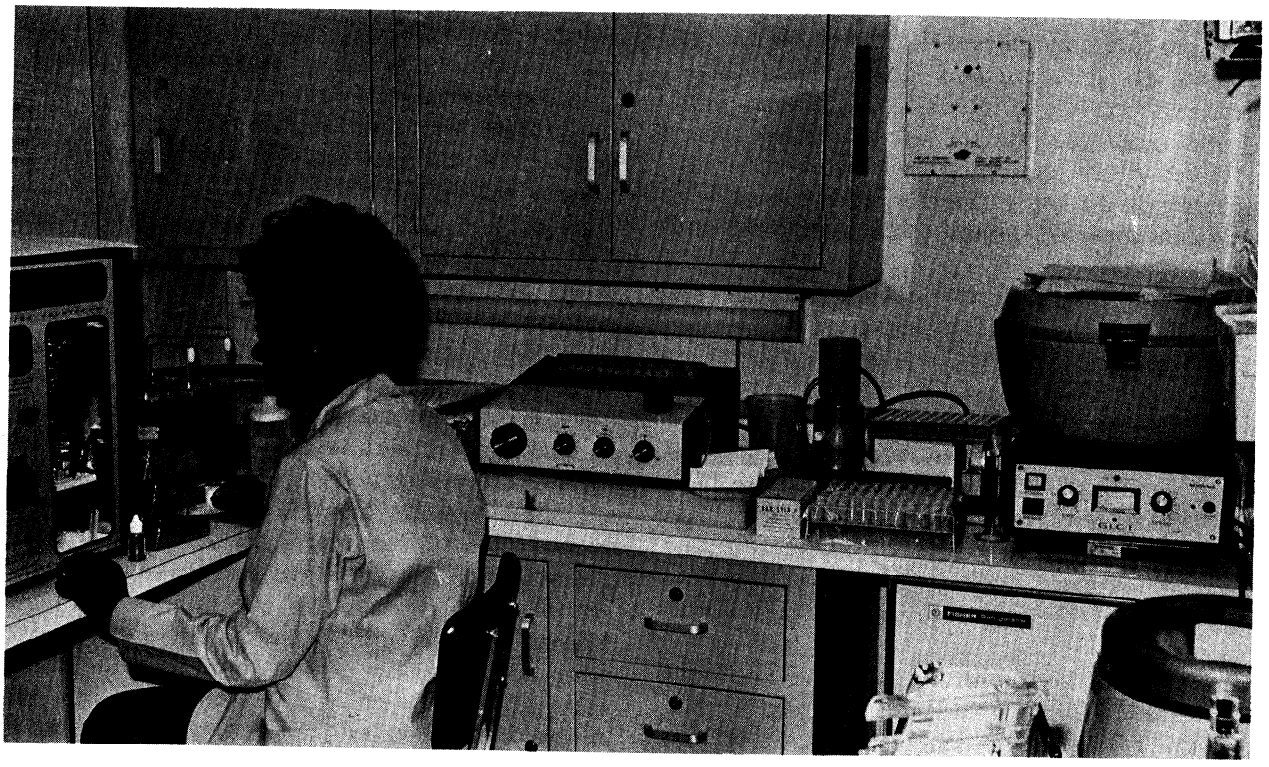

Figure 7. Examination center laboratory.

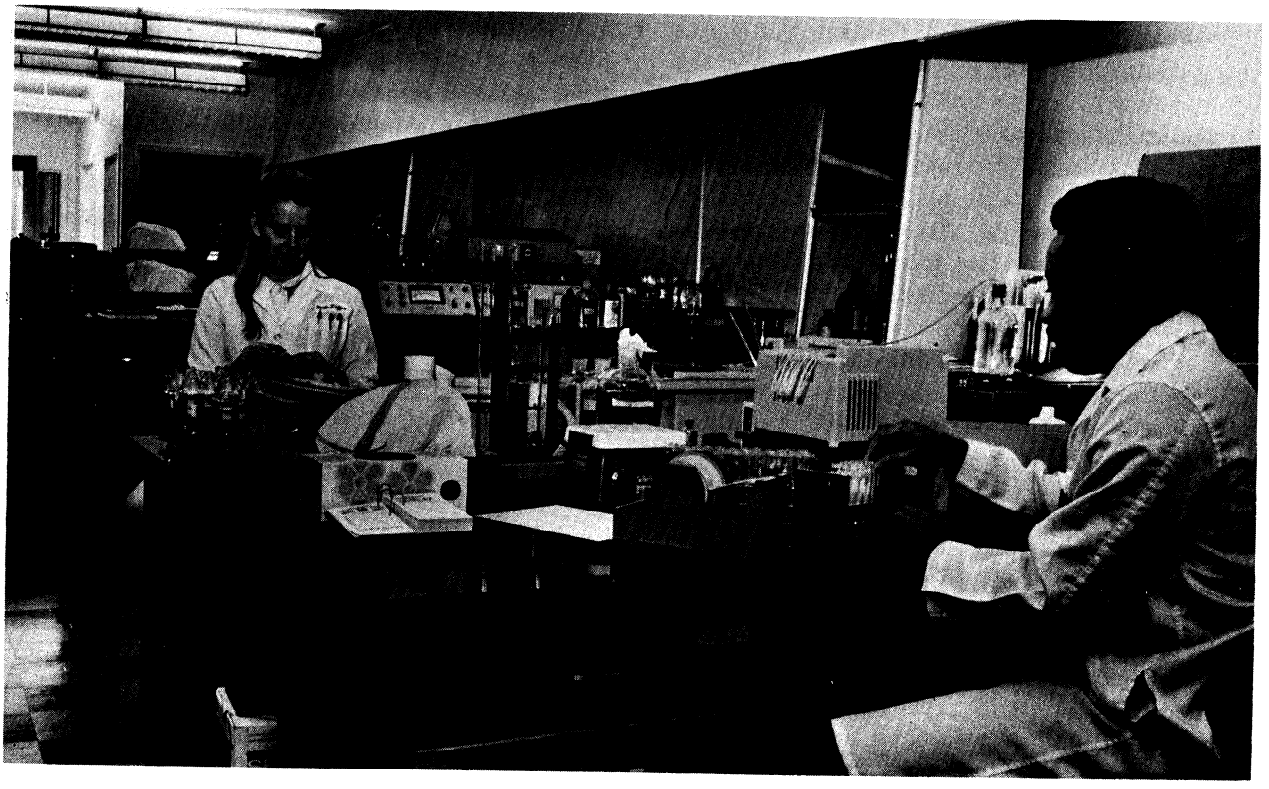

Figure 8. CDC Nutrition Laboratory.

skinfold measurements, and X-rays of the hand and wrist of examinees 1-17 years of age. In addition, these technicians are also responsible for conducting the following on all examinees in the detailed component of the survey: an audiometric test, spirometry, electrocardiogram, single breath diffusing capacity, goniometry, and X-rays of the chest, hand and wrist, hips, and knees.

Audiometric testing of detailed examinees is done in a specially constructed, acoustically treated room built into one of the trailers in each of the mobile examining units. The room is designed to provide sufficient 'sound attenuation for pure tone testing at frequencies of 250-6,000 Hz to at least as low as -20-dB relative to audiometric zero (International Standardization Organization, 1964) in the presence of the degree of external noise usually present during the course of the examinations at the various locations.

Each adult is tested at the following four frequencies: 500, 1,000, 2,000, and 4,000 Hz, with the l,OOO-Hz frequency repeated a second time. Air-conduction tests for both ears are completed first, then the bone-conduction tests in the order indicated on the recording form. Alternation of presentation to each ear varies among examinees with the testing started in the right ear when the examinee's sample number is odd and in the left ear when even. The threshold recorded for each frequency is the lowest decibel level at which 50 percent or more of the responses are obtained, that is, in two out of three or three out of five trials. Masking for the nontest ear is done in air-conduction testing only on retest when there is a 40-dB difference or more in the thresholds for the two ears. In bone-conduction testing, masking is done routinely in the nontest ear at 30, 40, and 50 dB above threshold for that ear. Standardized testing procedures are used to insure as consistent test results as possible throughout the survey. Any condition such as earache, cold, or other problem that might affect the test results is also recorded.

All detailed examinees are given a 12-lead electrocardiogram and spirogram with results recorded on magnetic tape using a Beckman Digicorder. Under terms of an agreement with the George Washington University School of Medicine, Washington, D.C., the tapes are forwarded to their facilities for processing. For each examinee, HANES is provided with tabular printouts and digital computer tapes of all basic data. For the electrocardiogram, these data consist of the amplitudes and durations of various waves in each of the 12 leads, as well as such data as QRS and T axes, and rates. Basic data for the spirogram consist of measurements from five trials of maximal forced expiratory volume, the forced expiratory volumes at ½, ¾, 1, 2, and 3 seconds, and flow rates including the maximum expiratory, the maximum midexpiratory, and the maximum terminal (figure 9).

The single breath carbon monoxide diffusion studies are performed on detailed examinees on a Collins modular lung analyzer machine with a digital readout module. Basic data are provided from which computations can be made of the diffusion of gases across the pulmonary membranes. In addition to compiling much-needed normative data on carbon monoxide diffusion, the test also identifies individuals with pulmonary deficiencies. These data will complement other HANES pulmonary data such as chest X-rays, spirometry, and respiratory history.

Examinees in the age range of l-l 7 years are given routinely an X-ray of the hand-wrist for bone age and density (figure 10). This X-ray is an 8 X 10 film taken at a distance of 36 inches. No other X-rays are made of nutrition examinees except in those few instances where an X-ray of the chest is indicated as an aid to a diagnosis by the physician. Detailed examinees,

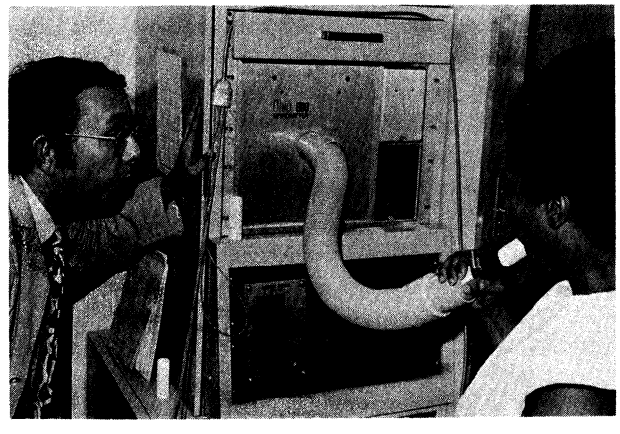

Figure 9. Spirometry.

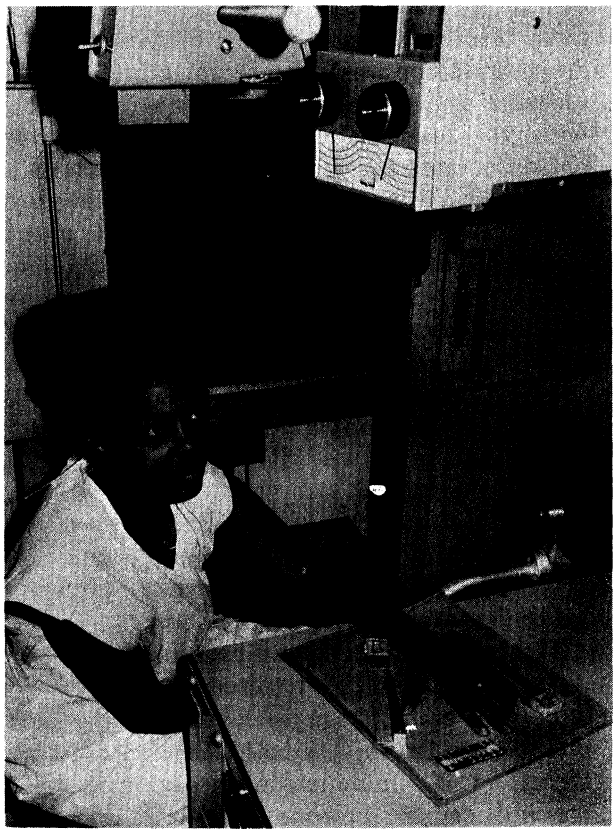

Figure 10. Hand and wrist X-rays.

however, do receive the chest X-ray routinely. Two 14 X 17 films are taken at a distance of 72 inches-one a PA film and the other a lateral film. In addition, detailed examinees also receive X-rays of the hips, knees, and hand-wrist. The hip and the knee X-rays are both 14 X 17 films; the former is taken at a distance of 72 inches and the latter is an anteroposterior film of both knees at 40 inches. The hand-wrist is an 8 X 10 film taken at a distance of 36 inches. Certain precautions are taken to protect examinees as well as technicians. Females between the ages of 12 and 45 are carefully screened so that those pregnant will not be X-rayed, and no female under the age of 50 is given an X-ray of the hip. To minimize radiation hazard, use is made of a special "no scatter" cone, of lead-rubber apron shields, and of radiation badges that are provided- at the beginning of testing in each location for each technician to wear. Periodic dosimetry field surveys are conducted by the Radiological Health Division of the PHS. All films, except the hand-wrist X-ray of the detailed examinees, are developed and reviewed so that unsatisfactory films can be repeated before the examinees leave the examination center.

Goniometry measurements are taken on all detailed examinees to determine the range of motion of certain joints, the hip, and the knee. Specifically, 16 measurements are taken involving the extension, flexion, abduction, adduction, both internal and external rotation of both hips, and the extension and flexion of the knees. This procedure will be discontinued after the 35th HANES stand to shorten the length of the examination time and because of problems encountered in the reproducibility of the data.

In addition to height and weight measurements and a determination of handedness, six other body measurements are made of all examinees. These include elbow breadth, upper arm girth, triceps and subscapular skinfolds (figure 11); bitrochanteric breadth, and sitting

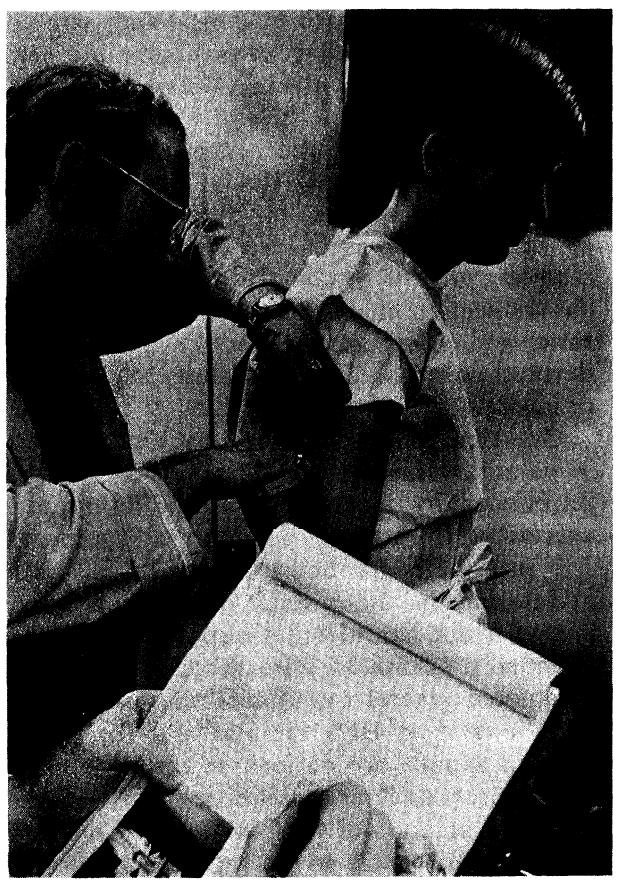

Figure 11. Taking skinfold measurements.

height. Children 1-7 years of age are also measured for head and chest circumferences. Chest circumference measurements of full inspiration and expiration are also made on all examinees in the detailed part of the examination.

QUALITY CONTROL

The efforts of the quality control program extend to all phases of the operation-from the beginning of the Census interview until all collected data have been coded, edited, and placed on magnetic tape for computer use. The goal of the program is to assure that the national estimates of the various characteristics collected by the survey represent data of the highest attainable accuracy and precision within the limitation imposed by reasonable procedures and costs. A report concerning quality control activities in previous HES cycles has been published!'

In HANES, as in all sample surveys, there are two sources of error to be considered-sampling error and nonsampling error. Sampling error, that is, error due to making measurements on a sample rather than on the entire population, can be quantified and is the concern of all statisticians in sample survey design and in analysis. During the data-collection phase, problems due to this type of error are minimal. The nonsampling error is of constant concern during the data-collection phase and considerable attention, time, and effort of the HANES personnel are devoted to minimizing and measuring this type of error.

One type of nonsampling error that can occur in voluntary surveys such as HANES is the bias introduced by nonresponse if the nonrespondents differ from the respondents with respect to the measurements being made. In past HES cycles and in the present HANES, a sample person is not considered a respondent unless he is actually examined, even though he may have completed several questionnaires during initial interviews. Past HES samples and the present HANES sample are defined at the time of the first household interview. Consequently, there is a certain amount of built-in nonresponse since persons who move, go on vacation, become ill, or for other reasons are not physically available cannot be examined. If nonrespondents differ from respondents for a given measurement, the amount of nonresponse bias introduced into an estimate generally would be expected to vary with the amount of nonresponse. Therefore, response rates for a survey such as HANES are important as indicators of possible nonresponse biases. Response rates for Cycles I, II, and III were 87, 96, and 90 percent, respectively. These high response rates may be attributed to various methodological studies, to advance planning and publicity, to much diligent work by the health examination representatives, and to proper handling of examinees by the entire staff as well as, in Cycles II and III, to the age of the population segment sampled.

The response rate in HANES at the time of preparation of this report had not been as high as in the earlier cycles, and the final rate will be lower than those obtained previously.

Concern over the lower response rate and its possible implications resulted in a study conducted in conjunction with the ongoing survey in the San Antonio, Texas, stand to determine the effect, of remuneration on response. Half of the 600 sample persons were told during the HER interview that they would receive $10 after the examination, while no mention of remuneration was made to the other half. All who were examined, however, received payment after the examination. The study design also controlled on family income, number of housing units per segment, and the HER assignments. The findings of the study showed- a response rate 12 percent higher in the group of sample persons offered the remuneration. As a result, payment of $10 is now being offered routinely to all sample persons if they participate in the examination. A report describing the methodology and findings of the study is currently being prepared for publication.

Another type of nonsampling error that is of great concern in the quality control program is the measurement error that inevitably occurs during the examination procedure. Its importance is easily recognized when it is considered that, in the present survey, each sample person represents approximately 7,500 persons; therefore, any blemish on the survey findings for a particular person is greatly enlarged in the final analysis of the larger universe. Not only is it

important to control and minimize this error, but it is equally important to measure, wherever possible, the amount of error.

In HANES, several procedures are relied upon to accomplish these objectives. Before the collection of data, it was necessary to define precisely what is to be measured and to obtain instruction as to how the measurement should be performed. Advisors, both from within the staff of HANES and from outside sources, were instrumental in constructing the necessary definitions and instructions, which were later incorporated into a staff instruction manual covering all procedures. Intensive specialized training is given to each examination staff member in the specific procedures performed by them in the survey. The special advisors within HANES provide training in their respective areas while additional training in other areas is obtained from various outside sources.

Although precise definitions and good initial training are necessary, they are generally not sufficient in a lengthy survey as HANES. The time factor creates a problem that does not occur when data are gathered in a short period of time. It is important to be consistent throughout the entire survey. In order to achieve consistency, in addition to providing the detailed written instructions on all aspects of the examination, the forms are structured, and periodic retraining is provided. Retraining time may range from a few minutes for a single item up to several days for an entire area, such as bodv measurements.

In further efforts to attack measurement error, mechanical equipment is used wherever feasible to obtain a "hard document." Employed for this purpose are such devices as tape recorders, automatic recording of weight, photographs of height, X-rays, and the recording of spirometry and electrocardiograms on magnetic tape. The reading and interpretation of the records so obtained can be done independently more than once. The use of instruments for measuring as well as for recording introduces another source of possible variation; thus, systematic calibration is necessary. All instruments are calibrated at the beginning of each stand and also periodically throughout the stand, some before each examination. In some instances-for example, audiometers-resources are not available in the examining center and machines must be sent away for calibration. Other instruments also receive periodic maintenance and service through special contract arrangements with the manufacturers.

Environment is another important factor in achieving valid and standardized data. Good lighting, heating, and air conditioning are essential. For example, it is very important to be able to standardize the light conditions under which the ophthalmology examination is given. Similarly, it is essential that the room in which the hearing test is given be soundproof.

The subject being examined can also introduce error into the measurement. If the examinee fails to stand up straight for a height measurement, is uncooperative during the spirometry examination, or does not understand the directions given for the audiometry test-to give only a few examples-error will occur. It is, therefore, very important that staff members be aware of such possibilities and see that the examinee fully understands what he is to do and that his fullest cooperation is obtained.

Despite precautions, there are biases and variable measurement errors that cannot be or are not judged important enough to be eliminated. Another objective of the quality control program, therefore, is the determination of the total effect of these errors. For certain parts of the examination performed by the health technician, the assignment of examinees is controlled so that the relative bias of individual technicians can be monitored. The collection of replicate data provides another means for evaluating measurement errors. Replicate data are obtained basically in two ways: by reevaluating or rereading a hard document or by reproducing an actual measurement, either by the usual procedure or bv another standard procedure. Although hard documents such as the weight and height measurements are reevaluated, the replicate program is primarily concerned with reproducing actual measurements.

During the actual operation of the survey , the primary use of replicate data is in indicating areas where retraining or reevaluation of procedures is needed. When the reports of findings of the survey are published, data from the replicates will be used to apprise the reader of the extent to which the data may be affected by

measurement error and to call his attention to this problem.

Replicate data are gathered in many specific areas of the examination with varying degrees of frequency. For example, replicate measurements are made on every examinee for measurements such as spirometry and hematocrit. Ophthalmologists from the NEI independently replicate the complete ophthalmic examination on all the first day's examinees for each test stand after the examiner is trained in the survey technique. The dental advisors systematically replicate the field examiners on a subsample of examinees for the purpose 'of surveillance and on-the-spot retraining. They also periodically replicate one another. Although replicates are performed for a different purpose, the data are preserved and in previous HES surveys have proved useful for indicating the extent of error in final evaluations. Additional blood is drawn from a systematic subsample of detailed examinees for the purpose of replicating thyroid hormone determinations. Comparisons are made upon receipt of results and have been valuable as the basis for corrective action. This type of replicate will also be used in the final evaluation of measurement process error.

Several measures are taken to assure completeness and consistency in the recording process. All questionnaires are reviewed for omissions and inconsistencies. With the exception of the questionnaires completed in the examining center, all are reviewed by personnel in the field management office. If errors are noted, correct information is obtained by phone or from the examinee when he comes in for the examination. Errors in recording body measurements, goniometry, and results of the dental examination are reduced by having a second person act as a recorder. In addition, all data gathered in the examining center are reviewed by the examination staff before the examinees leave. All Dietary, 24-Hour Recall and Food Frequency Questionnaires are coded by the interviewer in the field and are checked by another interviewer before being forwarded to headquarters. At each location, each dietary interviewer records two complete interviews on randomly selected sample persons. The resulting taped interviews are critiqued for adherence to established guidelines, procedures, and policies by an independent contractor experienced in the art of dietary interviewing.

PLANS FOR ANALYSIS AND PUBLICATION OF DATA

Because the data collection operation of the nutrition component in the HANES program will take about 2% years to complete, the sample and schedule designs have been arranged so that it will be possible to do some preliminary 'analysis of certain portions of the nutrition component before that time. Of the total 65 PSU's in the survey, a subset of 35 was selected carefully so as to be representative of the whole. These are scheduled for completion in October 1972, and the first preliminary analyses will be available in early calendar year 19 73.

All data from the subset will be statistically weighted and nonresponse adjusted so as to represent closely the total U.S. population with respect to age, race, sex, and several 0ther variables. Because of the small sample size, the preliminary reports will be unable- to provide some of the detailed subclassifications of the data, such as region or urbanization. More detailed breakdowns of the data will be available in the analysis of the 65 PSU's. The first of these reports as related to nutrition is scheduled for mid-1974.

The data for the first 35 sampling units will be reported in four primary categories with a necessarily limited content as follows:

Report Category	*Contents*
Dietary intake data	**Distribution of selected nutrients reported on the Dietary 24-hour Recall Questionnaire and percent of individuals not meeting recommended nutrient allowances.**
Hematological and biochemical test results	**Distributions of selected nutritionally related test results and percent of individuals below specified levels.**
Anthropometric data	**Distributions of selected nutritionally related measurement data by population groups with some comparative normative data from earlier DHES programs.**

Report Category	*Contents*
Nutritional findings from the physician's examination . .	**Prevalence of selected conditions as stigmata of nutritional deficiency by population groups.**

A final completion date for the collection of data of the detailed component has not been firmly established at the time of this writing, primarily because the unknown sample sizes of future PSU's affect scheduling. Based on the design of the survey, a complete cycle (for at least many parts .of the detailed component) encompasses two of the nutrition cycles, or about 130 PSU's.

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APPENDIX I

TECHNICAL NOTES ON THE SAMPLE DESIGN

Definition of Terms

Standard metropolitan statistical area (SMSA).—SMSA consists of a county or group of contiguous counties (except in New England) that contains at least one central city of 50,000 people or more, or "twin cities" with a combined population of at least 50,000 population. In addition, other contiguous counties are included in SMSA if, according to certain criteria, they are socially and economically integrated with the central city. Definitions of SMSA's that identify the composition and structure of each are given in an Office of Management and Budget publication, ***Standard Metropolitan Statistical Areas,*** 1967 edition.

Geographic regions. -For purposes of the Health Examination Survey, the 48 contiguous States and the District of Columbia are divided into four regions of about the same population size. The regions and their composition are as follows:

Region	*States Included*
Northeast . .	Pennsylvania, New Jersey, Connecticut, Rhode Island, Massachusetts, New York, Vermont, New Hampshire, Maine
Midwest . .	Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri
South	Delaware, Maryland,, Virginia, West Virginia, Kentucky, Arkansas, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, District of Columbia
West	Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Utah, Nevada, California, Arizona, New Mexico, Texas, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota

Con trolled selection. -This term refers to a scheme that permits some element of subjective determination in obtaining a "better balanced" or "more representative" sample, while retaining all the elements of true probability sampling. The procedure is described in a number of publications.[55,88] The control variables used for this sample design are "State groups" and "rate of population change," that are defined as follows:

State groups.

Separate groups were formed within geographic regions, as shown in table I. To form the State groups, the Health Interview Survey (HIS) design strata were classified as belonging to the State in which the HIS sample PSU was located. If a sample PSU was within two States, it was put in the State with the greater proportion of the population.

Rate of population change.

Groups were defined differently for each region as indicated in table II. In the Northeast Region, for example, PSU's with less than a 3-percent increase in population between 1950 and 1960 were classified in group 1, while this class in the Midwest Region included only those PSU's with a loss or with no gain in population.

Table I. State groups by geographic region

Region	State group number	States in group
Northeast	1	New York.
	2	Pennsylvania and New Jersey.
	3	Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island.
Midwest	1	Ohio.
	2	Michigan.
	3	Indiana and Illinois.
	4	Missouri.
	5	Kansas, Nebraska, Iowa, and North Dakota.
	6	Wisconsin and Minnesota.
South	1	Maryland, Delaware, and District of Columbia.
	2	Virginia and West Virginia.
	3	Kentucky and Tennessee.
	4	North Carolina and South Carolina.
	5	Georgia.
	6	Alabama and Mississippi.
	7	Florida.
	8	Arkansas, Louisiana, and Texas.
West	1	California and Nevada.
	2	Texas.
	3	Washington, Oregon, Idaho, and Montana.
	4	Oklahoma, Arkansas, and Louisiana.
	5	Wyoming, Utah, Colorado, New Mexico, and Arizona.
	6	North Dakota, South Dakota, Nebraska, Kansas, Minnesota, and Missouri.

Table II. Ranges for rate-of-population-change control groups by geographic region

Rate-of-population-change group number	Region			
	Northeast	Midwest	South	West
	Percent population change, 1950-60			
1	3 and under	0 and under	–10 and under	–5 and under
2	5-11	1-15	–9-0	–2-0
3	12-23	16-23	1-8	4-21
4	25-58	24-30	9-16	24-39
5	-	34-81	19-26	40-59
6	-		27-36	73-167
7	-	-	37-47	-
8		-	50-301	-

Population density groups. -In general, this term refers to the proportion of the population that lives in urban areas. The density groups are defined somewhat differently for each geographic region as shown in table 1 in the text of this report. For the very large SMSA's, except those in the South Region, the criterion for inclusion was population size; these SMSA's were chosen for the sample with certainty. In the South Region, the largest SMSA's were defined in the same way as "other large SMSA's," but were put in a different stratum for sampling purposes.

Current poverty areas.[a]—Poverty areas were originally defined on the basis of 1960 census data in the 100 largest metropolitan areas. They were determined by ranking census tracts in places with a 1960 population of 250,000 or more, according to the, relative presence of each of the following equally weighted poverty-linked characteristics: (1) family income below $3,000, (2) children in broken homes, (3) persons with low educational attainment, (4) males in unskilled jobs, and (5) substandard housing. Those tracts falling in the lowest quartile of the ranking were defined as poor tracts and further adjusted for contiguity and minimum size in order to approximate area1 concentrations of poverty. The "current poverty areas" are defined similarly, based on a detailed investigation made by local metropolitan officials and the Census Bureau in 1970 in these places with population of 250,000 people or more.

In general, census tracts were deleted from the list of poverty areas if local officials suggested deletion and if (1) the combined (five-factor) ranking of the tract fell in the highest quartile of "poor" tracts in 1960, (2) the combined ranking of the tract fell in the other three quartiles of poor tracts in 1960 but the income rank fell in the highest quartile, or (3) the 1960 population of the tract was less than 1,000 regardless of its rank, on the assumption that major changes could have taken place within it since 1960. Tracts originally classified as poverty areas were not included as current poverty areas when substantial urban renewal or other major improvements in housing conditions had taken place within them. Also, any "nonpoor" tract that was originally included in the 1960 poverty area because it was completely surrounded by poor tracts was deleted.

Census tracts were added as poverty areas as suggested by local officials and if (1) 1959 median family income of the tract was below $6,000, (2) the 1959 median family income of the tract was between $6,000 and $7,000 and its most recent welfare recipient or illegitimacy rates ranked in the lowest two quintiles within the city, or (3) when the 1959 median family income of the tract was $7,000 or more and it ranked in the lowest quintile of the characteristics cited above or if a specific written explanation was provided stating the reasons why the tract should be added in terms of changes that had taken place since 1960. No tract was added unless it was contiguous to a group of poor tracts and the resulting area had a combined population of 16,000 or more.

[a]Arno I. Winard, unpublished paper, U.S. Bureau of the Census.

Location of the 65 Health and Nutrition Examination Survey Stands by Region

Region	*Stand*
Northeast . .	New York Standard Consolidated Area (five stands)
	Philadelphia, Pa. (two stands)
	Boston, Mass.
	Pittsburgh, Pa.
	Albany-Schenectady-Troy, N.Y.
	Scranton, Pa.
	Springfield-Chicopee-Holyoke, Mass.
	Providence-Pawtucket, R.I.-Mass.
	Hartford-Tolland, Conn.
	Chemung-Tioga-Tompkins, N.Y.
	Mercer, Pa.
	Bedford-Fulton, Pa.
Midwest . .	Chicago Standard Consolidated Area (two stands)
	Detroit, Mich.
	Milwaukee, Wis.
	Minneapolis-St. Paul, Minn.
	Cleveland, Ohio
	Columbus, Ohio
	St. Joseph, MO.
	Fargo-Moorhead, N.Dak.-Minn.

Region	*Stand*
	St. Louis, MO .-Ill.
	Bay City, Mich.
	DeKalb-Steuben, Ind.; Branch, Mich.
	Cass-St. Joseph, Mich.
	Fayette-Ross, Ohio
	La Porte-Marshall-Starke, Ind.
	Boone-Greene, Iowa
	Fillmore, Minn.; Howard, Iowa
South	New Orleans, La.
	Washington, D.C., Md., Va.
	Columbia, S.C.
	Knoxville, Tenn.
	Roanoke, Va.
	Savannah, Ga.
	Tampa-St. Petersburg, Fla.
	West Palm Beach, Fla.
	Natchitoches, La.
	Lamar-Marion, Miss.
	Cabarrus-Stanley-Union, N.C.
	Clarborne-Hamblen-Hancock-Hawkins, Tenn.
	Barbour, Ala.
	Bullock-Jenkins, Ga.
	Sessex, Del.-Worcester, Md.
	Fayette, W. Va.
West	Los Angeles, Calif. (two stands)
	San Francisco, Calif.
	Dallas, Tex.
	San Antonio, Tex.
	Tucson, Ariz.
	Omaha, Nebr.-Iowa
	San Diego, Calif.
	Fresno, Calif.
	Monterey, Calif.
	Clallam-San Juan, Wash.
	Grant, Wash.
	Gila, Ariz.
	Avoyelles, La.
	Ottertail, Minn.

*U.S. GOVERNMENT PRINTING OFFICE : 1979 0-281-259/19

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