

VITAL & HEALTH STATISTICS

Prevalence of Diagnosed Diabetes, Undiagnosed Diabetes, and Impaired Glucose Tolerance in Adults 20–74 Years of Age United States, 1976–80

The total prevalence of diabetes and impaired glucose tolerance in U.S. adults aged 20–74 years was obtained from medical history and oral glucose tolerance tests. Plasma glucose distributions, associations with selected medical, genetic, and clinical characteristics, and comparisons with prevalence in the 1976 National Health Interview Survey are also presented.

**Data From the National Health Survey
Series 11, No. 237**

DHHS Publication No. (PHS) 87–1687

U.S. Department of Health and Human
Services

Public Health Service

National Center for Health Statistics

Hyattsville, Md.

February 1987

Copyright information

All material appearing in this report is in the public domain and may be reproduced or copied without permission; citation as to source, however, is appreciated.

Suggested citation

National Center for Health Statistics, W. C. Hadden and M. I. Harris: Prevalence of diagnosed diabetes, undiagnosed diabetes, and impaired glucose tolerance in adults 20-74 years of age, United States, 1976-80. *Vital and Health Statistics. Series 11, No. 237.* DHHS Pub. No. (PHS) 87-1687. Public Health Service. Washington. U.S. Government Printing Office, Feb. 1987.

Library of Congress Cataloging-in-Publication Data

Hadden, Wilbur Crane,

The prevalence of diagnosed diabetes, undiagnosed diabetes, and impaired glucose tolerance in adults 20-74 years of age, United States, 1976-80.

(Series 11, Data from the National Health Survey ; no. 237) (DHHS publication ; no. (PHS) 87-1687)

Bibliography:

Supt. of Docs. no.: HE20.6209:11/237

1. Diabetes—United States—Statistics. I. Harris, Maureen I. II. National Center for Health Statistics (U.S.) II. Title. IV. Series: Vital and health statistics. Series 11, Data from the national health survey ; no. 237. V. Series: DHHS publication ; no. (PHS) 87-1687. [DNLM: 1. Diabetes Mellitus, Insulin-Dependent—occurrence—United States. 2. Glucose Tolerance Test—United States—statistics.

W2 A N148vk no.237]

RA407.3.A347 no. 237 362.1'0973021 86-600308

[RA645.D6] [614.5'946200973021]

ISBN 0-8406-0349-5

National Center for Health Statistics

Manning Feinleib, M.D., Dr.P.H., *Director*

Robert A. Israel, *Deputy Director*

Jacob J. Feldman, Ph.D., *Associate Director for Analysis and Epidemiology*

George A. Schnack, *Associate Director for Data Processing and Services*

Alvan O. Zarate, Ph.D., *Assistant Director for International Statistics*

Peter L. Hurley, *Acting Associate Director for Interview and Examination Statistics*

Stephen E. Nieberding, *Associate Director for Management*

Gail F. Fisher, Ph.D., *Associate Director for Program Planning, Evaluation, and Coordination*

Monroe G. Sirken, Ph.D., *Associate Director for Research and Methodology*

Peter L. Hurley, *Associate Director for Vital and Health Care Statistics*

Office of Interview and Examination Statistics Program

Peter L. Hurley, *Acting Associate Director*

Mary Grace Kovar, Dr.P.H., *Special Assistant for Data Policy and Analysis*

Division of Health Examination Statistics

Robert S. Murphy, *Director*

Catherine E. Woteki, Ph.D., *Deputy Director*

Kurt R. Maurer, *Chief, Survey Planning and Development Branch*

Clifford Johnson, *Chief, Nutrition Statistics Branch*

Suzanne Haynes, Ph.D., *Chief, Medical Statistics Branch*

Data Processing and Services Program

George A. Schnack, *Associate Director*

Division of Data Services

James C. Jacks, Ph.D., *Director*

Phillip R. Beattie, *Deputy Director*

David L. Larson, *Chief, Health Examination Field Operations Branch*

Cooperation of the U.S. Bureau of the Census

Under the legislation establishing the National Health Survey, the Public Health Service is authorized to use, insofar as possible, the services or facilities of other Federal, State, or private agencies.

In accordance with specifications established by the National Center for Health Statistics, the U.S. Bureau of the Census participated in the design and selection of the sample and carried out the household interview stage of the data collection and certain parts of the statistical processing.

Contents

Introduction	1
Highlights	3
Data sources	4
Second National Health and Nutrition Examination Survey (NHANES II) sample design	4
NHANES II data collection procedures	4
National Health Interview Survey sample design	5
Data limitations and sources of error	6
Incomplete coverage of U.S. population	6
Sampling error	6
Nonresponse	6
Missing data	8
Reporting error	8
Other nonsampling error	8
Method of analysis	9
Statistical techniques	9
Estimates for the black population	9
Classification of sample persons	9
Findings	12
Prevalence of diagnosed and undiagnosed diabetes in the Second National Health and Nutrition Examination Survey (NHANES II)	12
Comparison of NHANES II and National Health Interview Survey (NHIS) estimates	12
Prevalence of impaired glucose tolerance	13
Total prevalence of glucose intolerance in the United States	13
Mean plasma glucose levels and percentile distributions in U.S. adults	14
Frequency distribution of plasma glucose values	15
Use of the fasting plasma glucose value as a screen for undiagnosed diabetes	16
Association of diabetes and IGT with medical history of borderline diabetes	17
Association of diabetes and IGT with medical history of potential diabetes and with parental history of diabetes	17
Association of diabetes and overweight	18
Discussion	20
References	22
List of detailed tables	24
Appendixes	
I. Statistical notes	42
II. Definition of sociodemographic terms	52
III. Medical history questionnaire items related to diabetes	53

List of text figures

1. Percent of adults aged 20–74 years with medical history of diabetes (NHIS, 1976) and percent with no medical history of diabetes who had undiagnosed diabetes or impaired glucose tolerance using National Diabetes Data Group criteria (NHANES II, 1976–80), by race, sex, and age: United States	14
2. Selected percentile distributions of fasting, 1-hour, and 2-hour plasma glucose values of the oral glucose tolerance test, by age: United States, 1976–80	15
3. Frequency distributions of fasting, 1-hour, and 2-hour plasma glucose values of the oral glucose tolerance test for adults aged 20–74 years with no medical history of diabetes: United States, 1976–80	16
4. Percent of persons in specific fasting plasma glucose (FPG) groups who are undiagnosed diabetics: United States, 1976–80	17
5. Selected percentile distributions of fasting, 1-hour, and 2-hour plasma glucose values of the oral glucose tolerance test, by percent desirable weight: United States, 1976–80	19

List of text tables

A. Response rates for adults aged 20–74 years: Second National Health and Nutrition Examination Survey, 1976–80 ...	6
B. Reason for loss of oral glucose tolerance test (OGTT) data for persons with no medical history of diabetes: Second National Health and Nutrition Examination Survey, 1976–80	6
C. Unweighted number and response rates of sample persons with complete medical history interviews and with classifiable oral glucose tolerance tests (OGTT's) and no medical history of diabetes, by race, sex, and age: Second National Health and Nutrition Examination Survey, 1976–80	7
D. Unweighted number of sample persons with no medical history of diabetes, by oral glucose tolerance test criteria of the National Diabetes Data Group and of the World Health Organization: Second National Health and Nutrition Examination Survey, 1976–80	10
E. Prevalence of diabetes in adults aged 20–74 years, by race, sex, and age: United States, 1976–80	12
F. Cumulative percent distribution of adults aged 20–74 years with undiagnosed diabetes, by fasting plasma glucose level according to criteria of the National Diabetes Data Group and of the World Health Organization: United States, 1976–80	17
G. Prevalence of diabetes in adults aged 20–74 years, by race, sex, and percent desirable weight: United States, 1976–80 ...	18

Symbols

---	Data not available
...	Category not applicable
-	Quantity zero
0.0	Quantity more than zero but less than 0.05
Z	Quantity more than zero but less than 500 where numbers are rounded to thousands
*	Figure does not meet standard of reliability or precision
#	Figure suppressed to comply with confidentiality requirements

Prevalence of Diagnosed Diabetes, Undiagnosed Diabetes, and Impaired Glucose Tolerance in Adults 20–74 Years of Age

by Wilbur C. Hadden, M.A., Division of Health Examination Statistics, National Center for Health Statistics, and
Maureen I. Harris, Ph.D., M.P.H., National Diabetes Data Group, National Institutes of Health

Introduction

The hallmark of diabetes and the basis for its diagnosis is the body's inability to adequately metabolize glucose circulating in the blood. Elevated blood glucose levels result from either inadequate production of insulin or impaired effectiveness of insulin. Both acute and chronic complications can occur. Severe insulin deficiency, or less severe insulin deficiency coupled with other conditions such as stress, fever, dehydration, or acute myocardial infarction, can cause ketoacidosis which may lead to coma and a life-threatening crisis. Chronic diabetes is associated with vascular and neurologic degeneration, and persons with diabetes are at increased risk of heart disease, blindness, renal failure, and inadequate circulation and sensation in peripheral tissues. These latter consequences make diabetics' feet highly susceptible to injury, ulceration, gangrene, infection, and ultimately amputation. Women with diabetes also have increased risk of stillbirths and congenital malformations in their children.¹ Diabetes is the seventh leading cause of death in the United States,² the leading cause of new cases of blindness in adults,¹ and the cause of 25 percent of new cases of end-stage renal disease.³ These direct consequences of diabetes make it a disease that is costly and difficult to manage. It is believed, however, that the complications of diabetes are caused primarily by elevated blood glucose levels and that they can be avoided in many cases by control of blood glucose and close medical supervision with appropriate intervention.⁴

Over the past 25 years, diabetes mellitus has been one of the conditions included in the National Health Interview Surveys (NHIS's) and Health Examination Surveys conducted by the National Center for Health Statistics to assess the health and disease status of U.S. residents. Because these surveys are based on national probability samples of the civilian noninstitutionalized U.S. population, they produce estimates of the prevalence of diabetes in the United States that may be more valid than those inferred from surveys of diabetes in individual communities. However, these national surveys have contained no component to medically verify that surveyed persons have diabetes or, with a single exception, to ascertain undiagnosed cases of diabetes. Also, insulin-dependent and non-insulin-dependent types of diabetes can only be inferentially differentiated. The exception is the Second National Health and Nutrition Examination Survey (NHANES II) conducted in 1976–80 in which oral glucose tolerance tests (OGTT's) were

administered to a representative sample of the civilian noninstitutionalized U.S. population aged 20–74 years.⁵

OGTT's conducted under standardized conditions were included in NHANES II at the request of the National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases (NIADDK) of the National Institutes of Health. Also at the request of NIADDK, similar medical history questions related to diabetes were included in NHANES II and in a special supplemental interview to the 1976 NHIS.⁶ The impetus for these requests can be traced to the U.S. National Commission on Diabetes, a commission constituted by the U.S. Congress in 1975 to formulate a long-range plan to combat diabetes and to develop specific recommendations for the utilization and organization of national resources.¹ The Commission was hampered in its work by the lack of valid data to assess the scope and impact of diabetes, particularly undetected diabetes, and it was envisioned that glucose tolerance testing of a sample of the U.S. population would document the extent of undiagnosed diabetes and provide important new epidemiologic correlations on the causes and consequences of diabetes.

The NHIS diabetes supplement and the diabetes component of NHANES II, including the medical history and the procedure for the OGTT, were designed by NCHS and NIADDK. NIADDK supported expenses incurred in performing the OGTT's and analyses of plasma glucose, and the National Diabetes Data Group, NIADDK, supported analyses of NHANES II diabetes data, providing funds and consultant services.

Knowledge of the prevalence of diabetes—those cases that exist in a defined population at a point in time—provides important information that serves several purposes. First, prevalence can be used to estimate the clinical workload, the resources in hospital and outpatient facilities, nutritional and patient education services, and the number of trained medical specialists required to provide primary care for diabetics. Second, prevalence estimated in groups identified by other variables can be used to assess the risk of developing diabetes, to explore hypotheses about factors that might cause diabetes, and to plan programs for control and prevention of diabetes. Third, prevalence data can be used to estimate the impact of diabetes on society, to place this disease in its proper perspective compared with other competing priorities, and to de-

termine how much of a community's resources should be applied to its detection and treatment. Prevalence data are important to clinicians in managing patients, to scientists in planning research, and to public health officials in developing programs to promote health in their communities.

This report presents estimates of age-, sex-, and race-specific prevalences of physician-diagnosed diabetes based on data collected in NHANES II and in the 1976 NHIS. This report also presents estimated prevalences of undiagnosed diabetes and of impaired glucose tolerance (IGT), based on the NHANES II OGTT data and using criteria of the National Diabetes Data Group⁷ and the World Health Organization.⁸

The estimates based on OGTT data should be interpreted cautiously because only 43 percent of eligible sample persons had OGTT results that met the specifications of the NDDG, and these persons may not be representative of the survey's target population. Furthermore, only 350 black persons completed the test. The validity of the estimates presented in this

report depends on an assumption that those sample persons who did not complete the OGTT are similar to those who did with respect to their glucose tolerance. Evidence is presented that this is a reasonable assumption. Because the black persons who completed the test lived in only a few communities, the estimates of their sampling error are probably unreliable.

This report also presents national estimates of the plasma glucose values of persons with no medical history of diabetes. It is believed that these data can serve as a national reference standard against which clinicians can compare the plasma glucose values of their individual patients and medical researchers can compare the values of their clinical and epidemiologic research populations. Finally, the report presents analyses of several factors that are thought to be influential in the natural history of diabetes (in addition to age, race, and sex), namely obesity, parental history of diabetes, and a previous diagnosis of borderline or potential diabetes.

Highlights

Estimates of the prevalence of diagnosed diabetes (diabetes that was reported by respondents to have been previously diagnosed by a physician) were 3.4 and 3.0 percent, for persons aged 20–74 years in the civilian noninstitutionalized population of the United States. These estimates are based on data from the Second National Health and Nutrition Examination Survey, 1976–80, and the National Health Interview Survey, 1976, respectively.

Estimates for undiagnosed diabetes based on oral glucose tolerance test results from the Second National Health and Nutrition Examination Survey, using either National Diabetes Data Group (NDDG) or World Health Organization (WHO) criteria, were very similar to each other—3.2 and 3.4 percent, respectively. These rates were approximately equal to the percent of persons with physician-diagnosed diabetes as reported in household interviews. In other words, about half the people with diabetes did not know it.

The prevalences of both diagnosed and undiagnosed dia-

betes increased with age and were higher for black persons than for white persons. Sex differences were smaller, but at ages 20–44 years women were more likely than men to have diabetes.

The prevalence of diabetes increased with level of obesity. Persons who were 50 percent or more above ideal body weight had diabetes at five times the rate of persons of ideal weight or lighter.

Estimates for impaired glucose tolerance using WHO criteria, 11.2 percent, were more than twice those using NDDG criteria, 4.6 percent. This difference is due to WHO criteria requiring two plasma glucose measures while NDDG criteria require three.

Using NDDG criteria, it appears that 11.2 percent of the U.S. population aged 20–74 years exhibit abnormal glucose tolerance, either diabetes or IGT. Using WHO criteria, 18.0 percent were glucose intolerant.

Data sources

Second National Health and Nutrition Examination Survey (NHANES II) sample design

The target population of NHANES II was the civilian noninstitutionalized population of the United States (including Alaska and Hawaii) aged 6 months–74 years. The NHANES II sample was a stratified probability sample of this target population, selected as follows. Areas of the United States, usually counties, were grouped into 64 categories called strata with approximately equal populations that were internally as homogeneous as possible with respect to region, median family income, and other demographic characteristics that varied with region. From each stratum, one area was selected by a technique that guaranteed the geographic and socioeconomic diversity of the sample. Within each of the 64 selected areas two additional strata were created: Clusters of eight households were grouped into segments, and segments were stratified into poverty and nonpoverty strata. Poverty segments were located in census enumeration districts with 13 percent or more of persons below the poverty level in the 1970 census. Segments were differentially sampled from these strata at rates determined by a mathematical model to produce a sample of the required size with minimum variance of the estimated proportion of persons below the poverty level. Within segments, interviewers enumerated household residents and systematically selected persons into the sample at rates based on age. The sampling rates of segments and persons were so set that children aged 6 months–5 years, adults aged 60–74 years, and all persons living in areas with 13 percent or more of people below poverty level are overrepresented in the sample.

The total sample size for NHANES II was 27,801 persons aged 6 months–74 years, but this report is based mainly on a subsample of adults aged 20–74 years who constitute an “oral glucose tolerance test” (OGTT) or “fasting” subsample. As the sample was selected, alternate sample persons aged 20–74 years were assigned to a one-half subsample and were asked to fast overnight; to attend the examination center in the morning; and, with the exception of diabetics using insulin, to submit to an OGTT. There were 17,390 persons aged 20–74 years in the total NHANES II sample and 8,686 persons in the fasting subsample. Additional details of sample design are presented in appendix I.

NHANES II data collection procedures

NHANES II included a household interview, conducted by trained U.S. Bureau of the Census interviewers, during which

demographic data (see definitions in appendix II) were obtained and a detailed medical history was taken. In some cases, sample persons initially refused the interview but later responded when contacted by National Center for Health Statistics field staff.

Examinations were conducted from February 1976 to February 1980 by two teams of health professionals working in three mobile examination centers. Because of limitations in the heating and cooling systems of these centers, examinations were scheduled so that sample persons residing in more southern areas were examined in the winter and sample persons in more northern areas were examined in the summer. Measurement of conditions that vary seasonally may therefore be confounded by this design.

NHANES II collected a large amount of data on each sample person. Data on diabetes used in this report are from both the medical history interview and the examination, which provided body measures of height and weight and OGTT data. Other data collected in NHANES II but not used in this report include components of the medical history, body measures other than height and weight, 24-hour diet recall and dietary frequency, blood chemistries, urinalysis, electrocardiogram, chest X-ray, and physician examination data.

Medical history

The presence of physician-diagnosed diabetes in interviewed persons was ascertained from the question, “Do you have diabetes or sugar diabetes?” Interview confirmation of a diagnosis of diabetes was attempted by asking those who responded positively “Did a doctor tell you that you had it?”; 99 percent of those responding “Yes” to the first question responded “Yes” to this followup question (see questionnaire in appendix III). No proxy responses were allowed. Persons who responded “Yes” to the question on physician diagnosis of diabetes or to questions on borderline, potential, or prediabetes were also queried on use of antidiabetic therapy. These questions elicited information on past use, current use, and duration of use of insulin, “diabetes pills” (in pretests this was equated by diabetics to oral antidiabetic medication), and a written diet for control of diabetes.

Examination

Height was measured with a steel tape attached to a vertical bar. Examinees wore disposable foam rubber slippers and stood on a level platform with their feet together and their back and heels against the vertical bar. They were instructed to “stand up tall” or “stand up real straight” and to “look straight

ahead.” A horizontal bar attached perpendicularly to the vertical bar was lowered snugly on the examinee’s head. In the same plane as the horizontal measuring bar, a Polaroid camera^a was attached and used to photograph the examinee’s height and sample person number. These photographs were read by NHANES II field staff. This technique minimized observer and recording error by eliminating parallax and created a permanent record of this measurement. Weight was measured on a Toledo self-balancing scale^a that mechanically printed weight to one-quarter of a pound onto a permanent record. The scale was calibrated at each survey location before the examinations.

OGTT and blood glucose analysis

OGTT’s were administered according to National Diabetes Data Group (NDDG) recommendations,⁷ which require the following: Subjects fast overnight for 10–16 hours; OGTT’s are performed in the morning; a fasting blood sample is taken; subjects drink flavored water containing 75 grams of glucose or carbohydrate equivalent; and additional blood samples are taken. The drink used in NHANES II was Glucola,^a a cola-flavored preparation containing a carbohydrate equivalent of 75 grams of glucose.

Although the NDDG recommends that blood samples be taken at one-half-hour intervals up to the final 2-hour sample, in this voluntary survey NHANES II field staff did not attempt to obtain multiple midtest venipunctures. (The test recommended by the World Health Organization requires only fasting and 2-hour blood samples.) They did obtain fasting, single midtest, and 2-hour blood samples in 98 percent of OGTT’s in compliance with NDDG guidelines. More than 95 percent of all midtest and 2-hour samples were obtained within 5 minutes of the specified times, and 99 percent were within 10 minutes. For purposes of classification, the analyses include all midtest values (range of 20–86 minutes), but only those 2-hour values that were taken within 105–135 minutes after sample persons drank Glucola were used. For estimating 1- and 2-hour plasma glucose distribution statistics, all values obtained within 15 minutes of the specified times were used.

Venous blood samples were obtained in each venipuncture. Plasma was separated from blood, frozen, and shipped in Dry Ice to the Centers for Disease Control for analysis. There, glucose determinations were made by the Clinical Trials Section, Metabolic Biochemistry Branch, Clinical Chemistry Division, using a microadaptation of the national glucose reference method.⁹ This method has been shown to have several desirable

properties including reliability, transferability, specificity, and precision. It has an average bias of less than 2 percent. Further information on processing of blood samples is presented in appendix I.

National Health Interview Survey sample design

The National Health Interview Survey is a continuous survey, the design of which has been detailed in previous publications.^{6,10} The target population for the National Health Interview Survey is the civilian noninstitutionalized population of the United States living at the time of the interview. The sampling plan follows a multistage probability design that permits continuous sampling such that the sample of households interviewed each week is representative of the target population and weekly samples are additive over time. The sampling in 1976 was not designed to oversample any population subgroup. At the first stage of sampling, 376 areas of the country were selected; at the second stage, segments of an expected four households were selected from each area. The sample contained approximately 40,000 eligible occupied households and about 113,000 persons, of whom 69,006 were aged 20–74 years and 2,442 reported a medical history of diabetes. Field operations of the survey were performed by the U.S. Bureau of the Census under specifications established by the National Center for Health Statistics. A special supplement to the household interview contained diabetes-related questions in common with the medical history interview questions of NHANES II. Each person 19 years of age and over present at the time of interview was interviewed individually. For adults not present in the home at the time of interview, information was obtained from a related household member, such as a spouse or parent. Spouses provided the majority of proxy responses for adults.¹¹

The presence of physician-diagnosed diabetes in surveyed persons was ascertained in several sections of the household interview; specifically, through respondents reporting that household members had disabilities due to diabetes, a hospital stay or doctor visit for diabetes, or by responding positively to the direct question, “Do you (or anyone in the household) have diabetes or sugar diabetes?” Interview confirmation of a diagnosis of diabetes was attempted by asking the person, “How old were you (or the household member) when a doctor told you that you had it?”; 98 percent responded with an age at diagnosis to this followup question. Persons who responded “Yes” to the question on physician diagnosis of diabetes were also queried on use of antidiabetic therapy, including past use, current use, and duration of use of insulin, “diabetes pills,” and a written diet for control of diabetes.

^aMention of brand name is for the purpose of specific identification of the equipment or product used in the survey and does not imply endorsement by the U.S. Department of Health and Human Services.

Data limitations and sources of error

There are many potential sources of limitation or error during the design, data collection, and processing phases of surveys. The most important of these for the Second National Health and Nutrition Examination Survey (NHANES II) are limitation in the coverage of the U.S. population, sampling error, nonsampling error, nonresponse, missing data, and reporting error.

Incomplete coverage of U.S. population

Persons in institutional settings such as nursing homes, long-term care hospitals, and prisons were not included in the NHANES II and National Health Interview Survey (NHIS) samples. Consequently, to the extent that persons in institutional settings are part of the U.S. population, the surveys underestimate the total prevalence of diabetes. The majority of persons in health care institutions reside in nursing homes and, from the National Nursing Home Survey, it is estimated that approximately 60,000 diabetics aged 20–74 years were known to be in these facilities in 1977.¹² They constitute only 1.3 percent of the diagnosed diabetic population estimated from NHANES II in this report.

Sampling error

Estimates based on sample surveys are subject to several types of error. These errors may be divided into two general types—sampling and nonsampling errors. The sampling errors of estimates presented in this report estimate the amount by which estimates might differ from results that would have been obtained if another sample had been drawn or a complete census had been taken using the same instruments, instructions, interview and examination personnel, and procedures. Because of the probability design of the survey, it is possible to generalize from the sample to the population and to estimate the potential sampling error. In doing so, however, it is necessary to assume that those who participated in the survey and completed the procedures are a representative sample; that is, that those who responded are like those who did not. This assumption is discussed further in the following section and in appendix I.

Nonresponse

Response rates to NHANES II for persons aged 20–74 years are presented in tables A, B, and C. In both the total NHANES II adult sample and the oral glucose tolerance test

(OGTT) subsample, 88 percent of sample persons participated in the demographic-medical history interview and 68 percent participated in the examination (table A). Approximately 4 percent of persons in both samples reported a history of physician-diagnosed diabetes. OGTT's that conformed to National Diabetes Data Group requirements were obtained from 43 percent of persons in the OGTT subsample, which represents 52 percent of interviewed OGTT subsample persons with no medical history of diabetes. Reasons for loss of OGTT data are summarized in table B. The main reasons were refusal to participate in the examination component of NHANES II and not attending the exam center during the morning hours. The numbers and response rates of sample persons with complete medical history interviews or classifiable OGTT's are shown by age, race, and sex in table C.

One possible source of bias for estimates presented in this report is differential interview and examination nonresponse by population subgroups. A previous analysis of NHANES II

Table A. Response rates for adults aged 20–74 years: Second National Health and Nutrition Examination Survey, 1976–80

Response category	Total sample		OGTT ¹ subsample	
	Number	Percent	Number	Percent
Sample persons	17,390	100.0	8,686	100.0
Interviewed	15,357	88.3	7,688	88.5
Medical history of				
diabetes	756	4.3	381	4.4
Examined	11,860	68.2	5,903	68.0
Classifiable OGTT ² . . . . .	...	...	3,772	43.4

¹ OGTT = oral glucose tolerance test.

² Only persons with no medical history of diabetes.

Table B. Reason for loss of oral glucose tolerance test (OGTT) data for persons with no medical history of diabetes: Second National Health and Nutrition Examination Survey, 1976–80

Reason for loss	Number	Percent
Interviewed sample persons with no medical history of diabetes	7,307	100.0
Refused examination	1,678	23.0
Did not attend morning examination	877	12.0
Did not fast 10–16 hours	442	6.0
Refused OGTT	178	2.4
Missing or incomplete OGTT's ¹	360	4.9
Classifiable OGTT's	3,772	51.6

¹ Length of fast unknown, technical errors, samples lost, unsuccessful venipuncture, sample persons became ill, or other reason.

Table C. Unweighted number and response rates of sample persons with complete medical history interviews and with classifiable oral glucose tolerance tests (OGTT's) and no medical history of diabetes, by race, sex, and age: Second National Health and Nutrition Examination Survey, 1976-80

Race and sex	Age					Age				
	Total, 20-74 years	20-44 years	45-54 years	55-64 years	65-74 years	Total, 20-74 years	20-44 years	45-54 years	55-64 years	65-74 years
All races ¹										
Number with complete interview										
Both sexes.....	15,357	6,531	1,866	3,328	3,632	88.3	91.2	86.8	86.0	86.2
Male.....	7,074	3,064	892	1,525	1,593	87.6	89.7	84.8	85.5	87.5
Female.....	8,283	3,467	974	1,803	2,039	88.9	92.6	88.8	86.5	85.3
Percent of sample completing interview										
White										
Both sexes.....	13,311	5,587	1,613	2,925	3,186	88.1	91.2	87.2	85.9	85.7
Male.....	6,167	2,635	787	1,347	1,398	87.4	89.5	85.4	85.0	86.9
Female.....	7,144	2,952	826	1,578	1,788	88.8	92.7	89.1	86.6	84.7
Black										
Both sexes.....	1,762	795	212	364	391	90.1	92.0	85.1	88.1	91.1
Male.....	765	354	87	163	161	89.8	91.9	79.8	89.1	92.0
Female.....	997	441	125	201	230	90.4	92.1	89.3	87.4	90.6
All races ¹										
Number with classifiable OGTT's ²										
Both sexes.....	3,772	1,608	490	841	833	43.4	45.0	45.6	44.1	39.1
Male.....	1,772	740	216	423	393	43.1	42.9	42.1	44.9	42.0
Female.....	2,000	868	274	418	440	43.7	47.0	48.8	43.2	36.8
Percent of sample completing OGTT's ³										
White										
Both sexes.....	3,348	1,408	437	753	750	44.3	46.2	46.9	45.0	39.5
Male.....	1,585	648	200	383	354	44.1	43.8	44.1	46.2	42.8
Female.....	1,763	760	237	370	396	44.5	48.5	49.6	43.8	36.9
Black										
Both sexes.....	351	159	42	79	71	36.5	36.6	36.8	37.4	35.0
Male.....	154	73	14	36	31	35.2	37.2	28.6	35.0	34.4
Female.....	197	86	28	43	40	37.6	36.1	43.1	39.8	35.4

¹Includes races other than white or black.

²Only persons with no medical history of diabetes.

³Persons with medical history of diabetes excluded from numerator but included in denominator.

nonresponse showed that the interview nonresponse rates varied with age, region, residence in a standard metropolitan statistical area, and family size; the examination nonresponse rate varied with wanting to discuss a health problem with a doctor, work status, and number of cars owned.¹³ After comparing NHANES II and NHIS estimates of several important health measures, the author of this earlier study concluded that the statistical weighting procedures (that is, nonresponse adjustments and poststratification) substantially reduced the bias due to differential interview and examination nonresponse rates. These weighting procedures were also used in this report.

However, as noted above, the data for the OGTT study are subject to even further nonresponse because of failure to obtain classifiable OGTT's for a substantial proportion of the interviewed and the examined OGTT sample. Details of analyses of the potential magnitude and effect of nonresponse bias are presented in appendix I. To check for differential nonresponse, estimates of population distributions for various socioeconomic and demographic variables for sample persons who completed the OGTT were compared with estimates for the same variables based on the interviewed and the examined

NHANES II samples and the NHIS sample. Only small differences were observed between corresponding estimates, indicating that, even though failure to obtain classifiable OGTT's was differentially distributed across socioeconomic and demographic subgroups, these differentials were so small they probably did not substantially affect the estimates presented in this report.

To evaluate the effects of nonresponse on health measures, prevalence estimates based on medical history items related to diabetes were computed for NHIS and for NHANES II interviewed, examined, and OGTT-completed groups. Distributions of height, weight, body mass index, diastolic and systolic blood pressure, and cholesterol were estimated for all examined sample persons, the OGTT-examined subsample, and the OGTT-completed group. For most items the estimates were very similar, but two potentially important problems were uncovered. First, a smaller proportion of persons with a medical history of diabetes participated in the exam or met the requirements for the OGTT than persons with no history of diabetes. Second, a larger proportion of persons with a medical history of borderline (59.4 percent) or potential (63.1 percent) diabetes or having

a parent with diabetes (58.3 percent) participated in the exam and met the requirements of the OGTT compared with all OGTT sample persons with no history of diabetes (50.6 percent) (appendix I, table V).

To estimate the magnitude of potential bias caused by this higher response of persons having a parent with diabetes or a history of borderline or potential diabetes, standardized estimates were calculated; that is, estimates from the OGTT-completed group were adjusted to the prevalence of these background items in the interviewed sample. These adjusted estimates differed from the survey estimates by only small amounts, less than 0.4 percent, for any of the detailed sex-age cells presented in this report (appendix I, table VIII). Thus, it appears that the differential response rates for these two groups did not substantially bias prevalence estimates for either the entire population or its subgroups.

The sensitivity of estimates of unknown diabetes or impaired glucose tolerance to violations of an assumption of independence in two groups—those with and those without either a medical history of borderline or potential diabetes or a parent with diabetes—was modeled mathematically. The model showed that the greater effect on prevalence estimates would be caused by overresponse or underresponse by persons with no history of borderline or potential diabetes and whose parents did not have diabetes. Overestimating or underestimating prevalence in nonrespondents by 25 percent would cause about a 15 percent error in estimates presented in this report (appendix I, table IX).

For the 1976 NHIS the noninterview rate was 3.7 percent. Respondent refusal was 2.1 percent; the remaining 1.6 percent was primarily failure to find an eligible respondent at home after repeated calls.⁶

Missing data

The number of respondents with missing data for any of the medical history items used in this report was very small.

Sample persons with missing medical history data were simply excluded from any analysis or tabulation where appropriate. For those few examinees with missing height or weight, values were imputed with a regression model based on NHANES I data using their other body measures, age, race, and sex.

Reporting error

In 1962, a study was performed to examine the accuracy of reporting a diagnosis of diabetes in the National Health Interview Survey. It was found that about 15 percent of persons with diabetes on their medical records failed to tell the interviewer that they were diabetic; there was only about 1 percent overreporting of this disease.¹⁴ It is not known whether similar levels of reporting error existed 15 years later during NHANES II. There was no followback to medical records of the 756 persons who reported that they were diabetic in response to the NHANES II medical history interview.

Other nonsampling error

Every effort possible was made during the design, execution, processing, and analysis of NHANES II to prevent or minimize nonsampling errors. By thorough training of the staff, use of mobile examination centers, and careful review of operating procedures, interobserver and interarea variability in the data were minimized. In editing the NHANES II data, 27 sample persons were identified whose plasma glucose values appeared to reflect either failure of the participant to fast, inaccurate labeling of the time the blood sample was taken, or glucose measurement errors. These persons were excluded from analyses in this report.

Method of analysis

Statistical techniques

Data from all Second National Health Interview Survey (NHANES II) interviewed persons aged 20–74 years were used in this report for prevalence estimates of data from the medical history interview, most importantly the prevalence of physician-diagnosed diabetes. For items measured during the NHANES II examination, most importantly height and weight, examined persons were used as a base for prevalence estimates. Estimates of prevalence of undiagnosed diabetes and impaired glucose tolerance are based only on persons for whom classifiable oral glucose tolerance test (OGTT) data were obtained.

Because of the complex sample designs of the National Health Interview Survey (NHIS) and NHANES II, as well as the stratification and oversampling of children, of adults aged 60–74 years, and of persons living in poverty areas, weighting was employed in the calculation of all estimates in this report. The weights take into account the probability with which persons were drawn into the samples and certain adjustments, based on the known demographic characteristics of interviewed or examined persons versus all eligible persons, to minimize the effects of nonresponse and bias. When summed, the weights of all interviewed or all examined persons closely approximate the estimated target populations at the midpoint of the survey periods (March 1, 1978, for NHANES II; July 1, 1976, for NHIS).

There are no formulas for exact measures of sampling error because of the many complex features of the NHANES II and NHIS sample designs. Approximations were used in analyses reported here. They were calculated using a method of Taylor series linearization of approximate formulas incorporated in the computer programs SURREGR¹⁵ and SESUDAAN.¹⁶ Statistical tests were performed with a method of weighted least squares for multivariate categorical data which produces test statistics that are asymptotically chi-square.¹⁷ The calculations were made using the computer program GENCAT.¹⁸ This program makes possible the construction of multivariate tests of significance that take into account the full covariance matrix of estimates. These tests have greater statistical power than tests based on comparisons of paired estimates using the method for combining estimates presented in appendix I. Thus, analyses using the GENCAT procedures may produce somewhat different results than comparison of paired estimates using standard errors shown in the detailed tables. All findings in this report are statistically significant at levels of probability less than, usually much less than, 0.05 percent.

Estimates for the black population

Estimates for black persons must be interpreted with caution because of the small number of black people in the sample and their low (36 percent) OGTT completion rate (table C). The reliability of estimates as measured by their standard errors is related to sample size, sample distribution across primary sampling units, and the magnitude of the estimate. Making precise estimates for conditions that are as rare as diabetes is in some subpopulations requires larger samples than the NHANES II sample of black persons. In this report the estimates for all black persons and sometimes for all black females or males can be considered reasonably precise, that is, the standard error of an estimate is less than 30 percent of the estimate itself. But for many estimates, especially those based on the OGTT results, the sample size is inadequate for precise estimates. Furthermore, as described in the previous section, the standard errors presented in this report are also subject to error; estimated standard errors may not be reliable because of the small numbers of black persons in certain cells and their concentration in certain areas of the country.

Despite these limitations, results for black persons are presented because the prevalence of diabetes and glucose intolerance for black and white persons provides an important racial comparison, and other studies do not have comparable data. Although estimates for detailed age and sex groups of black persons are not individually reliable, they are presented to demonstrate the variability of the data by age and sex. Other researchers may find these data useful for generating hypotheses or building their own models. Results for black persons based on these data must be interpreted cautiously; they should be replicated in other studies before they are accepted as adequate national estimates of the prevalence of diabetes and glucose intolerance for the black population.

Classification of sample persons

In this report, sample persons are classified to the extent possible according to the system developed by the National Diabetes Data Group (NDDG).⁷ This classification has been endorsed by the American Diabetes Association, and the World Health Association (WHO) Expert Committee on Diabetes has accepted its substantive recommendations.⁸ In this system, the main types of diabetes are insulin-dependent diabetes mellitus (IDDM), non-insulin-dependent diabetes mellitus (NIDDM), gestational diabetes, and diabetes secondary to other diseases and conditions. In addition, the NDDG and WHO

have defined a category based on the OGTT that is termed impaired glucose tolerance (IGT) and represents glucose levels intermediate between those considered diabetic and those considered normal.^{7,8}

Classification of persons with medical history of diabetes

Persons with a medical history of diabetes were classified as diabetic based on data obtained in their medical history interview. The interview question did not ascertain the criteria that physicians used for diagnosis of diabetes and, consequently, it is not known if reported cases of diabetes met the NDDG or WHO diagnostic criteria for diabetes. However, data from the interview indicate that these respondents should be considered diabetic. Among the 756 NHANES II subjects who indicated a medical history of physician-diagnosed diabetes, 26 percent were using insulin and 35 percent were taking oral antidiabetic medication at the time of the survey. An additional 14 percent had been given a written diet for control of their diabetes and were following their diets. The remaining 25 percent were not following any of these three therapies at the time of the survey; however, virtually all had a history of use of insulin, oral antidiabetic agents, or diet. Similar results on past and current use of diabetes therapies were reported by participants in the 1976 NHIS.¹¹ Because these therapy histories are consistent with a diagnosis of diabetes, all persons in NHANES II and NHIS who reported a physician diagnosis of diabetes have been designated "medical history" or "diagnosed" diabetics.

In another study of the validity of classification based on medical histories, the medical records of diabetics in the population of Rochester, Minnesota, who were diagnosed between 1945 and 1969 were reexamined.¹⁹ It was found that approximately 21 percent of diabetics did not meet the NDDG criteria at their initial diagnosis, although one-third of these did meet the criteria after 10 years duration of diabetes. The diabetic population of Rochester is primarily diagnosed by elevated fasting plasma glucose, however, whereas NDDG and WHO permit diagnosis of diabetes by either elevated fasting plasma glucose or abnormal OGTT.

Plasma glucose values have not been used in classifying the 381 medical history diabetics in the fasting subsample.

Because participation in this survey was voluntary, it was considered inappropriate to request that the 75 insulin-taking diabetics in the examined subsample have an OGTT; in addition, the remaining number of persons with a medical history of diabetes who received an OGTT (100 persons) was deemed too small for valid analysis. Half of these met the NDDG criteria for diabetes; the other half may not have because they were on blood-glucose-lowering therapies.

The data collected in NHANES II do not permit accurate differentiation of medical history diabetics into the categories IDDM and NIDDM. However, an estimate can be made by assuming that all persons diagnosed as diabetic under the age of 30 years who reported using insulin for the duration of their diabetes (plus or minus 1 year) had IDDM, and that the remainder had NIDDM. Using these criteria, approximately one-third of medical history diabetics aged 20–44 years could be classified as having IDDM. Over age 44 years, less than 2 percent appear to have IDDM. Similar results were found in the 1976 NHIS.¹¹ IDDM and NIDDM have not been analyzed separately in this report.

The category of gestational diabetes diagnosed by an abnormal OGTT in pregnancy will not be used in this report. There were 52 pregnant women in the interviewed sample; none of the 32 who received an OGTT was diabetic.

It cannot be determined how many NHANES II persons with a medical history of diabetes have diabetes that is secondary to other conditions; in a recent study,¹⁹ this category represented only 2 percent of all medically diagnosed cases of diabetes.

Classification of persons with no medical history of diabetes

For those persons who did not report a medical history of diabetes, the diagnostic criteria recommended by NDDG and WHO were applied to their venous plasma glucose values in the fasting state and during the OGTT to classify them as diabetic, IGT, or nondiagnostic (table D). For 3,701 of 3,772 sample persons who met NDDG requirements for conduct of the OGTT, all three plasma glucose values were obtained. There were 71 sample persons for whom one of the OGTT values was missing but whose other values excluded the diag-

Table D. Unweighted number of sample persons with no medical history of diabetes, by oral glucose tolerance test criteria of the National Diabetes Data Group and of the World Health Organization: Second National Health and Nutrition Examination Survey, 1976–80

Fasting and 2-hour plasma glucose concentrations ¹	National Diabetes Data Group					
	World Health Organization		1 hour, 200 mg/dl or more		1 hour, less than 200 mg/dl	
	Classification	Number of persons	Classification	Number of persons	Classification	Number of persons
Fasting, 140 mg/dl or more	Diabetes	44	Diabetes	44	Diabetes	-
Fasting, less than 140 mg/dl:						
2 hour, 200 mg/dl or more	Diabetes	148	Diabetes	136	Nondiagnostic	12
2 hour, 140–199 mg/dl	Impaired glucose tolerance	532	Impaired glucose tolerance	227	Nondiagnostic	303
2 hour, less than 140 mg/dl	Normal	2,991	Nondiagnostic	196	Normal	2,783
Classified with partial data	Normal	4			Normal or nondiagnostic = 71	
Total number of persons		3,719			3,772	

¹mg/dl = milligrams per deciliter.

noses diabetes or IGT. For development of WHO estimates, which require only fasting and 2-hour values, 58 of these could not be classified because their 2-hour value was missing. The effect of this was to reduce the sample base for WHO estimates. Despite the greater complexity of the NDDG system, more sample persons could be classified because the 1-hour value could be used to exclude IGT and diabetes. Fifteen persons were unclassifiable under NDDG criteria because of partial data that did not exclude diagnoses of diabetes or IGT; but in the WHO system, which utilizes only the fasting and 2-hour blood glucose values, five of these persons could be classified.

Only about one-fourth of undiagnosed diabetics could be classified as diabetic on the basis of an elevated fasting plasma glucose (140 milligrams per deciliter or more); the remainder were classified as diabetic based on their 1- or 2-hour post-glucose challenge levels (200 milligrams per deciliter or more) (table D).

IDDM is a disease with such classic onset and obvious symptoms that virtually no patients are undiagnosed; consequently, no cases of undiagnosed diabetes in NHANES II are considered to be IDDM.

Findings

Prevalence of diagnosed and undiagnosed diabetes in the Second National Health and Nutrition Examination Survey (NHANES II)

Tables 1–3 present age-, race-, and sex-specific rates of diagnosed diabetes and undiagnosed diabetes. More detailed age rates for white persons only are presented in table 4. The prevalence of physician-diagnosed diabetes (table 1) rose with age and was higher for black than for white persons. Prevalence at ages 65–74 years (9.3 percent) was 8.5 times that at ages 20–44 years (1.1 percent). Prevalence for black persons (5.2 percent) was 1.6 times greater than for white persons (3.2 percent). Prevalence rates for males and females were not statistically different except for white persons aged 20–44 years and black persons aged 65–74 years.

The prevalence of undiagnosed diabetes as defined either by the National Diabetes Data Group (NDDG) (table 2) or the World Health Organization (WHO) (table 3) also rose with age and was higher for black than for white persons in all age groups. Using NDDG criteria, the prevalence of undiagnosed diabetes rose from 0.9 percent in the youngest age group to 8.4 percent in the oldest group. Using WHO criteria, the rates rose from 0.9 to 9.4 percent. Both definitions provided similar total prevalence rates—3.2 and 3.4 percent, respectively. The WHO definition produced slightly higher estimates in age groups 55 years and over because, although all oral glucose tolerance tests (OGTT's) that met the NDDG criteria for diabetes also met the WHO criteria, 12 of 192 that met the WHO criteria did not meet the NDDG 1-hour criteria (table D). Estimates for individual age groups of black persons were unreliable, although the increase with age was consistent with the pattern of estimates for white persons. Differences between male and female rates were statistically significant only for white persons aged 20–64 years; within this age range undiagnosed diabetes was about 1.5 times more prevalent in females than males.

Table E presents the sums of NHANES II rates for diagnosed and undiagnosed diabetes using NDDG criteria shown in tables 1 and 2. These sums represent an estimate of the total prevalence of diabetes in the United States for persons aged 20–74 years. Because sample persons on which estimates for undiagnosed diabetes in NHANES II are based are a subset of sample persons on which estimates for physician-diagnosed diabetes are based, these estimates are not independent. Because computer programs for estimating their covariances were unavailable, estimates of standard errors for total prevalences

Table E. Prevalence of diabetes in adults aged 20–74 years, by race, sex, and age: United States, 1976–80

Race and sex	Total, 20–74 years	Age			
		20–44 years	45–54 years	55–64 years	65–74 years
All races ¹					
Percent of population					
Both sexes	6.6	2.0	8.4	12.8	17.7
Male	5.7	1.5	7.8	9.6	19.2
Female	7.3	2.5	9.0	15.5	16.5
White					
Both sexes	6.2	1.6	8.1	11.9	16.9
Male	5.3	1.0	7.7	9.0	18.1
Female	7.0	2.2	8.5	14.6	16.1
Black ²					
Both sexes	9.6	3.1	12.9	20.8	25.8
Male	8.4	2.7	11.0	14.4	29.4
Female	10.5	3.5	14.5	25.4	23.1

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: Includes both persons reporting in medical history interview that a doctor had told them they had diabetes and persons classified diabetic on an oral glucose tolerance test using National Diabetes Data Group criteria (see text for criteria).

of diabetes in table E could not be calculated. However, the fact that age and race effects were similar in tables 1 and 2 strongly suggests that the increase in total prevalence with age and the higher rates for black than for white persons were statistically significant.

The prevalence of diabetes in persons aged 65–74 years (17.7 percent) was 8.8 times that for persons aged 20–44 years (2.0 percent). Total diabetes was 1.5 times more prevalent for black than for white persons (9.6 and 6.2 percent, respectively). Relative sex differences shown in table E were smaller than those in tables 1 and 2 and may not be statistically significant except for white persons aged 20–44 years; in this group the prevalence of total diabetes for females (2.2 percent) was greater than for males (1.0 percent).

Comparison of NHANES II and National Health Interview Survey (NHIS) estimates

Estimates of previously diagnosed diabetes based on the 1976 NHIS are presented in table 5. Compared to NHANES II estimates in table 1, there were some differences in the prev-

absence of known diabetes, with estimates from NHANES II generally being higher than those from NHIS. For example, 3.4 percent of persons aged 20–74 years in NHANES II reported a medical history of diabetes, versus 3.0 percent in NHIS. For specific race-sex-age groups, the difference between NHANES II and NHIS varied. Generally, the NHANES II estimates were 10 percent higher than those of NHIS. These discrepancies might be partly explained by the different time periods during which the surveys were conducted. For example, the 1979–81 NHIS, conducted at the end of NHANES II, found that 3.3 percent of persons aged 20–74 years reported a medical history of diabetes.²⁰ However, rates of diabetes in the individual years of NHANES II did not show an increase in prevalence between 1976 and 1980. The discrepancy might also be due to underreporting of diabetes by proxy respondents in NHIS. Using only self-respondents in NHIS to estimate diabetes prevalence reduces the difference between the surveys by about two-thirds. The rest of the difference was probably due to sampling error and the sum of effects of differences in interviewers, question context, editing, and processing.

In general, the NHIS estimates of physician-diagnosed diabetes (table 5) showed the same pattern as the NHANES II estimates (table 1). As in NHANES II, the prevalence of known diabetes increased with age and was higher for black than for white persons in all age groups. Prevalence for the oldest age group (8.3 percent) was 8.3 times that of the youngest (1.0 percent). Prevalence for black persons (4.4 percent) was 1.6 times that for white persons (2.8 percent). For white persons aged 20–44 years, the rate for females (1.1 percent) was higher than for males (0.7 percent).

It is informative to assess the relative prevalence of diagnosed and undiagnosed diabetes. This could not be done with NHANES II data alone, as explained earlier. It can be done, however, by comparing NHANES II estimates with NHIS estimates.

The prevalence of undiagnosed diabetes in NHANES II using NDDG criteria (table 2) and WHO criteria (table 3) was similar to the prevalence of physician-diagnosed diabetes measured in NHIS (table 5). The only statistically significant differences between these sets of estimates were sex differences for white persons aged 20–64 years and for black persons aged 20–54 years. In NHANES II, for white persons aged 20–64 years, females had higher rates of undiagnosed diabetes than males; but in NHIS, females had higher rates than males only in the age group 20–44 years. For black persons aged 20–54 years there was no sex difference in undiagnosed diabetes in NHANES II, whereas there was a difference in the prevalence of diagnosed diabetes in this group in NHIS.

From table 2 it can be seen that 3.2 percent of the U.S. population aged 20–74 years could be considered to have met the NDDG criteria for diabetes but had not yet been diagnosed as diabetic. From table 3 it can be seen that 3.4 percent could be considered to have met WHO criteria for diabetes. These rates of undiagnosed diabetes were similar to the rate of diagnosed diabetes ascertained in NHIS (3.0 percent) and indicate that diabetes may be twice as prevalent in the United States as the rates found by medical history surveys such as NHIS. Comparison of NHANES II estimates of known and unknown

diabetes with NHIS estimates of known diabetes shows that this ratio held across age and race groups.

Prevalence of impaired glucose tolerance

Table 6 presents estimates of impaired glucose tolerance (IGT) using NDDG and WHO criteria, and table 7 presents estimates for white persons by more detailed age groups. Estimates of IGT using WHO criteria were higher than those using NDDG criteria, often more than twice as high. For all persons, the prevalence of IGT was estimated at 4.6 percent using NDDG criteria, and at 11.2 percent using WHO criteria.

The different criteria of NDDG and WHO account for this difference in prevalence of IGT. Both sets of criteria require a 2-hour plasma glucose concentration of 140–199 milligrams per deciliter for definition of IGT. However, WHO criteria define IGT solely on the basis of this 2-hour value, while NDDG requires both the 2- and 1-hour values of 200 milligrams per deciliter or more; if the 1-hour value is less than 200 milligrams per deciliter, NDDG designates the OGTT as “nondiagnostic,” rather than as IGT. Table D shows that nearly twice as many persons were classified as IGT by WHO criteria as by NDDG criteria.

Despite the difference in magnitude, the effects of age and race generally were similar using either NDDG or WHO criteria. IGT increased with age for white persons but not for black persons (although these data for black persons, like those in tables 2 and 3, must be interpreted with caution). Using NDDG criteria, the prevalence of IGT in white persons rose from 2.0 percent in the youngest age group to 9.5 percent in the oldest; using WHO criteria the increase was from 5.6 to 23.0 percent. A greater proportion of white females than white males had IGT in the age group 20–44 years: For white males in this age group, 1.0 and 4.6 percent had IGT using NDDG and WHO criteria, respectively, compared with 2.8 and 6.5 percent for white females. In the age group 55–64 years, white female rates were lower (5.5 percent) than white male rates (10.1 percent) under the NDDG definition; the difference using WHO criteria was not statistically significant.

Total prevalence of glucose intolerance in the United States

Table 8 and figure 1 present estimates from NHIS and NHANES II of the total prevalence of glucose intolerance in the United States (sum of rates of diagnosed diabetes from the 1976 NHIS and undiagnosed diabetes and IGT using NDDG criteria from NHANES II). The method of calculating standard errors of estimates in this table is presented in appendix I. These estimates show that glucose intolerance affected about 11 percent of the total population aged 20–74 years and as many as 26 percent of persons aged 65–74 years. These high rates have not been reported in white populations, although they have been found in some American Indian tribes,²¹ Pacific Island populations,²² and Mexican Americans.²³

Interestingly, the black-white differences were not significant when total glucose intolerance was considered. The only statistically significant sex difference was for white persons aged 20–44 years where the prevalence of glucose intolerance

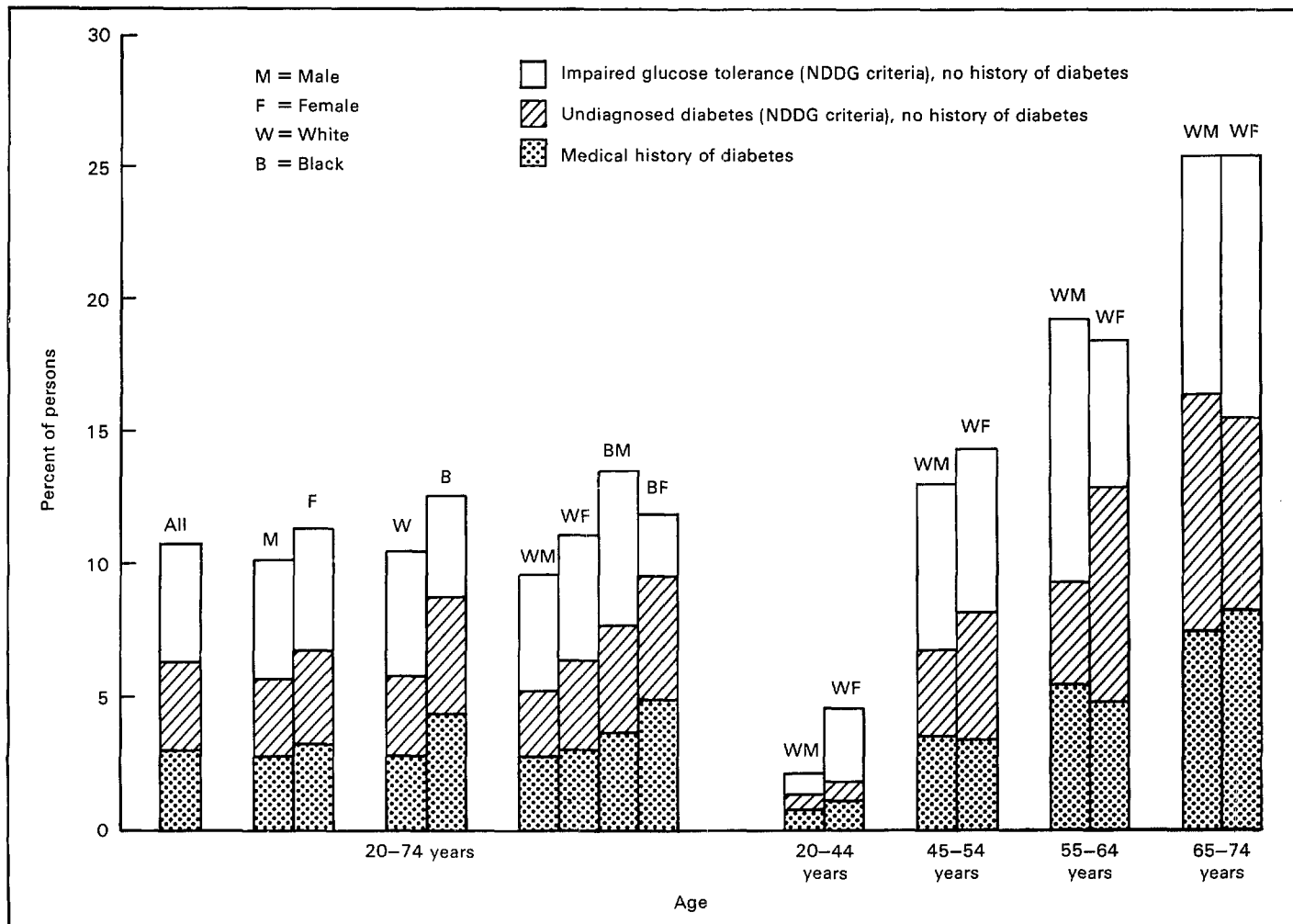


Figure 1. Percent of adults aged 20-74 years with medical history of diabetes (NHIS, 1976) and percent with no medical history of diabetes who had undiagnosed diabetes or impaired glucose tolerance using National Diabetes Data Group (NDDG) criteria (NHANES II, 1976-80), by race, sex, and age: United States

was higher for females (4.6 percent) than for males (2.2 percent). In general, the race and sex differences in previously diagnosed and unknown diabetes and IGT were in opposite directions and canceled out when added together in table 8. Diagnosed diabetes constituted about 30 percent of total glucose intolerance, undiagnosed diabetes contributed about 30 percent, and IGT accounted for about 40 percent, using NDDG criteria. For black females, however, IGT constituted only 19 percent. When WHO criteria were used, the percent of total glucose intolerance accounted for by IGT did not differ by race or sex.

Mean plasma glucose levels and percentile distributions in U.S. adults

Tables 9-11 show the mean (and standard deviation and standard error) of fasting, 1-hour, and 2-hour plasma glucose concentrations for adults aged 20-74 estimated from the NHANES II population who did not report a physician-diagnosed medical history of diabetes. More detailed age data for white persons are shown in table 12.

The mean fasting plasma glucose value showed only a slight upward trend with age; it rose from 89.5 milligrams per deciliter

at ages 20-44 years to 98.1 milligrams per deciliter at ages 65-74 years (table 9). In contrast, the mean 1- and 2-hour plasma glucose values showed a large increase with age, from 130.1 to 171.0 milligrams per deciliter (table 10) and from 100.0 to 133.4 milligrams per deciliter (table 11), respectively.

Race differences for mean glucose values were not statistically significant for any of the three venipunctures (tables 9-11).

Males had higher 1-hour plasma glucose concentrations than females; the differences averaged about 13 milligrams per deciliter (table 10). There were other differences between the sexes in certain groups, but they were so small as to be of little importance. Males had higher concentrations of glucose in the fasting venipuncture than females aged 20-44 years (92.2 versus 87.2 milligrams per deciliter) and in white persons aged 65-74 years (99.7 versus 96.8 milligrams per deciliter). At age 20-44 years, females had higher (102.4 milligrams per deciliter) concentrations of glucose than males (97.4 milligrams per deciliter) 2 hours after challenge.

Tables 9-11 also show the percentile distributions of plasma glucose levels by race and sex in the NHANES II population who reported no medical history of diabetes. The distributions by age are plotted in figure 2. There was an upward trend with

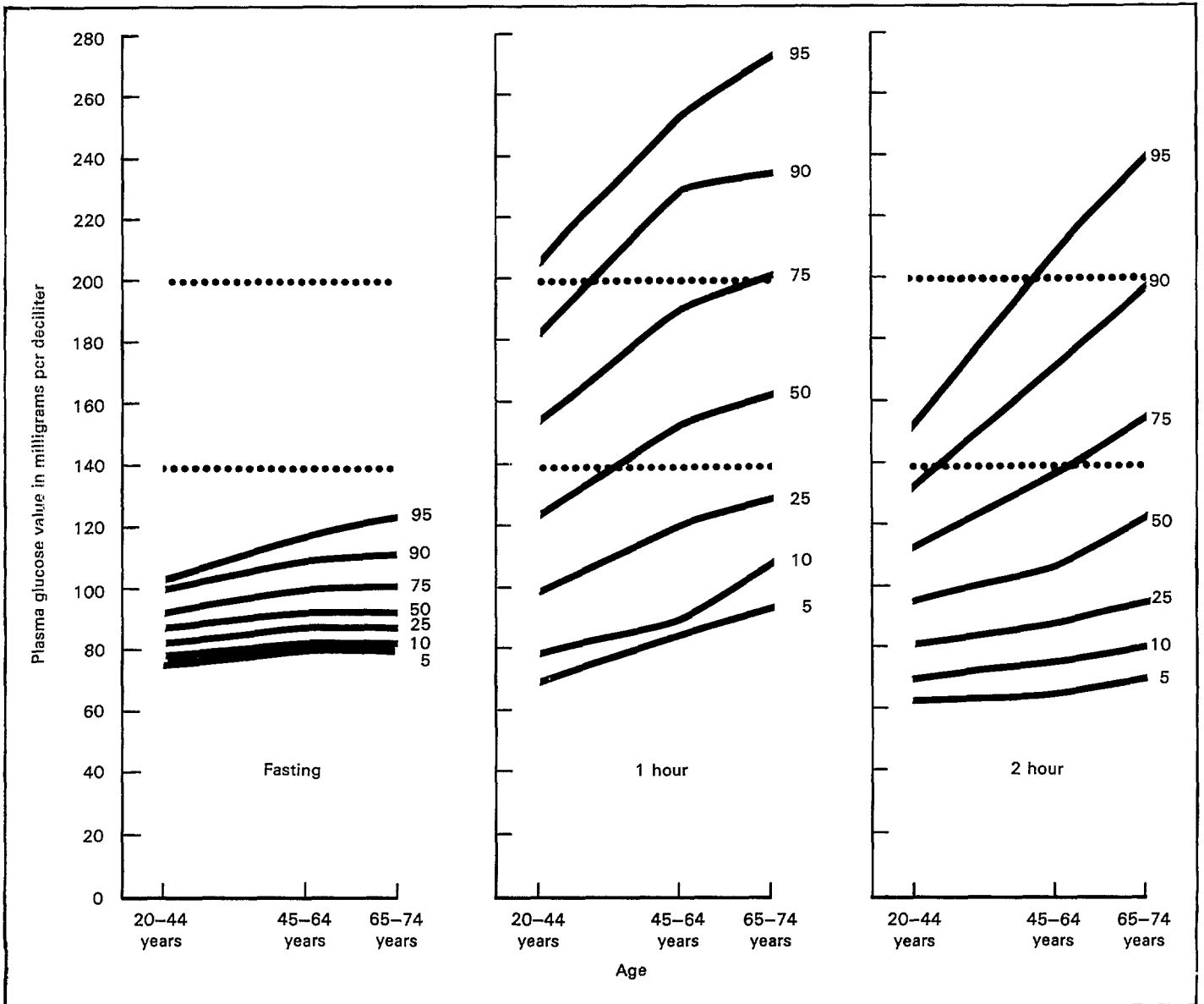


Figure 2. Selected percentile distributions of fasting, 1-hour, and 2-hour plasma glucose values of the oral glucose tolerance test, by age: United States, 1976-80

age in each percentile value for both post-glucose challenge values. There were no differences by race and only small differences by sex within age groups.

A decline of glucose tolerance with age has been shown in a number of community-based studies. In addition, data from NHANES II provide evidence that this occurs in the general U.S. population, as shown by the increases in the means and the percentile values with age. However, whether this phenomenon is a normal physiological process related to aging or is, in fact, a pathological process related to the increasing prevalence of diabetes is still the subject of debate.

Frequency distribution of plasma glucose values

Figure 3 illustrates the frequency distributions of the fasting, 1-hour, and 2-hour plasma glucose values on a base 10 log-

arithmic scale for NHANES II sample persons with no medical history of diabetes. Relatively symmetric unimodal distributions can be observed. The frequency distributions of glucose tolerance values in most populations have been reported to be unimodal with skewing toward higher values, especially in older age groups.²⁴ Bimodal distributions that conform to a model of overlapping Gaussian distributions have been shown in several populations with high prevalence of diabetes when data from all persons, diabetics and nondiabetics, are considered together,²¹⁻²³ with persons with normal levels constituting the lower glucose component and diabetics constituting the higher component. In these bimodal populations, the major contribution to the age-related rise of plasma glucose appears to be due to the increasing prevalence of diabetes with age. The exclusion of glucose values of persons with a medical history of diabetes from figure 3 may be the reason for unimodality and the lack of skewness.

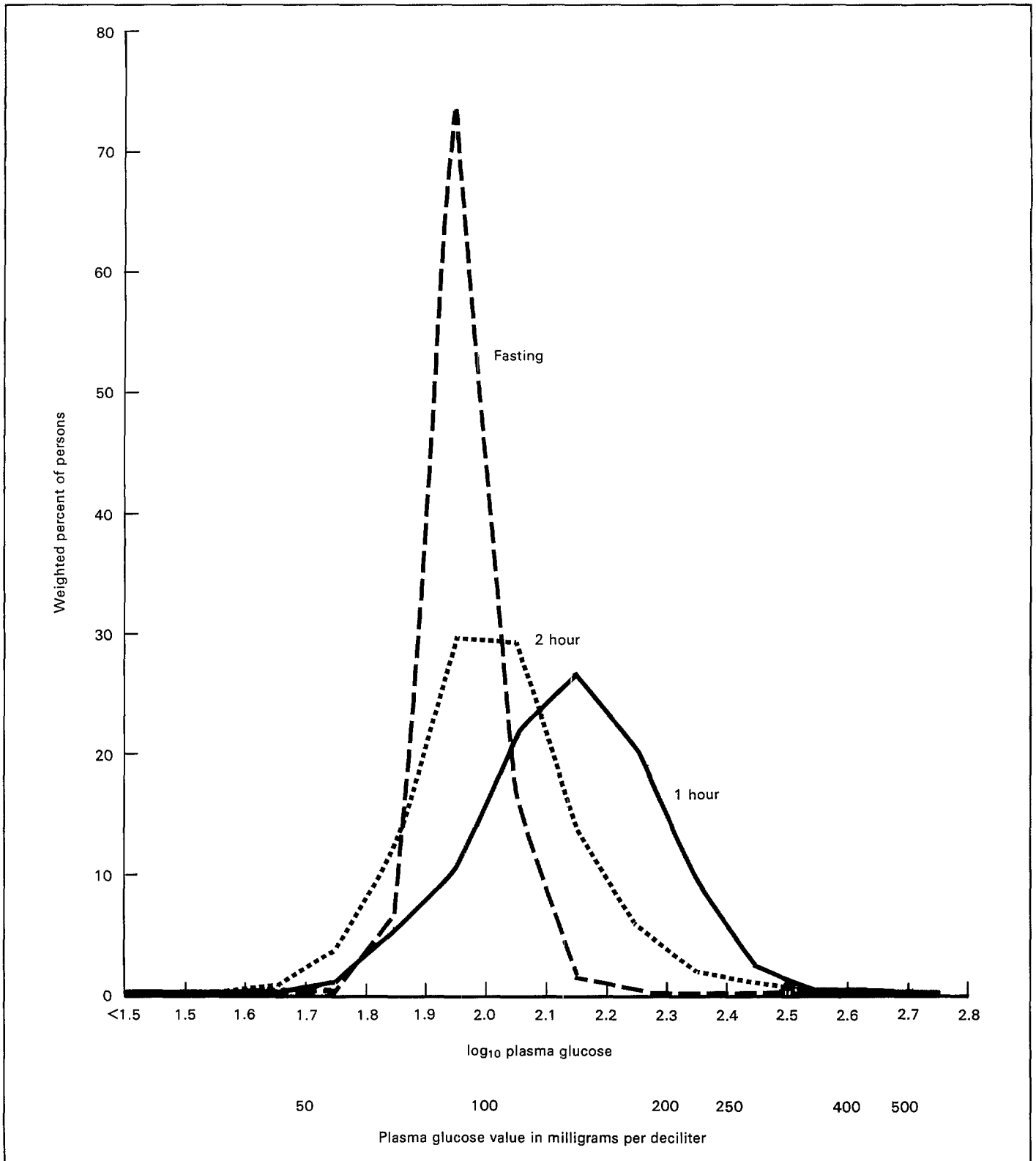


Figure 3. Frequency distributions of fasting, 1-hour, and 2-hour plasma glucose values of the oral glucose tolerance test for adults aged 20-74 years with no medical history of diabetes: United States, 1976-80

Use of the fasting plasma glucose value as a screen for undiagnosed diabetes

In many circumstances, such as community screening for diabetes, it may be impossible or impractical to conduct a full

2-hour OGTT. In these cases the fasting plasma glucose (FPG) might be used as a proxy for the OGTT if it were sufficiently sensitive in predicting diabetes. Table 13 presents the percent of persons in certain FPG groups who would be considered diabetic according to NDDG and WHO criteria. These data

are illustrated in figure 4, which shows that below an FPG value of 110 milligrams per deciliter, only a small percent of persons were diabetic. Above this value, the percent who were diabetic at each FPG value steadily rose, up to the value of 140 milligrams per deciliter, the level that both NDDG and WHO consider to be diagnostic of diabetes. No clear break in the curve is seen; although the "yield" of diabetics rose with FPG, there was still a large proportion of persons in each FPG group, even at the highest FPG value (135–139 milligrams per deciliter), who were not shown by the OGTT to be diabetic. Hence, using FPG as a screen for diabetes has a high false-positive rate if a cutoff below 140 milligrams per deciliter is chosen.

This situation is explored further in table F in which the cumulative percents of all persons with undiagnosed diabetes (according to either elevated FPG or abnormal OGTT) are displayed by FPG values. About half of the undiagnosed diabetics had FPG values less than 120 milligrams per deciliter, which is 20 milligrams per deciliter below the NDDG and WHO fasting criterion for diabetes (140 milligrams per deciliter or greater). Based on this criterion, only about 26–28 percent were diabetic. The remaining 72–74 percent were diabetic based on their abnormal OGTT results. Thus the conclusion is that FPG lacks sensitivity in detecting undiagnosed diabetics.

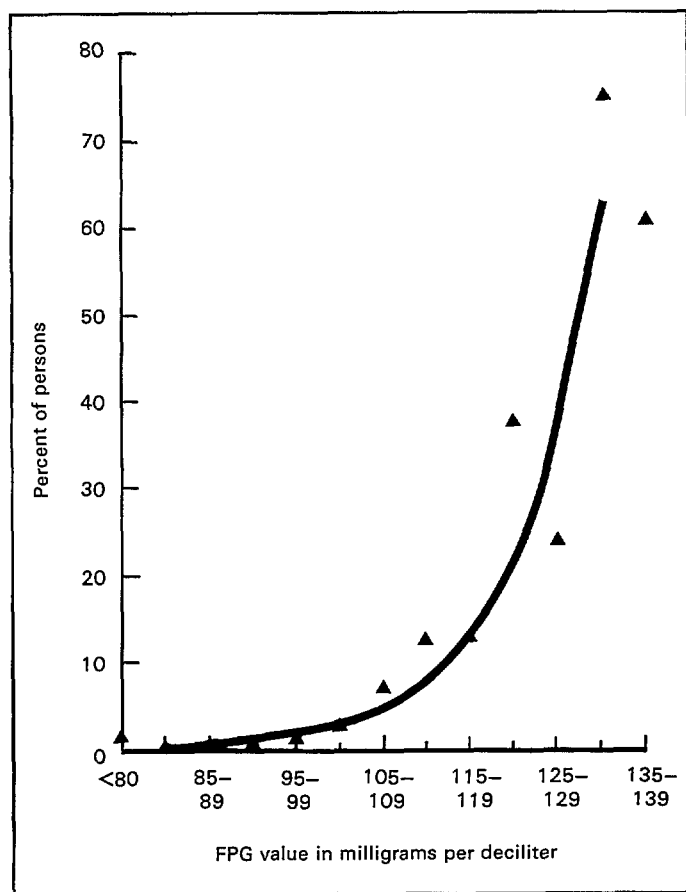


Figure 4. Percent of persons in specific fasting plasma glucose (FPG) groups who are undiagnosed diabetics: United States, 1976–80

Table F. Cumulative percent distribution of adults aged 20–74 years with undiagnosed diabetes, by fasting plasma glucose level according to criteria of the National Diabetes Data Group and of the World Health Organization: United States, 1976–80

Fasting plasma glucose level ¹	National Diabetes Data Group criteria	World Health Organization criteria
	Cumulative percent distribution	
Total	100.0	100.0
80 mg/dl or more	97.1	97.3
85 mg/dl or more	95.5	95.8
90 mg/dl or more	93.3	93.2
95 mg/dl or more	89.8	89.0
100 mg/dl or more	82.7	80.5
105 mg/dl or more	76.2	72.6
110 mg/dl or more	65.3	62.3
115 mg/dl or more	57.3	54.7
120 mg/dl or more	52.6	50.2
125 mg/dl or more	44.2	42.3
130 mg/dl or more	39.9	38.3
135 mg/dl or more	35.1	33.7
140 mg/dl or more	27.9	26.4
180 mg/dl or more	11.7	11.1
200 mg/dl or more	10.2	9.7

¹mg/dl = milligrams per deciliter.

NOTE: See text for criteria defining diabetes.

Association of diabetes and IGT with medical history of borderline diabetes

Borderline diabetes is a term that NDDG recommended be abandoned.⁷ It has been applied in the past by physicians to patients who had some impairment of glucose tolerance that might classify the person as being between normal and clearly diabetic. In table 14, borderline diabetes is related to the glucose tolerance status of the NHANES II population. The percent of persons with a history of borderline diabetes increased as the severity of glucose intolerance increased from normal, to diabetes with no medical history, to diabetes with a medical history (and presumably longer duration of hyperglycemia than diabetes with no medical history). The percent of persons with IGT who had a history of borderline diabetes was between, but not statistically different from, the percent with undiagnosed diabetes and the percent with normal glucose tolerance. These findings are consistent with previous studies showing that diabetes tends to arise more frequently among persons who already have some impairment of glucose tolerance.^{21,25}

Association of diabetes and IGT with medical history of potential diabetes and with parental history of diabetes

Numerous studies, most notably a study of concordance for diabetes in identical twins,²⁶ have strongly implicated genetic factors in the etiology of diabetes. In the past, genetic or other factors in a person's medical history, including a family history of diabetes, that placed a person at a higher risk of developing diabetes may have resulted in a diagnosis of potential diabetes, a term no longer recommended for use.

Table 14 presents the prevalence of two genetic indicators—previous diagnosis of potential diabetes and parental history of

diabetes—in the NHANES II population divided into diabetes status groups. The rates for a previous diagnosis of potential diabetes were equal among persons with normal glucose tolerance, IGT, and undiagnosed diabetes, but higher among persons with a medical history of diabetes. Persons with a medical history of diabetes or IGT were more likely to report a parental history of diabetes than persons with normal glucose tolerance, and the difference between undiagnosed diabetics and those with normal glucose tolerance approached statistical significance ($p = 0.11$). The percent of persons with undiagnosed diabetes who reported a parental history of diabetes was not statistically significantly different from the percent reported by either diagnosed diabetics or persons with IGT. These findings support the importance of genetics in the etiology of diabetes, although it is likely that the lower rate of parental diabetes in persons with normal glucose tolerance was partly due to their being significantly younger and their parents not having developed diabetes yet.

Association of diabetes and overweight

To assess obesity, body mass index (BMI)²⁷ was calculated, which is weight (in kilograms) divided by height (in meters) squared. This ratio was then converted to percent desirable weight (PDW). Of the overweight indexes that utilize height and weight, BMI has the highest correlation with independent measures of obesity, such as skinfolds or body density.²⁷ Other analysts have found that an index of weight divided by height to the 1.5 power has a lower correlation with height for females, which indicates that it may be preferable to BMI.²⁸ However, height squared has been used in this report to be consistent with other studies on diabetes. Although BMI adjusts weight for differences in height, the interpretation of specific BMI values differs by sex. For example, 120 percent of PDW calcu-

lated from the Metropolitan Life Insurance medium-frame tables as adapted by an international expert committee²⁹ corresponds to a BMI of 27 for males but only 25 for females. To compare overweight-related sex differences, BMI was converted to PDW by multiplying BMI by 4.76 for females and 4.39 for males. These multipliers were obtained from the international committee's table of recommended weight in relation to height.²⁹ Percent desirable weight also has a moderate nonlinear relationship with age.²⁸

Table 14 shows the percent of persons in each diagnostic group who were 20 percent or more over ideal body weight, which is equivalent to 120 percent of PDW. Over half of diagnosed diabetics were overweight by this criterion. Over half of persons with undiagnosed diabetes and IGT were also overweight, whereas only one-third of persons with normal glucose tolerance were 20 percent or more over ideal body weight. Obesity has repeatedly been linked with NIDDM and with insulin resistance leading to high blood glucose levels;^{30,31} and, anecdotally, about 80 percent of diagnosed diabetics are thought to be overweight. However, weight loss is a treatment for diabetes, and it is possible that the rate of only 55.6 percent was due to diabetics maintaining more normal weight levels than expected. Another explanation could be differential mortality wherein very overweight diabetics die at a rate greater than less overweight diabetics. This hypothesis cannot be tested from the NHANES II cross-sectional data.

In table G, the relationship between diabetes and overweight is explored by race, sex, and PDW groupings. Tables 15 and 16 present these data for persons with and without a medical history of diabetes. The prevalence of diabetes rose with PDW for those with and those without a medical history of diabetes, but differences by race and sex were insignificant or inconsistent. Consequently, the only correlate of diabetes prevalence in table G was overweight. The prevalence of dia-

Table G. Prevalence of diabetes in adults aged 20–74 years, by race, sex, and percent desirable weight: United States, 1976–80

Race and sex	Percent desirable weight ¹					150 or higher
	Less than 100	100–109	110–119	120–134	135–149	
All races ²						
	Percent of population					
Both sexes	3.6	4.0	4.6	7.7	10.2	20.6
Male	4.3	4.4	5.3	6.9	8.6	13.3
Female	2.8	3.6	3.8	8.4	11.0	22.4
White						
Both sexes	3.6	3.5	4.5	7.3	10.4	19.3
Male	4.5	3.2	5.2	6.2	8.6	11.0
Female	2.8	3.7	3.6	8.4	11.5	21.3
Black ³						
Both sexes	3.7	7.0	6.6	9.7	10.1	24.5
Male	3.5	10.4	5.1	12.6	9.1	28.4
Female	4.0	3.1	7.0	8.3	10.5	24.4

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

²Includes races other than white or black.

³Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: Includes both persons reporting in medical history interview that a doctor had told them they had diabetes or sugar diabetes and persons classified diabetic on an oral glucose tolerance test using National Diabetes Data Group criteria (see text for criteria).

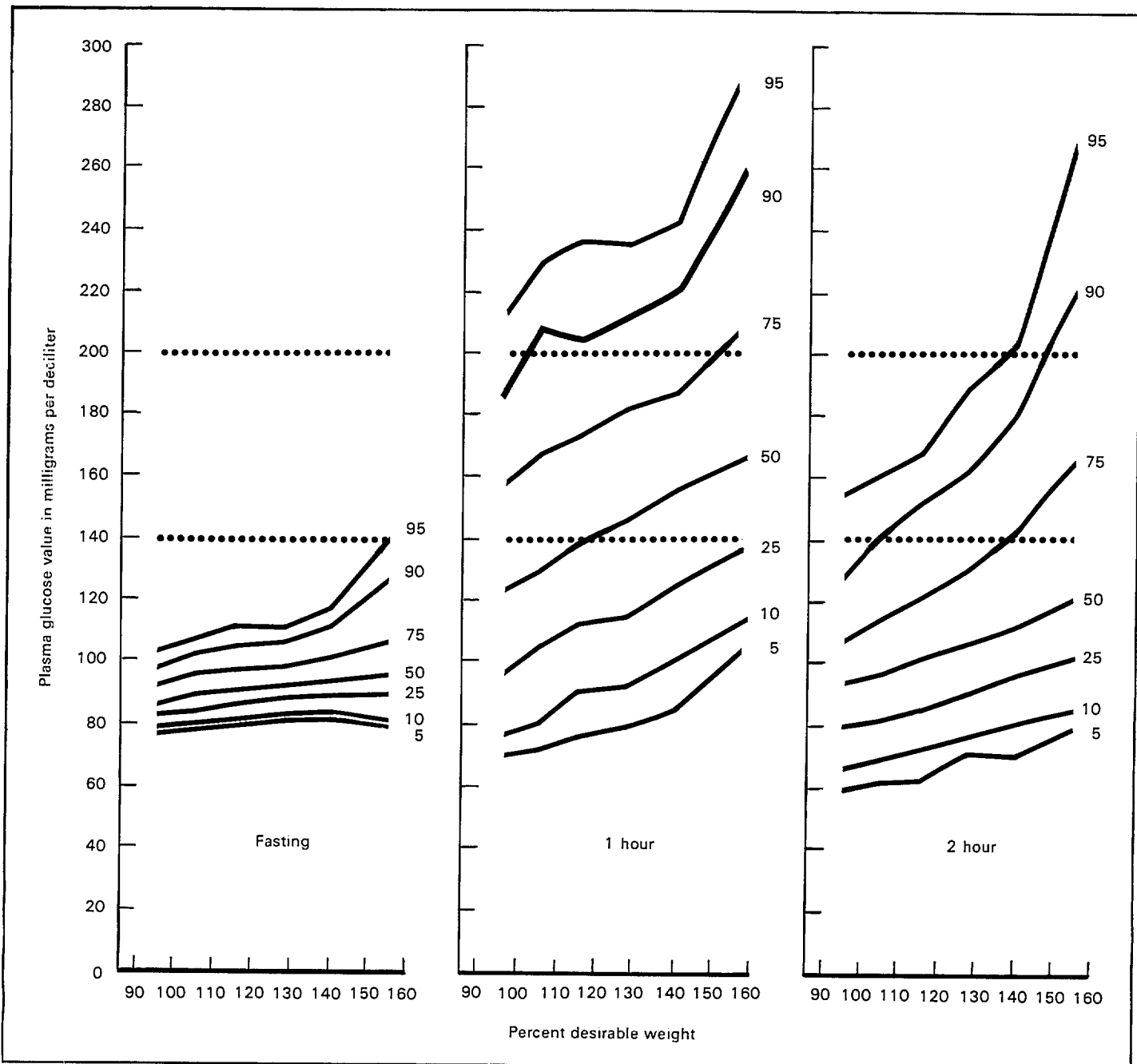


Figure 5. Selected percentile distributions of fasting, 1-hour, and 2-hour plasma glucose values of the oral glucose tolerance test, by percent desirable weight: United States, 1976-80

betes for those at least 1½ times desirable weight (20.6 percent) was 5.7 times the prevalence for those less than desirable weight (3.6 percent).

Table 17 presents, for reference purposes, the estimated percent distribution of all civilian noninstitutionalized persons in the United States aged 20-74 years by PDW class. In table 18, the relationship of the fasting and 2-hour glucose levels to PDW is presented for persons with no medical history of diabetes. The percent of persons with FPG 140 milligrams per deciliter or greater was not clearly related to PDW. The percent with FPG 115 milligrams per deciliter or greater showed an upward trend with increasing PDW value, from 2 percent in the less than desirable weight group to 15 percent in the most overweight. The percent of persons with 2-hour values of 200

milligrams per deciliter or greater or 140-199 milligrams per deciliter also showed an upward trend with increasing PDW. Because the 2-hour value of 200 milligrams per deciliter is highly correlated with the diagnosis "diabetes" and the 2-hour value of 140-199 milligrams per deciliter approximates the diagnosis "IGT," the trend in table 18 is to be expected in light of the trend seen in table G. Other investigators have also demonstrated this apparent loss of glucose tolerance with increasing overweight.^{32,33}

This phenomenon of decreasing glucose tolerance with increasing overweight is clearly illustrated in table 19 and figure 5, where a distinct rise in mean fasting, 1-hour, and 2-hour post-glucose challenge values occurred with increasing PDW. Table 20 shows that these increases occurred in each age group.

Discussion

The Second National Health and Nutrition Examination Survey (NHANES II) is the first national study to rigorously investigate the prevalence of diabetes and impaired glucose tolerance using oral glucose tolerance tests (OGTT's) and classification criteria of the National Diabetes Data Group (NDDG) and the World Health Organization (WHO). The sample was so designed that, after weighting and other statistical adjustments, it would be representative of the civilian noninstitutionalized population of the United States during 1976–80. In the execution of the study, however, there was substantial nonresponse to the household medical history interview, to the physical examination, and to the OGTT. Because of this nonresponse, it is possible that response bias affected the estimates presented in this report. Analysis of the NHANES II data suggests that such effects were not substantial, but this evidence is of necessity inconclusive. Estimates for black persons based on NHANES II data are particularly problematical. The sample size for black persons was small, and this was compounded by such low OGTT response rates that the estimates for black persons should be interpreted as preliminary or exploratory. Rates should be investigated in other studies in which the number of black sample persons is larger.

Based on the NHANES II medical history, 3.4 percent of adults aged 20–74 years had been previously diagnosed by a physician as having diabetes. This estimate is slightly larger than an estimate from the 1976 National Health Interview Survey (NHIS), 3.0 percent, probably because NHANES II relied on self-reported medical histories whereas NHIS accepted proxy respondents. (In the 1976 NHIS, estimates using self-respondent data are higher than estimates from combined self-respondents and proxy respondents.)

Based on NHANES II OGTT results, the prevalence of undiagnosed diabetes was 3.2 percent using NDDG criteria and 3.4 percent using WHO criteria in adults aged 20–74 years in 1976–80.

The NDDG and WHO criteria for classifying and diagnosing diabetes and glucose intolerance^{7,8} were based on probabilities of developing complications of diabetes (that is, retinopathy and nephropathy) assessed in population-based prospective studies. These criteria have become widely accepted internationally, and NHANES II is the first national study in which these criteria have been used. Consequently, the results of NHANES II may serve as a reference against which researchers and clinicians can compare their subjects and patients.

The prevalence of a medical history of physician-diagnosed

diabetes has been documented in many studies of U.S. communities³⁴ and in the NHIS, which has been continuous since 1958. However, it is difficult to compare the NHANES II estimates for diabetes with those of earlier studies because there was no generally accepted, standard definition of diabetes and because of differences in measurement and methodology. The NHANES II estimates of previously diagnosed diabetes are similar to an estimate from the Health Insurance Study (2.7 percent of persons aged 14–64 years) conducted in several U.S. communities in the midseventies.³⁵ They are higher than rates reported in earlier community studies reviewed in West,³⁴ but this is to be expected because the prevalence of diabetes in the United States has been increasing as documented by NHIS since 1958.²⁰

In a study in Oxford, Massachusetts, in 1946–47 the prevalence of known diabetes was found to be 0.77 percent for persons aged 14–75 years, and diabetes was discovered in 0.88 percent using both hyperglycemia and glycosuria to define diabetes. In this study if hyperglycemia had been the only criterion used, 2.7 percent would have been classified as newly discovered diabetics.³⁶ In another study in Massachusetts, the Framingham heart study, which began in 1948, the prevalence of diabetes was 1.9 percent, and approximately half of these were newly diagnosed at study examinations.³⁷ In a study in Baltimore in 1953–56, 58 percent of persons classified as diabetic were not previously aware that they had diabetes.³⁸ In Sudbury, Massachusetts, in 1964, 1.4 percent of persons over 14 years of age reported a medical history of diabetes and 1.2 percent were newly diagnosed on the basis of a diagnostic OGTT.³⁹ In Tecumseh, Michigan, in the early sixties, known diabetes was found in 2.5 percent of persons aged 20 years and over, and 5.3 percent were found to be hyperglycemic 1 hour after a 50-gram oral glucose challenge.⁴⁰ At about the same time, 1960–62, the National Health Examination Survey estimated that 1.8 percent of the U.S. population aged 18–74 years had known diabetes and, with a 50-gram glucose challenge, 1.9 percent were hyperglycemic.⁴¹ A study of adults aged 30–95 years in Rancho Bernardo (a predominantly white, upper-middle-class community in California) in 1972–74 found 4.5 percent prevalence of known diabetes and 2.9 percent unknown diabetes based on fasting plasma glucose concentrations of 140 milligrams per deciliter or more.⁴²

NHANES II was not designed to assess the prevalence of diabetes in Hispanic Americans, but three studies of Mexican Americans in Texas found that the prevalence of diabetes was higher for this group than for white Americans generally. In

Laredo in 1979, 14.5 percent of Mexican-American adults aged 45–74 years had known diabetes, and 2.4 percent were found to be diabetic with fasting plasma glucose concentrations of 140 milligrams per deciliter or more.⁴³ In samples of persons aged 25–64 years from three San Antonio neighborhoods in 1979–81, diabetes was found in 6.5 percent of white Americans and in 15.5 percent of Mexican Americans.⁴⁴ In 1981 diabetes was found in 7.9 percent of a sample of persons aged 15 years and over from the urban areas of Starr County; 6.4 percent were previously known and 1.5 percent were determined by an OGTT with NDDG criteria after preliminary screening.⁴⁵

In general, using various criteria and methods to define diabetes, these earlier studies found the prevalence of undiagnosed diabetes to be about equal to or even greater than that of known diabetes.³⁶ The NHANES II data continue to document this one-to-one ratio, even though the NDDG criteria are far stricter than earlier criteria for diagnosing diabetes. The ratio holds not only for all adults, but also for all age and race groups. For all adults the ratio of known diabetes (3.4 percent) to unknown diabetes (3.2 percent) was 1.1. For white persons the ratio was 1.1 and for black persons, 1.2. For the youngest age group, persons aged 20–44 years, it was 1.2, and for the oldest, persons aged 65–74 years, 1.1. It would appear that a large reservoir of undiagnosed diabetes still persists in the United States.

Impaired glucose tolerance (IGT) is a new diagnostic category suggested by NDDG and WHO in 1979 for the purpose of eliminating the label “diabetes” from persons formerly termed “borderline” or “chemical” diabetics. The prevalence found in NHANES II indicates that IGT is a significant category in terms of numbers of people. Using NDDG criteria, 4.6 percent of adults aged 20–74 years had IGT; using WHO criteria, 11.2 percent had it. The clinical significance of IGT has not been fully investigated. From earlier studies it appears that persons with IGT progress to overt diabetes at about four times the rate of persons with normal glucose tolerance.^{46,47} However, many persons with IGT remain in this class for years, or return to normal glucose tolerance. Although IGT does not appear to be associated with development of the microvascular complications characteristic of diabetes, it does seem to be associated with increased rates of macrovascular disease.²⁵ Major discrepancies exist between the IGT rates obtained from NDDG criteria and those from WHO criteria. Differences between criteria are still unresolved by these organizations. Most preferable would be criteria that define an impaired glucose tolerance category that is predictive of complications, but the NHANES II cross-sectional data are not ideal for this purpose. Rather, prospective studies are needed to assess the significance of IGT in populations.

References

- ¹National Commission on Diabetes: *Report to the Congress of the United States*. DHEW Pub. No. (NIH) 76-1018. Public Health Service. Washington. U.S. Government Printing Office, 1976.
- ²National Center for Health Statistics: Annual summary of births, deaths, marriages, and divorces: United States, 1983. *Monthly Vital Statistics Report*. Vol. 32, No. 13. DHHS Pub. No. (PHS) 84-1120. Public Health Service. Hyattsville, Md., Sept. 21, 1984.
- ³P. W. Eggers, R. Connerton, and M. McMullan: Medicare experience with endstage renal disease. *Health Care Financing Rev.* 5:69-88, 1984.
- ⁴G. F. Cahill, D. D. Entzweiler, and N. Freinkel. Control and diabetes. *N. Engl. J. Med.* 294:1004-1005, 1976.
- ⁵National Center for Health Statistics, A. McDowell, A. Engel, J. T. Massey, and K. Maurer: Plan and operation of the Second National Health and Nutrition Examination Survey, 1976-80. *Vital and Health Statistics*. Series 1, No. 15. DHHS Pub. No. (PHS) 81-1317. Public Health Service. Washington. U.S. Government Printing Office, July 1981.
- ⁶National Center for Health Statistics, E. R. Black: Current estimates from the Health Interview Survey, United States, 1976. *Vital and Health Statistics*. Series 10, No. 119. DHEW Pub. No. (PHS) 78-1547. Public Health Service. Washington. U.S. Government Printing Office, Nov. 1977.
- ⁷National Diabetes Data Group: Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. *Diabetes* 28:1039-1057, 1979.
- ⁸World Health Organization: Report of the Expert Committee on Diabetes Mellitus. *Technical Report Series*, No. 646. Geneva, Switzerland, 1980.
- ⁹Center for Disease Control, J. W. Neese, P. Duncan, D. Bayse, et al.: Development and evaluation of a hexokinase/glucose-6-phosphate dehydrogenase procedure for use as a national glucose reference method. U.S. DHEW Pub. No. (CDC) 77-8330. Washington. U.S. Government Printing Office, 1976.
- ¹⁰National Center for Health Statistics, M. G. Kovar and G. S. Poe: National Health Interview Survey design 1973-84, and procedures, 1975-83. *Vital and Health Statistics*. Series 1, No. 18. DHHS Pub. No. (PHS) 85-1320. Public Health Service. Washington. U.S. Government Printing Office, Aug. 1985.
- ¹¹M. I. Harris: Unpublished data from the 1976 National Health Interview Survey, National Center for Health Statistics.
- ¹²National Institutes of Health, J. F. Van Nostrand: Nursing Home Care for Diabetics, in M. I. Harris and R. F. Hamman, eds., *Diabetes in America*, DHHS Pub. No. (NIH) 85-1468. Public Health Service. Washington. U.S. Government Printing Office, Aug. 1985.
- ¹³R. N. Forthover: Investigation of nonresponse bias in NHANES II. *Am. J. Epidemiol.* 117:505-515, 1983.
- ¹⁴National Center for Health Statistics, W. G. Madow: Net differences in interview data on chronic conditions and information derived from medical records. *Vital and Health Statistics*. Series 2, No. 57. DHEW Pub. No. (HRA) 76-1331. Health Resources Administration. Washington. U.S. Government Printing Office, June 1973.
- ¹⁵M. M. Holt: *SURREGR: Standard Errors of Regression Coefficients From Sample Survey Data*. Research Triangle Institute, Research Triangle Park, N.C., 1977.
- ¹⁶B. V. Shah: *Standard Errors Program for Computing Standardized Rates From Sample Survey Data*. Research Triangle Institute, Research Triangle Park, N.C., Apr. 1981.
- ¹⁷J. E. Grizzle, C. F. Starmer, and G. G. Koch: Analysis of categorical data by linear models. *Biometrics* 25:489-505, 1969.
- ¹⁸J. R. Landis, W. M. Stanish, J. L. Freeman, and G. G. Koch: A computer program for the generalized chi square analyses of categorical data using weighted least squares (GENCAT). *Comput. Programs in Biomed.* 6:196-231, 1976.
- ¹⁹L. J. Melton, P. J. Palumbo, and M. S. Chu-Pin Chu: Incidence of diabetes by clinical type. *Diabetes Care* 6:75-86, 1983.
- ²⁰National Center for Health Statistics, Division of Analysis and Epidemiology. Unpublished data from the National Health Interview Survey.
- ²¹P. H. Bennett, N. B. Rushforth, M. Miller, and P. M. LeCompte: Epidemiologic studies of diabetes in the Pima Indians. *Recent Progress in Hormone Research* 32:333-376, 1976.
- ²²P. Zimmet and S. Whitehouse: Bimodality of fasting and two-hour glucose tolerance distributions in a Micronesian population. *Diabetes* 27:793-800, 1978.
- ²³M. Rosenthal, C. A. McMahan, M. P. Stern, et al.: Evidence of bimodality of two hour plasma glucose concentrations in Mexican Americans: Results from the San Antonio Heart Study. *J. Chron. Dis.* 38:5-16, 1985.
- ²⁴N. S. Hayner, M. O. Kjelsberg, F. H. Epstein, and T. Francis: Carbohydrate tolerance and diabetes in a total community, Tecumseh, Michigan. *Diabetes* 14:413-423, 1965.
- ²⁵R. J. Jarrett, P. McCartney, and H. Keen: The Bedford survey, ten-year mortality rates in newly diagnosed diabetics, borderline diabetics, and normoglycemic controls and risk indices for coronary heart disease in borderline diabetics. *Diabetologia* 22:79-84, 1982.
- ²⁶A. H. Barnett, C. Eff, R. D. G. Leslie, and D. A. Pyke: Diabetes in identical twins. *Diabetologia* 20:87-93, 1981.
- ²⁷A. Keys, F. Fidanza, M. J. Karvonen, et al.: Indices of relative weight and obesity. *J. Chronic Dis.* 25:329-343, 1972.
- ²⁸National Center for Health Statistics, S. Abraham, M. D. Carroll, M. F. Najjar, and R. Fulwood: Obese and overweight adults in the United States. *Vital and Health Statistics*. Series 11, No. 230. DHHS

- Pub. No. (PHS) 83-1680. Public Health Service. Washington. U.S. Government Printing Office, Feb. 1983.
- ²⁹National Institutes of Health, G. A. Bray, G. F. Cahill, E. S. Horton, et al.: Recommendations of the Fogarty International Center Conference on Obesity, in G. A. Bray, ed., *Obesity in Perspective*, Vol. 2, Part 1. DHEW Pub. No. (NIH) 75-708. Public Health Service. Washington. U.S. Government Printing Office, 1975.
- ³⁰J. M. Olefsky and O. G. Kolterman: Mechanisms of insulin resistance in obesity and noninsulin-dependent diabetes. *Am. J. Med.* 70(1):151-168, 1981.
- ³¹P. J. Savage, P. H. Bennett, P. Gordon, and M. Miller: Insulin responses to oral carbohydrate in true prediabetics and matched controls. *Lancet* 1(7902):300-302, 1975.
- ³²J. V. Santiago, M. W. Haymond, W. L. Clarke, and A. S. Pagliara: Glucagon, insulin, and glucose responses to physiologic testing in normal and massively obese adults. *Metabolism* 26:1115-1122, 1977.
- ³³W. C. Knowler, D. J. Pettitt, P. J. Savage, and P. H. Bennett: Diabetes incidence in Pima Indians: Contributions of obesity and parental diabetes. *Am. J. Epidemiol.* 113:144-156, 1981.
- ³⁴K. M. West: *The Epidemiology of Diabetes and Its Vascular Lesions*. New York. Elsevier, 1978. p. 127-146.
- ³⁵R. H. Brook, K. N. Lohr, D. M. Berman, et al.: *Conceptualization and Measurement of Physiologic Health for Adults*, Vol. 7, Diabetes mellitus. Report R-2262/7-HHS. Santa Monica, Calif. Rand Corporation, Jan. 1981.
- ³⁶J. B. O'Sullivan, H. L. C. Wilkerson, and L. P. L. Krall: Prevalence of diabetes mellitus in Oxford and related epidemiologic problems. *Am. J. Pub. Health* 56:742-754, 1966.
- ³⁷T. R. Dawber: *Framingham Study*. Cambridge, Mass. Harvard University Press, 1980, p. 192-193.
- ³⁸Commission on Chronic Illness: *Chronic Illness in a Large City: The Baltimore Study. Chronic Illness in the United States*, Vol. 4. Cambridge, Mass. Harvard University Press, 1957.
- ³⁹J. B. O'Sullivan, R. F. Williams, and G. W. McDonald: The prevalence of diabetes mellitus and related variables. *J. Chron. Dis.* 20:535-543, 1967.
- ⁴⁰W. J. Butler, L. D. Ostrander, W. J. Carman, and D. E. Lamphiear: Diabetes mellitus in Tecumseh, Michigan: Prevalence, incidence, and associated conditions. *Am. J. Epidemiol.* 116(6):971-980, 1982.
- ⁴¹National Center for Health Statistics, T. Gordon: Glucose tolerance of adults, United States, 1960-62. *Vital and Health Statistics*. Series 11, No. 2. PHS Pub. No. 1000. Public Health Service. Washington. U.S. Government Printing Office, May 1964.
- ⁴²E. Barrett-Connor: Prevalence of diabetes mellitus in an adult community as determined by history of fasting hyperglycemia. *Am. J. Epidemiol.* 111(6):705-712, 1980.
- ⁴³M. P. Stern, S. P. Gaskill, C. R. Allen, Jr., et al.: Cardiovascular risk factors in Mexican Americans in Laredo, Texas. I. Prevalence of overweight and diabetes and distributions of serum lipids. *Am. J. Epidemiol.* 113:546-555, 1981.
- ⁴⁴M. P. Stern, S. P. Gaskill, H. P. Hazuda, et al.: Does obesity explain excess prevalence of diabetes among Mexican-Americans? Results of the San Antonio Heart Study. *Diabetologia* 24:272-277, 1983.
- ⁴⁵C. L. Hanis, R. E. Ferrell, S. A. Barton, et al.: Diabetes among Mexican Americans in Starr County, Texas. *Am. J. Epidemiol.* 118(6):659-672, 1983.
- ⁴⁶A. L. Rosenbloom, S. S. Hunt, E. K. Rosenbloom, and N. K. MacLaren: Ten-year prognosis of impaired glucose tolerance in siblings of patients with insulin-dependent diabetes. *Diabetes* 31:385-387, 1982.
- ⁴⁷J. B. O'Sullivan and C. M. Mahan: Prospective study of 352 young patients with chemical diabetes. *N. Engl. J. Med.* 278:1038, 1968.
- ⁴⁸R. Goodman and L. Kish: Controlled selection—a technique in probability sampling. *J. Am. Stat. Assn.* 45(251):350-373, 1950.
- ⁴⁹U.S. Department of Health, Education, and Welfare: *A Comparison and Analysis of Examined and Nonexamined Persons on Medical History Characteristics for the First Round of the Health and Nutrition Examination Survey*. Contract No. HSM-110-73-371. Rockville, Md. Westat, Inc. Jan. 24, 1974.
- ⁵⁰Health Services and Mental Health Administration: *The HANES Study*. Final report prepared by Institute for Survey Research, Temple University. Philadelphia, Pa. Apr. 1975.
- ⁵¹National Center for Health Statistics, H. W. Miller and P. Williams: Factors related to response in a health examination survey, United States, 1960-62. *Vital and Health Statistics*. Series 2, No. 36. PHS Pub. No. 1000. Public Health Service. Washington. U.S. Government Printing Office, Aug. 1969.
- ⁵²National Center for Health Statistics, W. L. Schaible: Memorandum to Arthur J. McDowell, Division of Health Examination Statistics. June 21, 1974.
- ⁵³National Bureau of Standards, R. Schaffer, J. Mandel, T. Sun, et al.: Evaluation by an ID/MS method of the AACC reference method for serum glucose. *NBS Special Publication* 260-280. U.S. Department of Commerce. Washington. Oct. 1982.
- ⁵⁴Centers for Disease Control, E. W. Gunter, W. E. Turner, J. W. Neese, and D. D. Bayse: Laboratory procedure used by the Clinical Chemistry Division, Centers for Disease Control, for the Second Health and Nutrition Examination Survey (HANES II), 1976-1980, Revised Edition. DHHS. Atlanta. 1985.

List of detailed tables

1. Percent of persons, standard error of percent, and number of interviewed persons aged 20–74 years reporting in a medical history interview of the Second National Health and Nutrition Examination Survey that a doctor had told them they had diabetes or sugar diabetes, by race, sex, and age: United States, 1976–80	25	glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by race, sex, and age: United States, 1976–80	34
2. Percent of persons, standard error of percent, and number of examined persons aged 20–74 years classified undiagnosed diabetic by oral glucose tolerance test (OGTT) using National Diabetes Data Group criteria, by race, sex, and age: United States, 1976–80	26	12. Mean plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of white adults aged 20–74 years with no medical history of diabetes, by fasting, 1-hour, and 2-hour venipunctures, sex, and age: United States, 1976–80	35
3. Percent of persons, standard error of percent, and number of examined persons aged 20–74 years classified undiagnosed diabetic by oral glucose tolerance test (OGTT) using World Health Organization criteria, by race, sex, and age: United States, 1976–80	27	13. Percent of adults aged 20–74 years with no medical history of diabetes, by level of fasting plasma glucose, who would be classified as having diabetes or impaired glucose tolerance, by criteria of the National Diabetes Data Group and of the World Health Organization: United States, 1976–80	37
4. Percent and standard error of percent of white adults aged 20–74 years with diabetes, by previous diabetes status, sex, and age: United States, 1976–80	28	14. Percent, standard error of percent, and median age of adults aged 20–74 years with medical history of borderline diabetes, potential diabetes, a parent with diabetes, or 120 percent or more of desirable weight, by diabetes status: United States, 1976–80	37
5. Percent and standard error of percent of adults aged 20–74 years with medical history of diabetes as reported in the National Health Interview Survey, by race, sex, and age: United States, 1976	29	15. Percent and standard error of percent of adults aged 20–74 years reporting in a medical history interview that a doctor had told them they had diabetes or sugar diabetes, by race, sex, and percent desirable weight: United States, 1976–80	38
6. Percent and standard error of percent of adults aged 20–74 years with impaired glucose tolerance, by criteria of the National Diabetes Data Group and of the World Health Organization, race, sex, and age: United States, 1976–80	30	16. Percent and standard error of percent of adults aged 20–74 years classified undiagnosed diabetic by oral glucose tolerance test using National Diabetes Data Group criteria, by race, sex, and percent desirable weight: United States, 1976–80	38
7. Percent and standard error of percent of white adults aged 20–74 years with impaired glucose tolerance, by criteria of the National Diabetes Data Group and of the World Health Organization, sex, and age: United States, 1976–80	31	17. Percent distribution of adults aged 20–74 years by percent desirable weight, according to race and sex: United States, 1976–80	39
8. Percent and standard error of percent of adults aged 20–74 years with diabetes or impaired glucose tolerance, using National Diabetes Data Group criteria, by race, sex, and age: United States, 1976–80	31	18. Percent and standard error of percent of adults aged 20–74 years with no medical history of diabetes and with abnormal fasting or 2-hour plasma glucose concentrations, by venipuncture, sex, and percent desirable weight: United States, 1976–80	39
9. Mean fasting plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by race, sex, and age: United States, 1976–80	32	19. Mean plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by venipuncture and percent desirable weight: United States, 1976–80	40
10. Mean 1-hour plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by race, sex, and age: United States, 1976–80	33	20. Mean fasting and 2-hour plasma glucose concentrations of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by percent desirable weight and age: United States, 1976–80	40
11. Mean 2-hour plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral			

Table 1. Percent of persons, standard error of percent, and number of interviewed persons aged 20–74 years reporting in a medical history interview of the Second National Health and Nutrition Examination Survey that a doctor had told them they had diabetes or sugar diabetes, by race, sex, and age: United States, 1976–80

Race and sex	Total,	Age				Total,	Age				Total,	Age			
	20–74 years	20–44 years	45–54 years	55–64 years	65–74 years	20–74 years	20–44 years	45–54 years	55–64 years	65–74 years	20–74 years	20–44 years	45–54 years	55–64 years	65–74 years
All races¹															
	Percent of population					Standard error of percent					Number of interviewed persons				
Both sexes	3.4	1.1	4.3	6.6	9.3	0.14	0.11	0.53	0.66	0.45	15,357	6,531	1,866	3,328	3,632
Male	2.9	0.6	4.3	5.6	9.7	0.25	0.12	0.82	0.64	0.71	7,074	3,064	892	1,525	1,593
Female	3.8	1.5	4.3	7.4	8.9	0.24	0.22	0.67	1.10	0.56	8,283	3,467	974	1,803	2,039
White															
Both sexes	3.2	1.0	4.2	6.0	8.9	0.16	0.12	0.55	0.58	0.49	13,311	5,587	1,613	2,925	3,186
Male	2.8	0.5	4.5	5.3	9.1	0.27	0.15	0.92	0.66	0.78	6,167	2,635	787	1,347	1,398
Female	3.6	1.4	3.9	6.6	8.8	0.23	0.22	0.60	0.91	0.64	7,144	2,952	826	1,578	1,788
Black²															
Both sexes	5.2	2.2	5.7	13.1	13.6	0.49	0.58	1.46	2.65	1.35	1,762	795	212	364	391
Male	4.5	*1.8	*3.6	9.2	17.2	0.60	0.63	*1.48	2.55	2.87	765	354	87	163	161
Female	5.9	*2.6	*7.5	16.3	10.8	0.99	1.00	*2.33	*4.03	1.51	997	441	125	201	230

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

Table 2. Percent of persons, standard error of percent, and number of examined persons aged 20–74 years classified undiagnosed diabetic by oral glucose tolerance test (OGTT) using National Diabetes Data Group criteria, by race, sex, and age: United States, 1976–80

Race and sex	Total,	Age					Total,	Age					Total,	Age				
	20–74 years	20–44 years	45–54 years	55–64 years	65–74 years	20–74 years	20–44 years	45–54 years	55–64 years	65–74 years	20–74 years	20–44 years	45–54 years	55–64 years	65–74 years			
All races¹																		
	Percent of population					Standard error of percent					Number of examined persons							
Both sexes	3.2	*0.9	4.2	6.2	8.4	0.35	0.31	0.81	1.03	0.85	4,044	1,636	524	928	956			
Male	2.8	*0.8	*3.6	4.0	9.5	0.41	0.39	1.28	1.03	1.42	1,889	747	232	464	446			
Female	3.6	*1.0	4.7	8.1	7.6	0.42	0.38	1.14	1.68	0.89	2,155	889	292	464	510			
White																		
Both sexes	3.0	*0.7	4.0	5.9	8.0	0.38	0.31	0.90	1.24	0.85	3,570	1,429	465	827	849			
Male	2.5	*0.5	*3.2	3.8	9.0	0.36	0.27	1.25	1.00	1.38	1,678	652	214	418	394			
Female	3.4	*0.8	4.6	7.9	7.3	0.52	0.40	1.25	2.08	0.95	1,892	777	251	409	455			
Black²																		
Both sexes	4.4	*0.9	*7.2	*7.7	*12.3	0.91	0.68	*	*3.75	*3.94	397	166	47	91	93			
Male	*4.0	*1.0	*7.5	*5.2	*12.2	1.72	*0.98	*	*	*	176	76	16	41	43			
Female	4.6	*0.9	*7.0	*9.1	*12.3	1.35	*0.91	*	*	*4.50	221	90	31	50	50			

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: Undiagnosed diabetes defined as meeting diagnostic criteria for diabetes without medical history of diabetes. Refer to text for National Diabetes Data Group criteria for classifying results of OGTT's.

Table 3. Percent of persons, standard error of percent, and number of examined persons aged 20–74 years classified undiagnosed diabetic by oral glucose tolerance test (OGTT) using World Health Organization criteria, by race, sex, and age: United States, 1976–80

Race and sex	Total, 20–74 years	Age				Total, 20–74 years	Age				Total, 20–74 years	Age			
		20–44 years	45–54 years	55–64 years	65–74 years		20–44 years	45–54 years	55–64 years	65–74 years		20–44 years	45–54 years	55–64 years	65–74 years
		Percent of population				Standard error of percent				Number of examined persons					
All races¹															
Both sexes	3.4	*0.9	4.2	6.8	9.4	0.35	0.35	0.81	1.11	0.89	3,991	1,607	518	922	944
Male	3.0	*0.8	*3.6	4.3	10.4	0.41	0.48	1.28	1.06	1.60	1,872	741	231	458	442
Female	3.9	*1.0	4.8	9.0	8.5	0.43	0.41	1.15	1.76	0.93	2,119	866	287	464	502
White															
Both sexes	3.2	*0.7	4.0	6.5	9.0	0.38	0.35	0.91	1.31	0.89	3,526	1,406	459	821	840
Male	2.7	*0.5	*3.3	4.1	10.0	0.36	0.42	1.25	1.03	1.57	1,664	649	213	412	390
Female	3.7	*0.8	4.8	8.6	8.2	0.53	0.42	1.26	2.14	1.09	1,862	757	246	409	450
Black²															
Both sexes	4.7	*1.0	*7.2	*9.4	*12.8	0.99	0.69	*	*4.29	*4.33	389	161	47	91	90
Male	*4.1	*1.0	*7.5	*5.4	*12.2	1.74	*1.01	*	*	*	173	73	16	41	43
Female	5.1	*0.9	*7.1	*11.6	*13.3	1.37	*0.93	*	*	*	216	88	31	50	47

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: Undiagnosed diabetes defined as meeting diagnostic criteria for diabetes without medical history of diabetes. Refer to text for World Health Organization criteria for classifying results of OGTT's.

Table 4. Percent and standard error of percent of white adults aged 20–74 years with diabetes, by previous diabetes status, sex, and age: United States, 1976–80

Previous diabetes status and sex	Total, 20–74 years	Age										
		20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	45–49 years	50–54 years	55–59 years	60–64 years	65–69 years	70–74 years
All diabetics		Percent of population										
Both sexes	6.2	0.9	1.3	1.3	1.8	3.7	7.2	9.0	10.3	13.8	16.1	18.0
Male	5.3	0.0	0.9	1.4	0.7	2.7	5.5	9.9	5.8	12.5	16.9	19.5
Female	6.9	1.7	1.7	1.2	2.8	4.5	8.8	8.2	14.1	15.1	15.4	16.9
Medical history of physician-diagnosed diabetes ¹												
Both sexes	3.2	*0.4	*1.0	*0.7	1.6	1.6	3.0	5.3	4.8	7.3	8.3	9.8
Male	2.8	0.0	*0.4	*0.4	*0.7	*1.5	*2.6	6.3	*3.2	7.5	7.5	11.2
Female	3.6	*0.7	*1.7	*0.9	2.5	*1.7	3.4	4.3	6.2	7.2	8.8	8.8
No medical history of diabetes ²												
Both sexes	3.0	*0.5	*0.3	*0.6	*0.2	*2.1	4.2	*3.8	*5.5	6.5	7.8	8.2
Male	2.5	0.0	*0.5	*1.0	0.0	*1.2	*2.8	*3.6	*2.6	5.0	9.4	8.3
Female	3.4	*1.0	0.0	*0.3	*0.4	*2.8	*5.4	*3.9	*7.9	7.9	6.6	8.1
All diabetics		Standard error of percent										
Both sexes	---	---	---	---	---	---	---	---	---	---	---	---
Male	---	---	---	---	---	---	---	---	---	---	---	---
Female	---	---	---	---	---	---	---	---	---	---	---	---
Medical history of physician-diagnosed diabetes ¹												
Both sexes	0.16	0.16	0.34	0.25	0.41	0.47	0.59	0.83	0.83	0.60	0.70	0.83
Male	0.27	...	0.22	0.31	0.44	0.63	0.87	1.59	1.03	0.88	0.99	1.49
Female	0.23	0.32	0.65	0.41	0.70	0.52	0.76	0.89	1.37	0.88	0.85	0.90
No medical history of diabetes ²												
Both sexes	0.38	0.53	0.28	0.34	0.19	1.57	1.24	1.32	2.20	1.17	1.06	1.55
Male	0.36	...	0.54	0.67	...	1.16	1.64	1.88	1.47	1.38	2.10	2.06
Female	0.52	0.94	...	0.32	0.36	2.04	1.90	2.05	3.81	1.67	1.43	1.90

¹Reported in medical history interview that a doctor had told them they had diabetes or sugar diabetes.

²Diagnosis based on oral glucose tolerance test using National Diabetes Data Group criteria in persons without medical history of diabetes.

Table 5. Percent and standard error of percent of adults aged 20–74 years with medical history of diabetes as reported in the National Health Interview Survey, by race, sex, and age: United States, 1976

Race and sex	Total, 20–74 years	Age				Total, 20–74 years	Age			
		20–44 years	45–54 years	55–64 years	65–74 years		20–44 years	45–54 years	55–64 years	65–74 years
All races ¹		Percent of population				Standard error of percent				
Both sexes.	3.0	1.0	3.8	5.5	8.3	0.08	0.05	0.18	0.22	0.32
Male.	2.7	0.8	3.7	5.7	7.9	0.11	0.07	0.27	0.30	0.47
Female.	3.2	1.2	3.9	5.4	8.7	0.11	0.08	0.24	0.29	0.44
White										
Both sexes.	2.8	0.9	3.5	5.2	7.9	0.08	0.05	0.20	0.22	0.33
Male.	2.7	0.7	3.5	5.5	7.5	0.11	0.07	0.27	0.32	0.49
Female.	3.0	1.1	3.4	4.9	8.3	0.10	0.07	0.26	0.30	0.46
Black										
Both sexes.	4.4	1.4	7.1	8.8	12.0	0.27	0.20	0.72	0.87	1.32
Male.	3.6	0.9	5.9	7.5	10.9	0.35	0.27	0.98	1.16	2.13
Female.	4.9	1.7	8.1	9.9	12.8	0.40	0.28	1.06	1.30	1.37

¹Includes races other than white or black.

Table 6. Percent and standard error of percent of adults aged 20–74 years with impaired glucose tolerance, by criteria of the National Diabetes Data Group and of the World Health Organization, race, sex, and age: United States, 1976–80

Criteria, race, and sex	Total, 20–74 years	Age				Total, 20–74 years	Age			
		20–44 years	45–54 years	55–64 years	65–74 years		20–44 years	45–54 years	55–64 years	65–74 years
NATIONAL DIABETES DATA GROUP CRITERIA										
All races ¹										
Percent of population										
Standard error of percent										
Both sexes.....	4.6	2.1	7.0	7.4	9.2	0.39	0.39	0.93	0.91	0.85
Male.....	4.6	*1.2	7.3	9.8	8.9	0.58	0.39	1.65	1.44	1.50
Female.....	4.7	2.8	6.7	5.2	9.4	0.67	0.70	1.48	1.24	1.15
White										
Both sexes.....	4.6	2.0	6.3	7.7	9.5	0.42	0.38	1.04	0.98	0.87
Male.....	4.4	*1.0	6.3	10.1	9.0	0.61	0.34	1.79	1.48	1.55
Female.....	4.7	2.8	6.2	5.5	9.9	0.68	0.73	1.15	1.43	1.20
Black ²										
Both sexes.....	3.8	*1.2	*10.7	*4.5	*3.4	0.82	0.84	*	*2.19	*2.09
Male.....	5.9	*1.4	*18.8	*7.0	*5.4	1.18	*1.30	*	*	*
Female.....	*2.3	*1.1	*5.1	*3.1	*1.9	1.24	*1.11	*	*	*2.22
WORLD HEALTH ORGANIZATION CRITERIA										
All races ¹										
Both sexes.....	11.2	6.4	14.8	15.1	22.8	0.52	0.59	1.48	1.23	1.70
Male.....	10.3	4.7	13.1	17.2	22.8	0.72	0.69	2.09	1.67	2.05
Female.....	12.0	7.8	16.3	13.4	22.7	0.97	0.98	2.52	1.89	2.59
White										
Both sexes.....	10.7	5.6	13.6	15.3	23.0	0.57	0.64	1.50	1.28	1.65
Male.....	10.2	4.6	12.6	17.2	22.8	0.76	0.72	2.25	1.79	2.04
Female.....	11.1	6.5	14.5	13.7	23.0	1.03	1.05	2.38	2.04	2.55
Black ²										
Both sexes.....	12.7	10.3	*17.0	14.4	*14.5	2.15	1.97	*	*2.24	*4.93
Male.....	11.3	*4.7	*18.8	*18.6	*22.6	2.02	*1.80	*	*	*
Female.....	13.6	14.2	*15.8	12.2	*8.2	2.70	*2.98	*	*	*

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: See text for criteria defining impaired glucose tolerance.

Table 7. Percent and standard error of percent of white adults aged 20–74 years with impaired glucose tolerance, by criteria of the National Diabetes Data Group and of the World Health Organization, sex, and age: United States, 1976–80

Criteria and sex	Total, 20–74 years	Age										
		20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	45–49 years	50–54 years	55–59 years	60–64 years	65–69 years	70–74 years
National Diabetes Data Group criteria		Percent of population										
Both sexes	4.6	*0.4	*1.7	*1.8	*2.9	*3.5	6.3	6.2	6.8	8.8	12.0	5.8
Male	4.4	*1.0	*0.4	*1.3	*0.7	*1.8	*7.8	*5.0	*8.8	11.5	9.3	8.5
Female	4.7	-	*3.1	*2.1	*4.7	*5.0	*5.0	7.4	*5.1	6.1	14.2	*3.7
World Health Organization criteria		Percent of population										
Both sexes	10.7	4.0	*3.6	5.4	7.5	8.9	13.9	13.2	14.0	16.9	22.8	23.0
Male	10.2	*5.5	*1.5	*3.7	*6.6	7.3	14.5	10.9	16.4	18.0	20.7	25.8
Female	11.1	*2.7	*6.0	6.6	8.3	*10.3	13.4	15.5	11.9	15.9	24.5	20.9
National Diabetes Data Group criteria		Standard error of percent										
Both sexes	0.42	0.30	0.82	0.67	1.04	1.07	1.87	1.10	1.72	1.06	1.28	1.05
Male	0.61	0.68	0.41	0.97	0.72	1.34	2.62	2.09	2.85	1.62	2.09	2.39
Female	0.68	...	1.66	1.06	1.71	2.38	2.53	1.45	2.34	1.60	1.78	1.24
World Health Organization criteria		Standard error of percent										
Both sexes	0.57	1.17	1.21	1.15	1.80	1.71	2.61	1.92	2.36	1.30	1.78	2.58
Male	0.76	2.26	0.92	1.53	2.89	1.91	3.36	2.85	3.56	1.89	2.88	3.21
Female	1.03	1.18	2.34	1.70	2.45	3.50	3.53	3.28	3.35	2.30	2.95	3.18

NOTE: See text for criteria defining impaired glucose tolerance.

Table 8. Percent and standard error of percent of adults aged 20–74 years with diabetes or impaired glucose tolerance, using National Diabetes Data Group criteria, by race, sex, and age: United States, 1976–80

Race and sex	Total, 20–74 years	Age					Total, 20–74 years	Age				
		20–44 years	45–54 years	55–64 years	65–74 years	20–44 years		45–54 years	55–64 years	65–74 years		
All races ¹		Percent of population					Standard error of percent					
Both sexes	10.8	4.0	15.0	19.1	25.9	0.52	0.45	1.24	1.39	1.32		
Male	10.1	2.8	14.6	19.5	26.2	0.78	0.55	2.11	1.76	2.15		
Female	11.4	5.0	15.3	18.7	25.7	0.70	0.81	2.07	1.76	1.48		
White		Percent of population					Standard error of percent					
Both sexes	10.4	3.5	13.7	18.8	25.4	0.56	0.47	1.34	1.55	1.38		
Male	9.6	2.2	13.0	19.3	25.4	0.77	0.46	2.22	1.92	2.17		
Female	11.1	4.6	14.3	18.4	25.4	0.69	0.79	1.89	2.00	1.45		
Black ²		Percent of population					Standard error of percent					
Both sexes	12.5	*3.5	25.0	21.0	27.6	1.11	1.31	*	*4.9	*4.4		
Male	13.5	*3.3	32.1	*19.7	28.5	1.81	*1.6	*	*	*		
Female	11.8	*3.8	20.3	22.1	27.0	1.48	*1.5	*	*	*5.3		

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: Sum of (a) percent of persons with medical history of diabetes estimated from the National Health Interview Survey, 1976, and (b) percent of persons with no medical history of diabetes but with diabetes or impaired glucose tolerance based on oral glucose tolerance tests according to National Diabetes Data Group criteria estimated from the Second National Health and Nutrition Examination Survey, 1976–80.

Table 9. Mean fasting plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by race, sex, and age: United States, 1976–80

Race, sex, and age	Mean	Standard deviation	Standard error	Percentile						
				5th	10th	25th	50th	75th	90th	95th
ALL RACES¹										
Both sexes										
Concentration in milligrams per deciliter										
20–44 years	89.5	10.8	0.34	77	79	84	88	94	100	104
45–64 years	96.8	19.3	0.79	81	84	89	94	101	111	119
65–74 years	98.1	19.0	0.70	82	84	89	94	102	112	125
Male										
20–44 years	92.2	9.0	0.33	80	83	87	91	97	102	106
45–64 years	97.9	16.5	0.74	83	85	90	95	103	112	117
65–74 years	99.8	20.6	0.99	83	87	91	96	103	115	129
Female										
20–44 years	87.2	11.8	0.46	75	78	82	86	92	97	102
45–64 years	95.9	21.7	1.19	80	83	87	93	99	108	120
65–74 years	96.8	17.9	0.83	81	83	88	94	101	111	121
WHITE										
Both sexes										
20–44 years	89.3	10.1	0.34	77	80	84	88	94	100	104
45–64 years	96.8	19.5	0.90	81	84	89	94	101	110	118
65–74 years	98.1	19.4	0.78	82	84	89	94	102	112	123
Male										
20–44 years	91.9	8.4	0.31	80	83	87	91	97	102	105
45–64 years	98.1	16.8	0.78	83	85	90	95	103	112	118
65–74 years	99.7	20.9	1.01	83	87	91	96	103	115	125
Female										
20–44 years	87.1	11.0	0.46	76	78	82	86	92	97	101
45–64 years	95.5	21.9	1.40	80	83	87	93	99	108	118
65–74 years	96.8	18.4	0.95	81	83	88	94	101	111	121
BLACK²										
Both sexes										
20–44 years	89.8	16.3	1.28	75	78	83	88	95	103	110
45–64 years	97.5	19.8	*1.35	81	82	89	94	102	111	130
65–74 years	97.2	16.2	*1.80	*	86	88	94	103	112	*
Male										
20–44 years	94.1	12.2	*1.34	*	80	88	92	98	106	*
45–64 years	95.7	12.8	*1.60	*	82	89	96	104	108	*
65–74 years	98.5	18.9	*	*	*	90	96	101	*	*
Female										
20–44 years	86.7	18.6	*1.87	*	76	80	84	89	97	*
45–64 years	98.7	24.1	*2.31	*	82	89	92	102	128	*
65–74 years	96.5	16.5	*3.17	*	*	88	91	105	*	*

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

Table 10. Mean 1-hour plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by race, sex, and age: United States, 1976–80

Race, sex, and age	Mean	Standard deviation	Standard error	Percentile						
				5th	10th	25th	50th	75th	90th	95th
ALL RACES¹										
Both sexes										
Concentration in milligrams per deciliter										
20–44 years	130.1	43.5	1.10	71	80	101	125	155	185	208
45–64 years	161.0	56.5	1.90	86	99	122	155	193	231	255
65–74 years	171.0	58.4	1.82	95	110	132	164	203	237	275
Male										
20–44 years	136.0	45.0	1.74	74	85	105	131	162	188	214
45–64 years	168.7	54.8	2.30	94	108	133	166	199	237	262
65–74 years	179.0	61.6	2.98	97	119	140	172	207	247	291
Female										
20–44 years	125.2	42.5	1.51	70	77	96	120	148	176	197
45–64 years	154.2	58.3	2.77	82	93	115	147	183	223	248
65–74 years	164.7	56.5	2.47	92	103	125	159	197	230	257
WHITE										
Both sexes										
20–44 years	129.3	42.1	1.37	71	80	102	125	153	183	203
45–64 years	161.2	56.8	2.20	86	100	122	155	193	231	253
65–74 years	171.0	58.3	1.85	92	109	132	165	204	235	266
Male										
20–44 years	135.6	43.2	1.72	76	85	106	131	161	187	210
45–64 years	168.6	55.2	2.54	94	109	132	166	198	236	263
65–74 years	178.3	60.6	2.97	95	119	140	172	207	242	285
Female										
20–44 years	123.9	41.0	1.72	70	77	96	118	147	175	196
45–64 years	154.4	58.6	3.19	84	95	115	148	185	222	246
65–74 years	165.1	57.3	2.61	90	102	126	159	198	231	257
BLACK²										
Both sexes										
20–44 years	129.7	52.5	3.38	73	81	97	119	155	179	232
45–64 years	159.1	60.8	*4.41	77	89	118	157	189	230	267
65–74 years	166.6	61.9	*8.70	*	113	123	155	193	265	*
Male										
20–44 years	131.9	54.6	*5.78	*	78	98	122	156	199	*
45–64 years	170.7	56.8	*6.86	*	107	138	180	207	239	*
65–74 years	179.3	71.8	*	*	*	141	160	206	*	*
Female										
20–44 years	128.0	54.5	*5.22	*	81	97	119	149	170	*
45–64 years	151.5	67.2	*8.02	*	79	112	143	171	225	*
65–74 years	158.4	59.0	*11.04	*	*	117	144	180	*	*

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

Table 11. Mean 2-hour plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by race, sex, and age: United States, 1976–80

Race, sex, and age	Mean	Standard deviation	Standard error	Percentile						
				5th	10th	25th	50th	75th	90th	95th
ALL RACES¹										
Both sexes										
Concentration in milligrams per deciliter										
20–44 years	100.1	30.6	0.75	63	71	81	96	113	132	152
45–64 years	119.0	51.7	1.87	66	75	90	109	135	170	209
65–74 years	133.4	58.5	1.94	72	80	97	122	154	199	240
Male										
20–44 years	97.4	29.1	1.20	60	67	81	94	111	125	144
45–64 years	116.0	48.1	2.29	62	70	88	108	133	166	191
65–74 years	133.9	62.9	3.27	72	79	95	119	154	207	243
Female										
20–44 years	102.4	32.4	1.12	66	72	82	98	115	136	156
45–64 years	121.6	55.6	2.62	70	79	91	109	136	177	222
65–74 years	133.1	56.3	2.33	72	80	99	124	154	196	232
WHITE										
Both sexes										
20–44 years	99.0	28.7	1.07	63	70	81	96	111	129	146
45–64 years	118.0	52.3	2.20	64	74	90	107	133	169	205
65–74 years	132.8	59.3	2.14	71	79	95	121	154	196	234
Male										
20–44 years	97.1	28.2	1.25	61	67	81	94	111	125	140
45–64 years	115.3	48.9	2.55	62	69	87	106	132	166	189
65–74 years	133.2	64.3	3.50	70	78	94	117	153	206	257
Female										
20–44 years	100.7	29.5	1.43	65	72	82	96	113	133	152
45–64 years	120.6	56.1	2.94	69	76	91	107	135	175	222
65–74 years	132.4	56.7	2.61	71	80	97	124	154	195	231
BLACK²										
Both sexes										
20–44 years	102.6	40.0	2.41	59	71	82	94	116	148	156
45–64 years	126.1	53.9	*4.89	74	81	95	115	147	179	215
65–74 years	137.4	59.3	*7.83	*	96	106	123	149	239	*
Male										
20–44 years	95.5	26.9	*2.25	*	69	83	93	108	126	*
45–64 years	124.8	44.3	*6.31	*	79	101	116	149	167	*
65–74 years	140.1	60.8	*	*	*	106	127	156	*	*
Female										
20–44 years	107.7	47.7	*3.60	*	74	82	99	128	155	*
45–64 years	126.9	61.4	*6.70	*	81	95	113	147	202	*
65–74 years	135.5	63.8	*9.86	*	*	106	114	140	*	*

¹Includes races other than white or black.

²Sex and age estimates for black persons are presented for information only. They are too unreliable to be considered national prevalence estimates.

Table 12. Mean plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of white adults aged 20–74 years with no medical history of diabetes, by fasting, 1-hour, and 2-hour venipunctures, sex, and age: United States, 1976–80

Venipuncture, sex, and age	Mean	Standard deviation	Standard error	Percentile						
				5th	10th	25th	50th	75th	90th	95th
FASTING										
Both sexes										
Concentration in milligrams per deciliter										
20–24 years.....	86.6	8.3	0.45	77	78	82	86	91	95	98
25–29 years.....	87.7	7.9	0.43	76	79	83	87	92	97	101
30–34 years.....	89.4	8.9	0.51	79	81	84	88	94	100	106
35–39 years.....	90.7	9.8	0.61	78	80	85	91	96	103	105
40–44 years.....	93.9	16.2	1.64	79	82	87	92	98	104	110
45–49 years.....	95.1	17.6	1.31	81	83	88	93	98	108	112
50–54 years.....	96.1	15.8	1.12	81	83	88	94	101	113	119
55–59 years.....	97.8	27.8	2.17	81	84	89	93	101	108	116
60–64 years.....	98.3	15.6	0.74	83	86	90	95	104	113	121
65–69 years.....	98.7	21.5	1.13	82	84	89	94	103	114	125
70–74 years.....	97.3	16.5	0.83	82	84	90	94	101	110	121
Male										
20–24 years.....	89.2	6.8	0.51	79	82	85	89	93	98	99
25–29 years.....	90.3	7.2	0.56	80	82	85	90	95	100	102
30–34 years.....	92.7	9.4	0.94	81	85	87	92	97	103	108
35–39 years.....	93.1	8.2	0.68	82	83	88	92	99	103	106
40–44 years.....	96.1	11.4	1.20	*	88	91	95	101	105	*
45–49 years.....	96.4	20.9	1.89	*	85	89	94	101	108	*
50–54 years.....	97.9	18.6	1.56	80	84	90	94	101	114	119
55–59 years.....	97.8	14.3	1.27	83	85	91	95	105	110	116
60–64 years.....	100.7	14.6	0.92	86	88	92	98	106	114	128
65–69 years.....	100.3	25.1	1.81	82	86	90	95	103	116	130
70–74 years.....	98.9	14.5	1.12	84	88	92	96	104	114	122
Female										
20–24 years.....	84.5	8.9	0.66	76	77	80	84	89	93	96
25–29 years.....	85.1	8.0	0.66	74	76	81	85	89	95	98
30–34 years.....	87.1	8.1	0.62	77	79	83	86	91	97	100
35–39 years.....	88.6	10.8	0.84	76	79	83	89	95	100	105
40–44 years.....	92.0	19.4	2.12	78	80	84	88	95	103	112
45–49 years.....	94.0	15.1	1.75	79	82	86	92	97	106	115
50–54 years.....	94.4	13.1	1.35	81	82	86	94	98	108	118
55–59 years.....	97.9	37.2	4.07	79	83	88	92	98	104	121
60–64 years.....	96.0	16.7	1.13	81	84	88	93	101	110	119
65–69 years.....	97.4	18.8	1.20	82	84	87	94	103	112	122
70–74 years.....	96.0	18.5	1.22	80	83	88	93	99	110	117
1 HOUR										
Both sexes										
20–24 years.....	119.5	38.4	2.58	68	75	95	118	140	164	181
25–29 years.....	124.5	40.2	2.05	71	80	98	119	147	177	198
30–34 years.....	128.9	42.0	2.44	71	80	104	124	152	182	207
35–39 years.....	137.4	41.5	2.79	76	89	110	135	164	187	208
40–44 years.....	141.5	54.0	4.77	76	84	107	136	172	198	223
45–49 years.....	153.6	58.6	3.51	76	88	113	148	178	229	249
50–54 years.....	159.4	55.7	3.59	88	97	122	152	192	227	265
55–59 years.....	164.1	63.2	4.35	95	107	127	155	190	236	249
60–64 years.....	169.3	52.6	2.43	95	108	136	165	199	232	252
65–69 years.....	171.8	60.3	2.56	90	102	131	164	207	242	263
70–74 years.....	169.9	57.3	2.92	100	114	132	166	196	232	268
Male										
20–24 years.....	124.7	40.4	3.50	67	79	97	122	147	177	187
25–29 years.....	126.7	42.6	3.46	71	80	103	120	148	178	198
30–34 years.....	140.0	42.8	3.49	80	99	114	137	159	193	223
35–39 years.....	139.5	44.0	3.46	76	87	111	139	170	188	210
40–44 years.....	155.4	50.6	4.87	*	100	129	153	181	203	*
45–49 years.....	163.9	60.6	5.46	*	109	122	162	180	234	*
50–54 years.....	168.0	61.1	6.14	80	105	131	162	197	229	284
55–59 years.....	166.0	53.7	4.43	95	110	134	163	195	241	255
60–64 years.....	177.9	52.5	3.01	100	118	142	177	211	242	271
65–69 years.....	178.1	65.2	4.26	91	115	139	169	209	253	289
70–74 years.....	178.7	57.5	5.09	114	121	144	175	206	234	283

Table 12. Mean plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of white adults aged 20–74 years with no medical history of diabetes, by fasting, 1-hour, and 2-hour venipunctures, sex, and age: United States, 1976–80—Con.

Venipuncture, sex, and age	Mean	Standard deviation	Standard error	Percentile						
				5th	10th	25th	50th	75th	90th	95th
1 HOUR—Con.										
Female										
Concentration in milligrams per deciliter										
20–24 years.....	115.4	37.6	3.21	68	74	90	114	136	157	174
25–29 years.....	122.2	40.1	3.33	70	81	95	118	145	173	197
30–34 years.....	120.8	40.9	3.17	68	72	94	115	145	173	191
35–39 years.....	135.6	40.6	3.54	76	92	109	133	161	185	204
40–44 years.....	129.5	55.0	6.04	72	78	96	119	163	187	214
45–49 years.....	144.2	58.8	5.46	67	82	106	139	175	222	241
50–54 years.....	151.6	52.9	4.92	90	95	114	144	181	217	242
55–59 years.....	162.5	73.8	7.74	91	106	125	151	188	233	249
60–64 years.....	160.9	53.1	3.65	93	102	129	153	191	226	247
65–69 years.....	166.8	58.1	3.59	89	99	126	159	206	232	256
70–74 years.....	162.5	58.5	3.56	95	110	125	160	184	226	265
2 HOUR										
Both sexes										
20–24 years.....	96.4	24.7	1.51	63	69	82	94	108	123	138
25–29 years.....	96.9	25.5	1.60	62	68	80	96	111	124	138
30–34 years.....	98.9	26.8	1.73	65	72	83	95	110	128	146
35–39 years.....	100.1	27.7	2.04	65	73	83	95	114	134	147
40–44 years.....	104.9	44.2	4.03	62	69	81	99	117	152	167
45–49 years.....	113.5	46.0	2.48	65	75	87	103	127	169	194
50–54 years.....	113.2	50.2	3.30	58	68	86	105	126	166	185
55–59 years.....	121.8	64.6	5.50	66	74	91	108	135	167	206
60–64 years.....	125.1	50.2	2.21	71	80	95	115	141	189	224
65–69 years.....	131.9	63.4	3.03	68	77	93	119	152	195	257
70–74 years.....	134.0	55.4	3.25	77	82	102	125	157	199	227
Male										
20–24 years.....	95.1	25.4	1.83	60	65	81	93	107	121	140
25–29 years.....	94.9	25.6	2.01	62	67	77	95	110	120	130
30–34 years.....	98.1	26.6	2.16	63	71	84	95	110	125	137
35–39 years.....	96.7	28.7	2.90	56	65	79	93	111	130	146
40–44 years.....	102.7	42.0	4.04	*	70	81	99	114	133	*
45–49 years.....	111.0	48.2	4.07	*	69	82	101	127	155	*
50–54 years.....	112.7	58.5	5.44	57	63	82	105	126	166	187
55–59 years.....	115.7	43.5	4.04	61	70	95	113	135	159	171
60–64 years.....	123.2	48.7	2.67	67	79	94	112	141	190	216
65–69 years.....	132.7	71.1	4.96	70	77	91	115	151	207	270
70–74 years.....	133.9	57.2	4.94	60	80	102	124	161	196	226
Female										
20–24 years.....	97.3	25.0	2.04	68	74	82	95	108	126	133
25–29 years.....	99.1	26.8	2.80	62	70	81	98	112	131	142
30–34 years.....	99.4	27.8	2.22	66	73	82	96	110	130	147
35–39 years.....	103.1	27.5	2.22	72	75	85	99	115	137	151
40–44 years.....	106.9	47.3	5.46	62	67	82	98	122	160	172
45–49 years.....	115.8	46.6	3.70	63	76	90	104	129	174	209
50–54 years.....	113.7	45.1	4.99	68	72	90	105	126	166	178
55–59 years.....	127.3	81.0	9.28	71	79	91	106	136	184	258
60–64 years.....	126.9	52.9	3.18	73	80	96	116	143	189	226
65–69 years.....	131.2	59.2	3.80	67	77	94	121	153	194	230
70–74 years.....	134.1	55.7	3.64	80	83	101	125	155	200	231

Table 13. Percent of adults aged 20–74 years with no medical history of diabetes, by level of fasting plasma glucose, who would be classified as having diabetes or impaired glucose tolerance, by criteria of the National Diabetes Data Group and of the World Health Organization: United States, 1976–80

Fasting plasma glucose level ¹	Diabetes ²			Impaired glucose tolerance ²	
	All adults	National Diabetes Data Group criteria	World Health Organization criteria	National Diabetes Data Group criteria	World Health Organization criteria
Percent of population					
Less than 80 mg/dl	7.1	1.3	1.4	1.4	9.0
80–84 mg/dl	14.5	0.4	0.4	1.0	3.5
85–89 mg/dl	21.2	0.4	0.4	1.9	5.8
90–94 mg/dl	22.4	0.5	0.7	2.8	9.2
95–99 mg/dl	15.7	1.5	1.9	4.4	15.1
100–114 mg/dl	14.9	5.7	6.2	13.0	24.1
115–139 mg/dl	3.2	31.0	31.3	28.6	36.6
140 mg/dl or more	0.9	100.0	100.0	...	...
100–104 mg/dl	7.9	2.7	3.6	9.6	20.7
105–109 mg/dl	4.8	7.4	7.5	11.9	24.7
110–114 mg/dl	2.1	12.6	12.6	28.1	35.3
115–119 mg/dl	1.3	12.9	12.9	27.8	40.3
120–124 mg/dl	0.7	37.7	36.9	35.9	39.6
125–129 mg/dl	0.6	24.0	24.0	33.6	46.2
130–134 mg/dl	0.2	75.2	75.2	17.6	17.6
135–139 mg/dl	0.4	60.7	65.0	15.6	15.6

¹mg/dl = milligrams per deciliter.

²See text for criteria defining diabetes and impaired glucose tolerance.

Table 14. Percent, standard error of percent, and median age of adults aged 20–74 years with medical history of borderline diabetes, potential diabetes, a parent with diabetes, or 120 percent or more of desirable weight, by diabetes status: United States, 1976–80

Diabetes status	Borderline diabetes	Potential diabetes	Parent with diabetes	120 percent or more of desirable weight ¹	Borderline diabetes	Potential diabetes	Parent with diabetes	120 percent or more of desirable weight ¹	Median age
Percent of population									
Total. 20–74 years	3.5	2.1	16.4	33.8	0.16	0.14	0.49	0.76	41.0
Medical history of diabetes ²	36.2	8.7	34.3	55.6	2.37	0.99	2.15	2.25	58.1
No medical history of diabetes:									
Undiagnosed diabetes ³	14.2	2.6	26.5	63.0	2.50	1.23	4.35	5.50	57.1
Impaired glucose tolerance ³	7.6	2.2	28.2	53.1	2.16	1.10	3.39	4.10	54.0
Normal glucose tolerance ³	2.6	2.5	17.0	33.6	0.33	0.35	0.71	0.99	40.0

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

²Reported in medical history interview that a doctor had told them they had diabetes or sugar diabetes.

³Based on oral glucose tolerance test using National Diabetes Data Group criteria.

Table 15. Percent and standard error of percent of adults aged 20–74 years reporting in medical history interview that a doctor had told them they had diabetes or sugar diabetes, by race, sex, and percent desirable weight: United States, 1976–80

Race and sex	Percent desirable weight ¹											
	Less than 100	100–109	110–119	120–134	135–149	150 or greater	Less than 100	100–109	110–119	120–134	135–149	150 or greater
	Percent of population						Standard error of percent					
All races²												
Both sexes	2.0	2.4	2.3	4.0	4.9	9.2	0.25	0.30	0.32	0.41	0.65	1.19
Male	2.2	2.1	2.7	3.2	4.1	8.8	0.40	0.52	0.47	0.58	0.80	1.93
Female	1.7	2.7	1.8	4.7	5.3	9.3	0.30	0.51	0.49	0.68	0.88	1.41
White												
Both sexes	1.8	2.4	2.3	3.8	4.7	8.4	0.24	0.32	0.32	0.47	0.72	1.26
Male	2.0	2.1	2.5	3.3	4.0	*6.1	0.46	0.53	0.44	0.63	0.93	1.88
Female	1.6	2.8	2.0	4.2	5.2	8.9	0.28	0.58	0.55	0.74	1.01	1.43
Black³												
Both sexes	*3.7	*2.2	*3.1	*4.8	*6.6	13.1	1.38	0.98	1.01	1.48	2.01	3.02
Male	*3.5	*2.7	*5.1	*2.7	*5.6	25.3	1.09	*1.51	*1.90	*1.68	*	*
Female	*4.0	*1.6	*1.0	*6.2	*7.1	*11.0	*3.19	0.78	*0.75	2.05	*2.69	3.32

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

²Includes races other than white or black.

³Estimates for black males and black females are presented for information only. They are too unreliable to be considered national prevalence estimates.

Table 16. Percent and standard error of percent of adults aged 20–74 years classified undiagnosed diabetic by oral glucose tolerance test using National Diabetes Data Group criteria, by race, sex, and percent desirable weight: United States, 1976–80

Race and sex	Percent desirable weight ¹											
	Less than 100	100–109	110–119	120–134	135–149	150 or greater	Less than 100	100–109	110–119	120–134	135–149	150 or greater
	Percent of population						Standard error of percent					
All races²												
Both sexes	1.6	*1.6	2.3	3.7	5.3	11.4	0.44	0.54	0.44	0.59	1.31	1.84
Male	*2.1	*2.3	2.6	3.7	*4.5	*4.5	0.71	0.94	0.76	0.65	2.00	2.32
Female	*1.1	*0.9	1.9	3.8	5.7	13.1	0.58	0.44	0.49	0.86	1.64	2.12
White												
Both sexes	1.8	*1.0	2.2	3.5	5.7	10.9	0.50	0.36	0.44	0.68	1.50	2.30
Male	*2.4	*1.2	2.7	2.9	*4.6	*4.9	0.84	0.46	0.79	0.48	2.23	2.85
Female	*1.2	*0.9	1.6	4.1	*6.3	12.3	0.63	0.46	0.39	1.16	1.94	2.67
Black³												
Both sexes	0.0	*4.7	*3.5	*4.8	*3.5	*11.3	---	*3.87	*2.12	*2.40	*	*5.24
Male	0.0	*7.6	0.0	*9.9	*3.6	*3.0	---	*6.86	---	*	*	*
Female	*0.0	*1.5	*5.9	*2.1	*3.4	*13.4	---	*	*	*1.58	*	*

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

²Includes races other than white or black.

³Estimates for black males and black females are presented for information only. They are too unreliable to be considered national prevalence estimates.

NOTE: Undiagnosed diabetes defined as meeting diagnostic criteria for diabetes with no medical history of diabetes. Refer to text for National Diabetes Data Group criteria for classifying results of oral glucose tolerance tests.

Table 17. Percent distribution of adults aged 20–74 years by percent desirable weight, according to race and sex: United States, 1976–80

Race and sex	All adults	Percent desirable weight ¹					
		Less than 100	100–109	110–119	120–134	135–149	150 or greater
All races ²		Percent distribution					
Both sexes	100.0	24.0	22.4	19.8	17.6	8.3	7.9
Male	100.0	25.3	24.3	23.1	18.0	6.2	3.0
Female	100.0	22.9	20.6	16.8	17.2	10.2	12.4
White		Percent distribution					
Both sexes	100.0	23.9	23.1	20.3	17.5	8.0	7.2
Male	100.0	24.0	24.7	23.9	18.5	6.2	2.8
Female	100.0	23.8	21.6	17.1	16.5	9.7	11.3
Black ³		Percent distribution					
Both sexes	100.0	22.3	16.2	16.5	19.5	10.9	14.6
Male	100.0	31.4	20.8	18.6	16.8	7.6	4.8
Female	100.0	14.9	12.5	14.8	21.7	13.5	22.6

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

²Includes races other than white or black.

³Estimates for black males and black females are presented for information only. They are too unreliable to be considered national prevalence estimates.

Table 18. Percent and standard error of percent of adults aged 20–74 years with no medical history of diabetes and with abnormal fasting or 2-hour plasma glucose concentrations, by venipuncture, sex, and percent desirable weight: United States, 1976–80

Venipuncture ¹ and sex	Percent desirable weight ²											
	Less than 100	100–109	110–119	120–134	135–149	150 or greater	Less than 100	100–109	110–119	120–134	135–149	150 or greater
FASTING												
140 mg/dl or more												
	Percent of population						Standard error of percent					
Both sexes	*0.3	*0.1	*0.9	*0.7	*1.7	*4.9	0.25	0.09	0.34	0.25	0.81	1.71
Male	*0.5	*0.3	*1.3	*0.9	*1.7	*2.9	0.52	0.18	0.50	0.39	1.45	1.96
Female	*0.1	-	*0.4	*0.5	*1.7	*5.3	0.07	...	0.30	0.33	0.97	1.97
115 mg/dl or more												
Both sexes	2.0	*1.8	4.2	4.0	6.4	15.1	0.57	0.56	0.86	0.68	1.30	2.93
Male	*2.2	*2.1	6.3	4.0	*7.7	*14.4	0.80	0.86	1.60	0.83	2.50	5.41
Female	*1.8	*1.4	*1.7	4.1	*5.7	15.2	0.80	0.69	0.62	0.89	1.82	2.95
2 HOUR												
200 mg/dl or more												
Both sexes	1.6	*1.7	2.5	4.1	6.0	13.0	0.45	0.58	0.46	0.52	1.47	1.92
Male	*2.2	*2.5	2.9	3.7	*4.4	*5.1	0.71	0.99	0.83	0.66	2.05	2.71
Female	*1.1	*1.0	2.1	4.4	6.9	14.8	0.61	0.47	0.53	0.74	1.87	2.19
140–199 mg/dl												
Both sexes	5.6	8.5	11.4	14.5	20.6	23.5	0.81	1.28	1.44	1.26	2.39	2.77
Male	6.0	7.0	10.1	13.5	29.3	*22.2	1.04	1.10	1.58	2.15	5.66	7.07
Female	5.3	9.9	13.0	15.4	15.6	23.8	1.16	2.09	2.31	1.75	2.60	3.24

¹mg/dl = milligrams per deciliter.

²Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

Table 19. Mean plasma glucose concentration, standard deviation, standard error, and selected percentiles of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by venipuncture and percent desirable weight: United States, 1976–80

Venipuncture and percent desirable weight ¹	Mean	Standard deviation	Standard error	Percentile						
				5th	10th	25th	50th	75th	90th	95th
Fasting				Concentration in milligrams per deciliter						
Less than 100	88.8	9.5	0.34	77	79	83	88	93	98	104
100–109	90.8	10.9	0.52	78	80	84	90	96	103	108
110–119	93.2	15.2	0.54	79	81	86	91	98	105	112
120–134	94.8	14.2	0.46	81	83	88	93	99	106	112
135–149	96.5	17.5	0.93	81	84	89	94	101	111	118
150 or higher	102.9	32.6	2.46	79	82	90	96	106	126	139
1 hour										
Less than 100	130.8	47.6	1.98	71	78	97	124	158	188	214
100–109	138.4	50.4	2.48	73	81	105	130	168	209	230
110–119	145.7	51.5	2.10	77	92	113	139	173	206	236
120–134	151.1	51.5	1.58	80	93	115	146	182	216	235
135–149	160.0	54.0	3.10	85	101	125	156	188	226	243
150 or higher	176.2	68.3	4.05	102	113	136	165	207	256	289
2 hour										
Less than 100	98.4	32.8	1.30	60	67	80	94	109	129	155
100–109	102.4	34.8	1.72	62	69	82	97	115	141	161
110–119	108.9	42.7	1.61	63	73	85	101	122	153	168
120–134	116.5	44.7	1.78	71	76	90	108	131	162	190
135–149	124.7	51.9	3.03	70	81	96	113	143	181	204
150 or higher	141.0	70.3	4.67	79	85	101	122	165	222	268

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

Table 20. Mean fasting and 2-hour plasma glucose concentrations of the oral glucose tolerance tests of adults aged 20–74 years with no medical history of diabetes, by percent desirable weight and age: United States, 1976–80

Venipuncture and percent desirable weight ¹	Total, 20–74 years	Age			
		20–44 years	45–54 years	55–64 years	65–74 years
Fasting		Concentration in milligrams per deciliter			
Total	92.93	89.52	96.02	97.80	98.12
Less than 100	88.77	87.28	90.98	92.01	94.09
100–109	90.83	88.49	92.39	95.29	95.09
110–119	93.25	89.88	95.61	97.35	97.29
120–134	94.77	91.18	96.64	97.43	102.29
135–149	96.52	92.21	97.06	102.57	99.58
150 or greater	102.92	95.97	112.36	109.86	102.36
2 hour					
Total	110.08	100.06	114.84	123.78	133.44
Less than 100	98.44	93.77	104.90	107.49	117.41
100–109	102.37	94.65	107.56	113.67	121.93
110–119	108.86	100.84	108.49	117.45	131.78
120–134	116.48	105.18	119.84	126.62	142.70
135–149	124.73	114.23	114.63	141.78	148.45
150 or greater	141.00	120.79	156.46	163.40	151.26

¹Percent desirable weight is an index of weight adjusted for height equal to k times weight divided by height squared, where k is 4.39 for males and 4.76 for females.

Appendixes

Contents

I.	Statistical notes.....	42
	Survey design.....	42
	Estimation procedures.....	42
	Nonresponse bias.....	44
	Standard deviations.....	49
	Standard errors.....	49
	Data limitations and reliability.....	50
	Combining and comparing estimates.....	50
	Analytic methodology.....	50
II.	Definition of sociodemographic terms.....	52
III.	Medical history questionnaire items related to diabetes.....	53

List of appendix tables

I.	Sample size and percent response of total sample and oral glucose tolerance test (OGTT) subsample, by demographic group: Second National Health and Nutrition Examination Survey (NHANES II), 1976–80.....	43
II.	Number of examined persons in oral glucose tolerance test subsample and estimated population, by race, sex, and age: Second National Health and Nutrition Examination Survey, 1976–80.....	44
III.	Percent distribution of population estimated from National Health Interview Survey (NHIS, 1976) and Second National Health and Nutrition Examination Survey (NHANES II, 1976–80) by demographic groups, according to total sample and oral glucose tolerance test (OGTT) subsample.....	45
IV.	Percent of adults aged 20–74 years by health status, body mass index, selected medical conditions, and diabetes therapy as reported in medical history interview: National Health Interview Survey (NHIS), 1976, and Second National Health and Nutrition Examination Survey (NHANES II), 1976–80.....	46
V.	Number and percent distribution of oral glucose tolerance test (OGTT) subsample persons by OGTT response, according to selected medical history items: Second National Health and Nutrition Examination Survey, 1976–80....	47
VI.	Mean and selected percentiles of height, weight, body mass index, systolic and diastolic blood pressure, and serum cholesterol, by selected samples: Second National Health and Nutrition Examination Survey, 1976–80.....	47
VII.	Percent bias for selected respondent-nonrespondent prevalence ratios and selected response rates: Second National Health and Nutrition Examination Survey, 1976–80.....	48
VIII.	Potential bias in estimated percent prevalence of undiagnosed diabetes and impaired glucose tolerance due to over-response by persons with medical history of borderline or potential diabetes or a parent with diabetes: Second National Health and Nutrition Examination Survey, 1976–80.....	49
IX.	Sensitivity of estimated prevalences of undiagnosed diabetes or impaired glucose tolerance to response selection bias in persons with or without medical history of borderline or potential diabetes or a parent with diabetes: Second National Health and Nutrition Examination Survey, 1976–80.....	49
X.	Percent and standard error of percent of adults aged 20–74 years with diabetes—sum of known diabetes estimated from the National Health Interview Survey (1976) and unknown diabetes estimated from the Second National Health and Nutrition Examination Survey (1976–80)—by race, sex, and age.....	51

Appendix I

Statistical notes

This report is based on data collected in the Second National Health and Nutrition Examination Survey (NHANES II) from February 1976 to February 1980. NHANES II, conducted by the National Center for Health Statistics (NCHS), was a survey of the civilian noninstitutionalized U.S. population (including Alaska and Hawaii) 6 months–74 years of age. Both interview and examination procedures were used to collect a broad spectrum of demographic, socioeconomic, and morbidity data and related medical and nutritional information. During household interviews, demographic, socioeconomic, and certain medical history data were obtained for sample persons. Dietary interview, medical examination, and related clinical tests and procedures were performed in specially designed mobile examination centers transported to each sample location to provide standardized conditions and equipment.

Survey design

NHANES II utilized a stratified, multistage probability sample design. In hierarchical order, the three stages of sample selection were primary sampling units (PSU's), segments, and sample persons. From the PSU's of the National Health Interview Survey (NHIS), another major survey program of the National Center for Health Statistics, 461 PSU's were formed in the first design stage. These PSU's are counties, or groups of small contiguous counties, or, in some New England States, areas defined by minor civil divisions. The PSU's were stratified into 64 strata on the basis of region, population size, median income, and other social and demographic characteristics that varied with region. One PSU was selected from each stratum using a modified Goodman-Kish controlled selection technique.⁴⁸ These 64 counties or areas were the geographic locations visited by a mobile examination center during the survey period.

The U.S. Bureau of the Census had the major responsibility for selecting households and sample persons within each of the PSU's. The second stage of the design consisted of selection of segments (clusters of eight households) within enumeration districts (ED's). An ED is a geographical area that contains approximately 300 housing units. Two sampling frames of housing units were used to select the sample within each of the PSU's. The list frame consisted of all housing units located in the 1970 Census of the Population. A new construction frame supplemented the list frame and contained all new housing units built since 1970.

NOTE: A list of references follows the text.

ED's within each PSU were stratified into poverty and nonpoverty strata. The poverty strata contained ED's with 13 percent or more of persons below the poverty level; the nonpoverty strata contained ED's with less than 13 percent of persons below the poverty level, as determined from the 1970 census. To oversample persons with low incomes, segments were drawn from the poverty strata with an average of 2.3 times the probability that segments were drawn from the nonpoverty strata. Sampling fractions were determined within PSU's by a mathematical model to ensure an adequate and manageable sample size and to minimize the variance of the estimated proportion of persons below the poverty level. To ensure sampling reliability, clusters of 16 listed addresses were drawn from the sampling frames and then systematically subsampled at a rate of 1 out of 2 to produce a final segment of 8 household address listings.

At the third stage of sampling the interviewer made a list of all eligible sample persons within the selected households. Using instructions and a worksheet in the interview folder, the interviewer selected sample persons to be examined so that approximately one person per sample household was selected and younger and older age groups were oversampled. Persons were selected at the following sampling rates:

Age	Rate
6 months–5 years	3/4
6–59 years	1/4
60–74 years	3/4

For each sample person selected who agreed to participate in NHANES II, the interviewer did a medical history interview and telephoned the field office to make an appointment for an examination. The field office staff assigned alternate persons ages 20–74 years to an oral glucose tolerance test (OGTT) subsample. It is this subsample that is the primary data base for this report. The sample size and response rates by several demographic variables are shown in table I. A more complete description of the survey design is included in *Vital and Health Statistics*, Series 1, No. 15.⁵

Estimation procedures

Because the design of NHANES II is a complex, multistage probability sample, national estimates are derived through a multistage estimation procedure. The procedure has three basic components: (a) Inflation by the reciprocal of the probability of selection, (b) adjustment for nonresponse, and (c)

Table 1. Sample size and percent response of total sample and oral glucose tolerance test (OGTT) subsample, by demographic group: Second National Health and Nutrition Examination Survey (NHANES II), 1976–80

Demographic group	Total adult NHANES II sample			OGTT subsample				OGTT-completed group as percent of examined subsample ¹
	Sample size	Interviewed	Examined	Sample size	Interviewed	Examined	OGTT completed ¹	
	Number	Percent		Number	Percent			
Total.....	17,390	88.3	68.2	8,686	88.5	68.0	44.6	65.6
Region								
Northeast.....	4,295	84.1	62.2	2,149	84.4	63.1	38.7	61.4
Midwest.....	4,577	89.4	68.6	2,283	89.7	68.4	46.3	67.6
South.....	4,576	90.8	69.4	2,290	90.9	68.6	42.2	61.5
West.....	3,942	88.9	73.0	1,964	89.1	72.0	51.8	72.0
Residence								
Outside standard metropolitan statistical area.....	7,265	92.6	73.1	3,627	92.5	72.4	48.3	66.7
Inside standard metropolitan statistical area.....	10,125	85.3	64.8	5,059	85.7	64.8	41.9	64.7
Segment type								
Nonpoverty.....	8,663	86.2	66.9	4,358	86.3	66.9	44.7	66.8
Poverty.....	8,727	90.5	69.5	4,328	90.8	69.0	44.5	64.4
Age								
20–44 years.....	7,161	91.3	73.2	3,570	91.1	72.1	44.7	62.0
45–54 years.....	2,149	86.8	67.6	1,075	86.1	65.9	47.1	71.5
55–64 years.....	3,868	86.1	66.1	1,909	86.5	67.1	45.8	68.3
65–74 years.....	4,212	86.2	62.1	2,132	87.3	62.9	42.0	66.9
Sex								
Male.....	8,074	87.7	69.4	4,114	87.9	69.2	44.5	64.3
Female.....	9,316	88.9	67.2	4,572	89.1	66.9	44.7	66.8
Race								
White and all other.....	15,435	88.1	68.2	7,724	88.3	68.1	45.4	66.7
Black.....	1,955	90.2	68.3	962	90.5	67.2	38.1	56.8
Family income group ²								
Less than \$6,000.....	3,289	95.9	72.5	1,644	96.0	71.6	43.5	60.7
\$6,000–\$9,999.....	3,737	94.5	70.5	1,845	94.7	69.5	44.4	63.9
\$10,000–\$14,999.....	3,195	94.3	73.9	1,585	93.9	73.8	48.5	65.6
\$15,000–\$24,999.....	3,893	94.9	76.2	1,982	95.1	76.3	52.5	68.8
\$25,000 or more.....	2,101	93.9	72.3	1,056	93.8	72.1	50.1	69.5
Unknown.....	1,175	...	...	574	...	...	...	...

¹Includes 75 diabetics on insulin exempted from the OGTT.

²Unknown income imputed from segment type and education for interviewed and examined survey participants.

poststratification by age, sex, and race. A brief description of each component is as follows:

- *Inflation by the reciprocal of the probability of selection.* The probability of selection is the product of the probabilities of selection from each stage of selection in the design—PSU, segment, sample person, and subsample.
- *Adjustment for nonresponse.* Estimates are inflated by a multiplication factor that brings estimates based on examined persons up to a level that would have been achieved if all sample persons had been examined. Nonresponse adjustment factors were calculated by dividing the sum of the reciprocals of the probability of selection for all selected *sample* persons within each of five income groups (less than \$6,000, \$6,000–\$9,999, \$10,000–\$14,999,

\$15,000–\$24,999, and \$25,000 or more), three age groups (6 months–5 years, 6–59 years, and 60–74 years), four geographic regions, and within or outside a standard metropolitan statistical area (SMSA) by the sum of the reciprocals of the probability of selection for *examined* sample persons in the same income, age, region, and SMSA groups.

- *Poststratification by age, sex, and race.* Estimates are ratio adjusted within each of 76 age-sex-race cells to independent estimates, provided by the U.S. Bureau of the Census, of the population as of March 1, 1978, the approximate midpoint of the survey. The ratio adjustment used a multiplication factor in which the numerator was the estimated U.S. civilian noninstitutionalized population and the denominator was the sum of the weights adjusted for nonresponse for examined persons. This ratio estima-

tion process brings the population estimates into close agreement with the U.S. Bureau of the Census estimates of the civilian noninstitutionalized population of the United States, and in general reduces sampling errors of NHANES II estimates. The number of sample persons and the population estimates for the fasting (OGTT) subsample are shown in table II.

Nonresponse bias

The three major categories of nonresponse in NHANES II are (a) household interview nonresponse, (b) examination nonresponse, and (c) item nonresponse. Household interview nonresponse occurred when a household medical history questionnaire was not completed. Examination nonresponse occurred when those sample persons who responded to the household interview did not come to the examination center for an examination. Item nonresponse occurred when sample persons did not complete some portion of either the household interview questionnaire or the examination. Intense efforts were undertaken during NHANES II to develop and implement procedures and inducements that would reduce all types of nonresponse and thereby reduce the potential for bias in the survey estimates. These procedures are discussed in *Vital and Health Statistics*, Series 1, No. 15.⁵

In NHANES II the total sample size aged 6 months–74 years was 27,801; of these sample persons, 25,286 (91 percent) were interviewed and 20,322 (73 percent) were examined. In the OGTT subsample there were 8,686 persons; 7,688 (89 percent) were interviewed and 5,903 (68 percent) were ex-

amined. Response rates in the OGTT sample were lower than those for the total sample because the former was limited to adults, and adults had lower response rates than children. The response rates to the interview and the examination for adults in the total sample and the OGTT subsample were very similar (table I).

In addition to interview and examination nonresponse, there was substantial (23 percent) item nonresponse for the OGTT. The main reasons for item nonresponse to the OGTT were sample persons not attending the examination center in the morning (11 percent), failing to comply with the instructions to fast (5 percent), or refusing to participate in the OGTT (2 percent). Other reasons (6 percent) included sample persons being (or becoming) ill and technical errors in test administration, laboratory analysis, and data processing.

The high level of nonresponse to the OGTT brings into question the validity of national estimates of glucose intolerance based on NHANES II OGTT data. For persons in the OGTT subsample, it cannot be determined whether the glucose tolerance of those completing the OGTT was similar to the glucose tolerance of those who did not complete it. However, analyses presented below using interview and examination data that might serve as proxies for glucose tolerance data indicate that potential bias introduced by nonresponse to the OGTT is not substantial.

A previous analysis of nonresponse to the interview showed that nonresponse was associated with age, region, residence in an SMSA, and family size.¹³ Response to the examination was associated with wanting to discuss a health problem with a doctor, work status, and number of cars owned. These items did not appear to be related to health outcome variables. Some of this previous analysis is repeated and extended in this appendix.

NOTE: A list of references follows the text.

Table II. Number of examined persons in oral glucose tolerance test subsample and estimated population, by race, sex, and age: Second National Health and Nutrition Examination Survey, 1976–80

Sex and age	All races ¹		White		Black	
	Sample persons	Population in thousands ²	Sample persons	Population in thousands ²	Sample persons	Population in thousands ²
Both sexes						
Total, 20–74 years	5,903	133,606	5,145	116,698	646	13,682
20–44 years	2,574	75,728	2,204	65,092	307	8,374
45–54 years	708	23,032	624	20,335	71	2,260
55–64 years	1,281	20,350	1,131	18,324	135	1,761
65–74 years	1,340	14,496	1,186	12,948	133	1,289
Male						
Total, 20–74 years	2,846	63,612	2,486	56,003	305	6,103
20–44 years	1,245	36,593	1,069	31,703	143	3,702
45–54 years	329	11,115	297	10,012	29	1,045
55–64 years	656	9,608	579	8,682	70	802
65–74 years	616	6,298	541	5,608	63	556
Female						
Total, 20–74 years	3,057	69,994	2,659	60,696	341	7,580
20–44 years	1,329	39,136	1,135	33,390	164	4,673
45–54 years	379	11,918	327	10,324	42	1,216
55–64 years	625	10,743	552	9,643	65	959
65–74 years	724	8,199	645	7,341	70	733

¹Includes races other than white and black.

²Estimated population as of the midpoint of the survey, March 1, 1978.

Table I shows that unweighted response rates varied by several socioeconomic and demographic variables. In table III, however, the weighted population percent distributions for the interview and examination groups were similar both to each other and to those of the NHIS. The OGTT-completed group was more western, female, and white than the target population. However, the general overall agreement between the distributions suggests that the weighting procedure described above ("Estimation procedures") substantially compensated for possible response bias associated with these variables. The remaining differences were small and should not substantially affect estimates presented in this report.

In table IV prevalence estimates of selected health variables on different NHANES II samples are compared with similar variables from NHIS. Overall, the estimates were quite similar, especially considering differences in survey design and administration, question content and context, and survey duration. In particular it is reassuring that the distribution of reported body mass index, an important item in analyses in this report,

was not affected by subsampling and nonresponse. The only item for which there was a striking difference is the estimate for hypertension; some of this difference may be due to increasing awareness of hypertension during the period of the NHANES II survey, and some of it may be due to underreporting of hypertension in NHIS by proxy respondents. All NHANES II data on adults are self-reported.

Some of the differences in table IV may, however, be due to response bias. In particular, OGTT completion rates were lower than average for persons who reported they had been told by a doctor they had diabetes, especially if they were taking diabetes pills. For this reason, and because insulin-using diabetics were ineligible for the test, OGTT data on persons with a medical history of diabetes are not analyzed in this report. Response rates were higher than average for persons with no medical history of diabetes who reported their parents had diabetes or who had been told that they had borderline or potential diabetes (table V). The effect of differential response rates in persons with and without a medical history of diabetes is lessened

Table III. Percent distribution of population estimated from National Health Interview Survey (NHIS, 1978) and Second National Health and Nutrition Examination Survey (NHANES II, 1976-80) by demographic groups, according to total sample and oral glucose tolerance test (OGTT) subsample

Demographic group	NHIS	NHANES II		
		Total sample, interviewed	OGTT subsample, examined	OGTT subsample, OGTT completed
Total	100.0	100.0	100.0	100.0
Region				
Northeast	23.1	23.0	23.4	22.3
Midwest	24.8	24.6	24.3	24.7
South	24.7	25.6	25.8	24.0
West	27.4	26.8	26.4	29.0
Residence				
Outside standard metropolitan statistical area	31.1	37.1	36.9	37.3
Inside standard metropolitan statistical area	68.9	62.9	63.1	62.7
Segment type				
Nonpoverty .....	...	65.7	65.8	66.5
Poverty .....	...	34.3	34.2	33.5
Age				
20-44 years	56.3	56.7	56.7	54.1
45-54 years	17.4	17.2	17.2	18.5
55-64 years	15.5	15.2	15.2	16.1
65-74 years	10.8	10.8	10.8	11.3
Sex				
Male	46.9	47.6	47.6	45.9
Female	53.1	52.4	52.4	54.1
Race				
White and all other	90.7	89.8	89.8	91.0
Black	9.3	10.2	10.2	9.0
Family income group				
Less than \$6,000	13.4	14.5	14.5	13.5
\$6,000-\$9,999	13.2	20.2	20.6	20.0
\$10,000-\$14,999	17.5	18.3	18.7	18.8
\$15,000-\$24,999	25.6	27.3	27.5	28.6
\$25,000 and over	20.8	15.4	15.1	16.0
Unknown	9.6	4.3	3.7	3.1

Table IV. Percent of adults aged 20–74 years, by health status, body mass index, selected medical conditions, and diabetes therapy as reported in medical history interview: National Health Interview Survey (NHIS), 1976, and Second National Health and Nutrition Examination Survey (NHANES II), 1976–80

Variable	NHANES II sample				
	NHIS	Interviewed	Examined	OGTT ¹ subsample, examined	OGTT ¹ subsample, OGTT completed ²
Health status ³					
Percent of total population					
Excellent	44.3	27.5	27.1	27.0	26.5
Very good . . . . .	...	26.8	27.3	28.6	29.2
Good	40.0	28.2	27.9	27.0	27.9
Fair	11.5	12.4	12.5	12.2	11.8
Poor	3.7	5.1	5.0	5.2	4.5
Unknown	0.4	0.1	0.1	0.1	0.1
Body mass index ⁴					
Less than 23 kg/m ²	35.6	32.9	32.3	32.5	32.0
23–27 kg/m ²	44.3	44.3	45.1	44.5	44.7
More than 27 kg/m ²	18.2	21.2	21.1	21.3	21.8
Unknown	1.9	1.6	1.5	1.6	1.5
Selected medical conditions					
With hospital stay in past 12 months	⁵ 12.2	14.1	13.7	14.0	13.7
Rheumatic heart disease . . . . .	...	0.7	0.7	0.8	0.6
Heart murmur . . . . .	...	7.4	7.6	8.3	7.8
Heart failure . . . . .	...	0.9	0.9	1.0	1.0
Heart attack	2.8	3.0	3.0	3.0	3.0
Other heart trouble	4.4	5.0	5.3	5.2	5.1
Hardening of arteries	1.9	2.4	2.5	2.5	2.2
Stroke	1.0	1.5	1.5	1.5	1.4
Hypertension ⁶	15.8	24.6	24.6	24.9	24.3
Cataracts	2.4	2.7	2.8	2.8	2.9
Glaucoma	0.8	0.8	0.8	0.9	0.8
Currently smokes cigarettes	34.9	37.8	37.0	36.8	34.7
Cannot read newspaper	1.7	1.2	1.1	1.0	1.0
Mother with diabetes	9.7	10.3	10.4	10.4	11.5
Father with diabetes	6.3	6.9	7.0	6.8	7.7
Diabetes	3.0	3.4	3.3	3.3	2.9
Borderline diabetes	2.0	2.3	2.5	2.8	3.2
Prediabetes	0.1	0.1	0.2	0.1	0.2
Potential diabetes	0.8	1.3	1.4	1.4	1.8
Trouble hearing	⁷ 7.3	8.9	9.3	9.1	9.2
Therapy for diabetes					
Percent of persons with known diabetes					
Taking insulin	21.3	26.1	25.8	30.5	...
Taking diabetes pills	41.9	35.2	33.8	30.4	22.4

¹OGTT = oral glucose tolerance test.

²Includes 75 diabetics on insulin exempted from OGTT.

³NHIS estimates based on data collected in 1978.

⁴As reported by respondent in interview; weight in kilograms divided by height in meters squared.

⁵Based on data collected in 1978.

⁶Measured with 1 question in NHIS, 2 questions in NHANES II.

⁷From National Center for Health Statistics, P. W. Ries: Hearing ability of persons by sociodemographic and health characteristics. *Vital and Health Statistics. Series 10*, No. 140. DHHS Pub. No. (PHS) 82–1568. Public Health Service, Washington, U.S. Government Printing Office, Aug. 1982.

in this report by presenting, where possible, estimates that are based on data for all interviewed persons rather than just OGTT sample persons.

To explore further the effects of differential nonresponse on estimates, the distributions of height, weight, body mass index, systolic and diastolic blood pressure, and cholesterol were estimated for the total examined sample, the OGTT subsample, and the OGTT-completed group (table VI). As with the interview items, there were only small differences, which suggests that response status was unrelated to these health measures.

Evidence from earlier studies similar to NHANES II also suggests no substantial nonresponse bias. An analysis of data

on examined and nonexamined (but interviewed) persons in the first 35 stands of NHANES I (conducted in 1971–72) found that the two groups were quite similar with respect to certain health characteristics.⁴⁹ A separate study of examined and nonexamined persons in NHANES I found no differences between the two groups with respect to health-related variables.⁵⁰ A study of factors relating to response in Cycle I of the National Health Examination Survey of 1960–62 found that 36 percent of nonexamined persons viewed themselves as being in excellent health, compared with 31 percent of examined persons.⁵¹ A self-appraisal of being in poor health was made by

NOTE: A list of references follows the text.

Table V. Number and percent distribution of oral glucose tolerance test (OGTT) subsample persons by OGTT response, according to selected medical history items: Second National Health and Nutrition Examination Survey, 1976–80

Selected medical history items	Interviewed OGTT subsample persons	OGTT completed	Not examined	Examined in afternoon	Improper fast	Refused	Other
	Number	Percent distribution					
Total.....	7,688	49.4	23.2	12.0	6.0	2.5	6.9
Diabetes							
Taking insulin.....	100	...	25.0	...	...	...	75.0
Taking diabetes pills.....	154	27.3	36.4	14.3	5.8	4.5	11.7
Other.....	127	42.5	22.0	17.3	7.1	4.7	6.3
No diabetes							
Total.....	7,307	50.6	23.0	12.0	6.0	2.4	5.9
Borderline diabetes.....	224	59.4	19.2	9.8	3.6	0.9	7.1
Prediabetes.....	31	51.6	25.8	12.9	...	...	9.7
Potential diabetes.....	141	63.1	22.0	9.2	2.1	0.7	2.8
Mother with diabetes.....	711	58.1	20.8	9.6	5.6	1.7	4.2
Father with diabetes.....	409	58.9	21.0	9.0	6.4	2.0	2.7

Table VI. Mean and selected percentiles of height, weight, body mass index, systolic and diastolic blood pressure, and serum cholesterol, by selected samples: Second National Health and Nutrition Examination Survey, 1976–80

Variable ¹ and sample	Mean	Percentile				
		10th	25th	50th	75th	90th
Height						
Centimeters						
Examined, full sample.....	168.3	156.0	161.0	167.9	175.5	181.4
Examined, OGTT subsample.....	168.4	156.2	161.2	168.0	175.7	181.4
OGTT completed.....	168.3	155.9	161.0	167.9	175.6	181.7
Weight						
Kilograms						
Examined, full sample.....	71.8	53.3	60.5	70.2	81.3	91.9
Examined, OGTT subsample.....	71.9	53.2	60.2	70.5	81.4	92.2
OGTT completed.....	72.0	53.1	60.1	70.7	81.6	92.5
Body mass						
Index ²						
Examined, full sample.....	25.3	20.0	21.9	24.6	27.7	31.5
Examined, OGTT subsample.....	25.3	19.9	21.9	24.5	27.8	31.4
OGTT completed.....	25.4	20.0	22.0	24.7	27.8	31.6
Systolic blood pressure						
Millimeters of mercury						
Examined, full sample.....	126.4	102.3	110.5	124.1	140.1	155.7
Examined, OGTT subsample.....	125.4	100.5	110.4	122.3	138.2	153.0
OGTT completed.....	124.8	100.4	110.3	122.2	136.8	150.9
Diastolic blood pressure						
Millimeters of mercury						
Examined, full sample.....	80.6	66.4	70.4	80.3	90.2	98.5
Examined, OGTT subsample.....	80.0	66.0	70.3	80.2	90.1	98.2
OGTT completed.....	79.3	64.5	70.3	80.2	90.0	96.3
Serum cholesterol						
Milligrams per deciliter						
Examined, full sample.....	213.2	156.4	179.5	208.5	242.8	277.2
Examined, OGTT subsample.....	211.2	156.2	178.6	206.1	241.0	274.2
OGTT completed.....	213.1	156.9	179.3	208.3	243.6	276.9

¹OGTT = oral glucose tolerance test.

²Body mass index is weight in kilograms divided by height in meters squared.

5 percent of nonexamined persons and by 6 percent of those who were examined. In a different study of the National Health Examination Survey of 1960-62,⁵² comparisons between two extreme groups—those who participated in the survey with no persuasive effort and those who participated only after a great deal of persuasive effort—indicated that differences between the two groups generally had little effect on estimates based on numerous examination and questionnaire items. This was interpreted as evidence that no large bias existed between the two groups and was offered as further support for the belief that there is little bias introduced to the findings because of differences in health characteristics between examined and nonexamined persons.

The validity of the estimates and analyses in this report rests on an assumption that the glucose tolerance status of sample persons participating in the OGTT did not differ from that of sample persons not participating. The importance of this assumption is illustrated in table VII. This table models the dependence of the results of the survey on the response rate and the prevalence of the attribute being estimated in respondents and nonrespondents. The model is based on the following equation:

$$t = pr + (1 - p)s$$

where t = true prevalence

p = proportion of sample responding

r = prevalence rate estimated based on respondents

s = prevalence rate in nonrespondents

This equation shows that true prevalence is the sum of prevalences in respondents and nonrespondents weighted by the proportions of respondents and nonrespondents. If B is the ratio of prevalence in nonrespondents to prevalence in respondents (s/r), then

$$\begin{aligned} t &= pr + (1 - p)Br \\ &= r(p + B - Bp) \end{aligned}$$

NOTE: A list of references follows the text.

Table VII. Percent bias for selected respondent-nonrespondent prevalence ratios and selected response rates: Second National Health and Nutrition Examination Survey, 1976-80

Ratio of prevalence rate for nonrespondents to prevalence rate for respondents	Percent of population responding		
	40 percent	45 percent	50 percent
0.50	43	38	33
0.75	18	16	14
0.90	6	6	5
1.00	0	0	0
1.10	-6	-5	-5
1.25	-13	-12	-11
1.50	-23	-22	-20

and the percent bias is

$$\frac{100(r - t)}{t} = \frac{100(1 - p - B + pB)}{p + B - pB}$$

The numbers in table VII were obtained by substituting values for p and B in the above equation. The table shows that bias is related to both differential response and response rate. There is no bias when prevalence is equal in both respondents and nonrespondents. With differential response the percent bias is higher at lower response rates. With only 45 percent response, if the prevalence in nonrespondents were 25 percent lower, or higher, than in respondents, the survey estimate would be 16 percent overestimated, or 12 percent underestimated.

It was shown earlier (table V) that persons with a parent with diabetes or a medical history of borderline or potential diabetes had higher OGTT completion rates than persons without these attributes; the rates of unknown diabetes and impaired glucose tolerance (IGT) are higher for persons with these attributes than without them. To estimate the impact of higher response rates in these higher prevalence groups, adjusted estimates of undiagnosed diabetes or IGT were calculated by direct standardization of estimates based on the OGTT-completed group to estimates based on the entire interviewed sample. Two categories were used in the calculation: Persons with a history of borderline or potential diabetes or a parent with diabetes, and persons without these backgrounds. The category-specific rates of undiagnosed diabetes or IGT in the OGTT-completed group were multiplied by the proportion of the population in each category estimated using all interviewed persons. The sum of these two quantities is the adjusted estimate and is the prevalence that would have been found had the prevalence of the attributes among members of the OGTT-completed group been the same as in the interviewed sample. These adjusted estimates are compared in table VIII with estimates based on the OGTT-completed group used in this report. The adjusted estimate for total prevalence was about 0.1 percent lower than the survey estimate, and the difference was less than 0.4 percent for any age-sex cell, indicating only a very small bias in estimates for either the entire population or for subgroups.

Even though bias due to differential response rates between population subdomains does not appear to be a substantial problem, the estimates based on the NHANES II OGTT data may still be subject to response bias. Because there were no glucose tolerance data on nonrespondents, it is impossible to test this assumption directly. To evaluate the potential impact of differential response, a sensitivity analysis was based on the following model:

$$t = pr + qs + ab$$

where t = true prevalence

p = proportion of sample responding

r = prevalence of undiagnosed diabetes or IGT in responding sample

Table VIII. Potential bias in estimated percent prevalence of undiagnosed diabetes and impaired glucose tolerance due to overresponse by persons with medical history of borderline or potential diabetes or a parent with diabetes: Second National Health and Nutrition Examination Survey, 1976-80

<i>Sex and age</i>	<i>Survey estimate</i>	<i>Adjusted estimate¹</i>	<i>Difference</i>
Percent with undiagnosed diabetes			
Total	3.208	3.139	0.069
Male			
20-44 years.	0.827	0.832	-0.005
45-54 years.	3.553	3.613	-0.060
55-64 years.	3.997	3.886	0.111
65-74 years.	9.478	9.264	0.214
Female			
20-44 years.	0.978	0.891	0.087
45-54 years.	4.700	4.655	0.045
55-64 years.	8.061	8.025	0.036
65-74 years.	7.607	7.301	0.306
Percent with impaired glucose tolerance			
Total	4.642	4.542	0.100
Male			
20-44 years.	1.197	1.193	0.004
45-54 years.	7.273	6.956	0.317
55-64 years.	9.836	9.653	0.183
65-74 years.	8.857	8.791	0.066
Female			
20-44 years.	2.839	2.705	0.134
45-54 years.	6.709	6.540	0.169
55-64 years.	5.239	5.227	0.012
65-74 years.	9.384	9.603	0.219

¹Adjustment made by direct standardization to categories in interviewed sample.

q = proportion of sample not responding who have a parent with diabetes or a history of borderline or potential diabetes

s = prevalence of undiagnosed diabetes or IGT in q

a = proportion of sample not responding who do not have a parent with diabetes or a history of borderline or potential diabetes

b = prevalence of previously undiagnosed diabetes or IGT in r

In table IX, p , r , q , and a were estimated from NHANES II data. Values for the differences between r and s and between r and b were assigned as shown in the row and column labels. The cells show the resulting values for t . The stronger effect on the estimates would be caused by error in estimating the prevalence of unknown diabetes or IGT in the group without a history of borderline or potential diabetes and whose parents did not have diabetes because this is the larger group (about 80 percent of the population). Overestimating or underestimating the prevalence of diabetes or IGT in these nonrespondents by 25 percent would cause about a 15-percent error in the survey estimates.

In addition to these analyses of response bias, there re-

Table IX. Sensitivity of estimated prevalences of undiagnosed diabetes and impaired glucose tolerance to response selection bias in persons with or without medical history of borderline or potential diabetes or a parent with diabetes: Second National Health and Nutrition Examination Survey, 1976-80

<i>Percent difference between prevalence for respondents and nonrespondents with medical history</i>	<i>Percent difference between prevalence for respondents and nonrespondents without medical history</i>				
	-25	-10	0	10	25
Percent with undiagnosed diabetes					
-25	2.8	2.9	3.1	3.2	3.4
-10	2.9	3.0	3.1	3.3	3.4
0	2.9	3.1	3.2	3.3	3.5
10	3.0	3.1	3.3	3.4	3.6
25	3.1	3.2	3.4	3.5	3.7
Percent with impaired glucose tolerance					
-25	4.0	4.3	4.4	4.6	4.8
-10	4.1	4.4	4.6	4.7	5.0
0	4.2	4.5	4.6	4.8	5.1
10	4.3	4.6	4.7	4.9	5.2
25	4.4	4.7	4.9	5.0	5.3

mains the possibility of bias caused by an association among glucose tolerance status, response status, and some unanalyzed or unmeasured variable. Given the information, the assumption that the glucose tolerance status of those who did not participate in the OGTT was like that of those who did seems reasonable. Accepting this assumption makes it possible to use these data to make prevalence estimates for previously undiagnosed diabetes and to explore the association of diabetes status with other variables.

Standard deviations

Sample standard deviation is the square root of sample variance. It is a measure of the dispersion of sample observations about the sample mean. If observations are normally distributed, the standard deviation is useful in describing how an individual observation compares with the sample mean: One standard deviation above and below the mean includes approximately 68 percent of observations; two standard deviations, approximately 95 percent; and 2½ standard deviations, approximately 99 percent.

Standard errors

Because the statistics presented in this report are based on a sample, they may differ from the figures that would have been obtained if a complete census had been taken using the same survey instruments, instructions, interview and examination personnel, and procedures. The probability design of this survey permits the estimation of standard errors that are appropriate for the estimates shown in this report using the assumptions about nonresponse presented above.

Standard error is primarily a measure of sampling variability, that is, the variation that might occur by chance because only a sample of the population is surveyed. As calculated for this report, the standard error also reflects part of the varia-

tion that arises in the measurement process. It does not include estimates of any bias that might be contained in the data. The chances are about 68 out of 100 that an estimate based on a sample using the same procedures and instruments would differ from the value obtained from a complete census by less than the standard error. The chances are about 95 out of 100 that the difference would be less than twice the standard error and about 99 out of 100 that it would be less than 2½ times as large. Estimates of sampling variability in this report were calculated using a Taylor series linearization method.¹⁵ The variances of statistics are approximated using the first two terms of a Taylor series expansion. If the higher order terms of the expansion are negligible and the sample is of a reasonable size for the domains of interest, then the approximation provides reliable variance estimates.

It should be noted that estimates of standard errors are themselves subject to errors that may be large if the number of sample persons on which an estimate is based is small or if these persons are concentrated in a few strata. To make estimates of standard errors, PSU's must be paired. If there were sample persons in fewer than 12 pairs of PSU's, the standard error estimates may be unstable. In the detailed tables of this report these estimates are presented with an asterisk. If there were sample persons in fewer than six pairs of PSU's, the estimates of standard errors were considered too unstable to present in the detailed tables and only the asterisk is shown. In this report estimates for age-sex specific groups of black persons meet these criteria for instability. They are based on relatively small numbers of sample black persons who were concentrated in relatively few strata. In an effort to improve the estimates of standard errors, different schemes for collapsing strata were tried. Each decreased only moderately the concentration of black persons in a few strata and produced substantially the same estimates of variance as the full strata scheme, so the latter was used for analysis in this report.

Data limitations and reliability

The criteria for reliability of estimates shown in this report consisted of the following: (a) That the sample size on which the estimated means or percents were based be at least 30 persons and (b) that the estimated coefficient of variation (that is, the standard error of the estimate divided by the estimate) be less than 30 percent. Thus, if the sample size was too small or if the variation too large, an asterisk was placed next to the value in the table. Such estimates are considered neither precise nor stable enough to meet reliability standards. However, the values are shown to give an impression of the observed distribution and to permit users to combine data into useful categories. For percentile distributions, if there were fewer than 100 sample persons in a subdomain, the estimated 5th and 95th percentiles were replaced with an asterisk; if there were fewer than 50, the 10th and 90th were also replaced.

Combining and comparing estimates

Estimates presented in the detailed tables of this report may be combined or compared by adding, subtracting, or calcu-

lating weighted estimates using the population estimates shown in table II.

The standard error of a sum or difference of estimates can be calculated as follows. Let S be the standard error of a sum, and S_1 and S_2 the standard errors of estimates X_1 and X_2 , then

$$S = [S_1^2 + S_2^2 + 2 \text{ cov}(X_1, X_2)]^{1/2}$$

The formula for the standard error of a difference is the same, except that the covariance term must be subtracted. If estimates X_1 and X_2 are independent, then their covariance is zero and the third term within the radical can be ignored. Independence can be assumed for most of the estimates in this report, but for certain ones that are of particular interest, independence cannot be assumed.

The hypothesis that two proportions are equal can be tested with a statistic that has a standard normal distribution obtained by dividing the difference of the proportions by the standard error of the difference.

The estimates in tables E and G, the total prevalence of diabetes by age and percent desirable weight, are sums of estimates based on those NHANES II sample persons who responded in the interview and those in the OGTT subsample who completed the OGTT. One estimate in the sum is thus based on a sample that is a subset of the sample base for the other estimate in the sum. The two components of the sum are not independent, and it cannot be assumed that their covariances are zero; thus variances for the sums cannot be calculated.

It is possible, however, to make alternate estimates for table E, total prevalence of diabetes, for which standard errors can be calculated by combining the estimates for undiagnosed diabetes based on NHANES II in table 2 with the estimates for diagnosed diabetes based on NHIS in table 5. In the body of the report estimates from NHANES II are compared with those from NHIS and shown to be only slightly larger. The PSU's for NHANES II were constructed from the PSU's for NHIS but, because there is a minuscule probability that the same local areas or sample people were in both surveys, it is reasonable to assume that the covariance of estimates based on these two surveys is negligible. These alternate estimates for the total prevalence of diabetes are shown in table X with their standard errors calculated as described above. The estimates in table 8 of prevalence of all forms of glucose intolerance were also computed with this method.

Analytic methodology

During the NHANES II physical examination, fasting, 1-hour, and 2-hour venipunctures were performed on OGTT subsample examinees. Blood was collected in evacuated specimen tubes containing 10 milligrams potassium oxalate plus 12.5 milligrams sodium fluoride. As soon after collection as possible, NHANES II laboratory technicians centrifuged the tubes and separated the plasma. Samples were refrigerated until shipped in Dry Ice to the Centers for Disease Control. There the plasma was kept frozen until glucose determinations were performed by the Clinical Trials Section, Metabolic Biochemistry Branch, Clinical Chemistry Division.

NOTE: A list of references follows the text.

Table X. Percent and standard error of percent of adults aged 20–74 years with diabetes—sum of known diabetes estimated from the National Health Interview Survey (1976) and unknown diabetes estimated from the Second National Health and Nutrition Examination Survey (1976–80)—by race, sex, and age

Race and sex	Total, 20–74 years	Age				Total, 20–74 years	Age			
		20–44 years	45–54 years	55–64 years	65–74 years		20–44 years	45–54 years	55–64 years	65–74 years
All races ¹		Percent of population				Standard error of percent				
Both sexes.....	6.2	1.9	8.0	11.7	16.8	0.36	0.32	0.83	1.05	0.91
Male.....	5.6	1.6	7.3	9.7	17.3	0.42	0.40	1.31	1.07	1.50
Female.....	6.7	2.1	8.6	13.4	16.3	0.44	0.39	1.17	1.71	1.00
White										
Both sexes.....	5.8	1.6	7.4	11.1	15.9	0.38	0.31	0.93	1.25	0.91
Male.....	5.2	1.3	6.7	9.3	16.4	0.37	0.28	1.28	1.05	1.47
Female.....	6.4	1.8	8.1	12.9	15.5	0.53	0.40	1.27	2.10	1.05
Black										
Both sexes.....	8.7	*2.3	14.3	16.5	24.2	0.95	0.71	3.13	3.85	4.15
Male.....	7.6	*1.9	*13.3	*12.7	*23.1	1.75	1.01	6.48	4.10	7.54
Female.....	9.5	*2.6	15.2	*19.0	25.1	1.41	0.95	3.85	6.06	4.71

¹Includes races other than white or black.

The method of analysis was a hexokinase/glucose-6-phosphate dehydrogenase procedure. It is a microadaptation of the method chosen (National Glucose Reference Method) after extensive testing showed it to be accurate, specific, and reliable, and to have other economic and administrative virtues.⁹ Its precision was studied using an isotope dilution mass spectrometric method for providing essentially bias-free, precise serum glucose analyses. The bias in the reference method was found to be less than 2 percent.⁵³

For quality control, pools were prepared from pooled human plasma. Part of the pool was diluted and another part was concentrated to form low, normal, and high concentration pools. Two systems of quality control were used:

- “Bench” quality control pools inserted by the analysts and measured from two to four times in each analytical run.

- “Blind” quality control samples placed in vials and labeled by the quality control supervisor so that they were indistinguishable from regular samples. The results of these samples were decoded and reviewed by the quality control supervisor.

If the average of replicate values of either “bench” or “blind” quality control samples fell outside their respective established 95 percent confidence limits, the run was repeated. For the plasma glucose quality control pools used during the survey, the coefficient of variation (the standard deviation divided by the mean) ranged from 0.81 to 2.53 percent, indicating very tight quality control and high reliability of the test.⁵⁴ In the sample data there was much greater variation by stand, but there was no trend apparent over time.

NOTE: A list of references follows the text.

Appendix II

Definition of sociodemographic terms

Age—Two ages were recorded for each examinee: Age at last birthday prior to the time of examination and age at the time of the census interview. The age criterion for inclusion in the sample used in this survey was defined as age at the time of census interview. The adjustment and weighting procedures used to produce national estimates were based on age at the interview. Data in the detailed tables and text of the report are also shown by age at the time of the interview.

Race—For each individual, race (as observed by the interviewer) was recorded as “white,” “black,” or “other.” Other includes Japanese, Chinese, American Indian, Korean, Eskimo, and all races other than white and black. Persons of Mexican descent were included with “white” unless definitely known to be American Indian or of another race. Black persons and persons of mixed black and other parentage were recorded as black. When a person of mixed racial background was uncertain about his or her race, the race of the father was recorded.

Sex—For each individual, sex was recorded as observed by the interviewer or examiner.

Family income group—The respondent was given a card listing categories and was instructed to select the one that represented his or her total combined family income for the past 12 months. Respondents were asked to include income from all sources such as wages, salaries, social security or retirement benefits, help from relatives, rent from property, and so forth.

Place of residence—The place of residence of a member of the civilian noninstitutionalized population is classified as inside a standard metropolitan statistical area (SMSA) or outside an SMSA.

Standard metropolitan statistical areas—The definitions and titles of SMSA’s are established by the U.S. Office of

Management and Budget with the advice of the Federal Committee on Standard Metropolitan Statistical Areas.

The definition of an individual SMSA involves two considerations: First, a city (or cities) of at least 50,000 inhabitants that constitutes a central city and identifies the county in which it is located as a central county; second, economic and social relationships with contiguous counties (except in New England) that are metropolitan in character so that the periphery of the specific metropolitan area may be determined. SMSA’s are not limited by State boundaries. In New England SMSA’s consist of towns and cities, rather than counties.

Geographic region—The United States was divided into four broad geographic regions of approximately equal population. The regions, which deviate somewhat from the groups used by the U.S. Bureau of the Census, are as follows:

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

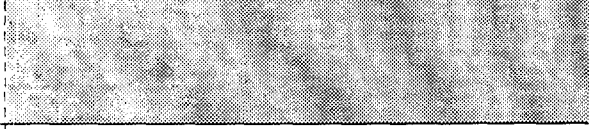
Appendix III

Medical history questionnaire

items related to diabetes

DIABETES	
26a. Do you have diabetes or sugar diabetes? _____	(264) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (27)
b. Did a doctor tell you that you had it? _____	(265) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No
27a. How many living brothers and sisters do you have? Do not count adopted, step or half brothers and sisters. _____	(266) _____ Living 0 <input type="checkbox"/> None (27c)
b. How many of these brothers and sisters have diabetes or sugar diabetes? _____	(267) _____ Diabetics 0 <input type="checkbox"/> None
c. How many of your brothers and sisters are not living? _____	(268) _____ Not living 0 <input type="checkbox"/> None (27e)
d. How many of these brothers and sisters had diabetes or sugar diabetes? _____	(269) _____ Diabetics 0 <input type="checkbox"/> None
e. Including those living and deceased, how many of your brothers and sisters were born before you? _____	(270) _____ Number 0 <input type="checkbox"/> None
f. Is your mother still living? _____	(271) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No
g. Does (did) she have diabetes or sugar diabetes? _____	(272) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No
h. Is your father still living? _____	(273) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No
i. Does (did) he have diabetes or sugar diabetes? _____	(274) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No
28. Have you EVER been told by a doctor that you have –	Yes No
Borderline diabetes?	(275) 1 <input type="checkbox"/> 2 <input type="checkbox"/>
Prediabetes?	(276) 1 <input type="checkbox"/> 2 <input type="checkbox"/>
Potential diabetes?	(277) 1 <input type="checkbox"/> 2 <input type="checkbox"/>
Notes	(278) _____ (279) _____

CHECK ITEM F

	<p>(280) 1 <input type="checkbox"/> "No" in 26a and all of 28 (Check Item G) 2 <input type="checkbox"/> All other (29)</p>
<p>29a. About how old were you when the doctor first told you that you had (diabetes/. . .)?</p>	<p>(281) _____ Years old</p>
<p>b. Were you a patient in a hospital at the time a doctor first told you that you had it?</p>	<p>(282) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (30)</p>
<p>c. Were you in the hospital at that time because you had symptoms of (diabetes/. . .)?</p>	<p>(283) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>30. (Not counting that first time) Have you ever been hospitalized because of your (diabetes/. . .)?</p>	<p>(284) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>31a. Have you EVER taken insulin injections?</p>	<p>(285) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (33)</p>
<p>b. Have you been taking insulin injections for most of the past 12 months?</p>	<p>(286) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>c. Are you NOW taking insulin injections?</p>	<p>(287) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>d. How many years (have you been taking/did you take) them?</p>	<p>(288) _____ Years 0 <input type="checkbox"/> Less than 1 year</p>
<p>32a. Do you know what an insulin reaction is?</p>	<p>(289) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (33)</p>
<p>b. Have you EVER had an insulin reaction?</p>	<p>(290) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (33)</p>
<p>c. How many insulin reactions have you had during the past 30 days?</p>	<p>(291) _____ Number 0 <input type="checkbox"/> None</p>
<p>d. (Including these reactions) About how many have you had during the past 12 months?</p>	<p>(292) _____ Number 0 <input type="checkbox"/> None</p>
<p>33a. Have you EVER taken diabetes pills?</p>	<p>(293) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (34)</p>
<p>b. Have you taken them most of the past 12 months?</p>	<p>(294) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>c. Are you NOW taking diabetes pills?</p>	<p>(295) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (33e)</p>
<p>d. What is the name of the medicine? - Specify</p> <p>_____</p>	
<p>e. How many years (have you been taking/did you take) them?</p>	<p>(296) _____ Years 0 <input type="checkbox"/> Less than 1 year</p>

FORM HES-32 (1-23-76)

<p>34a. Have you EVER been given a WRITTEN diet for your (diabetes/ . . .)?</p>	<p>(297) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (35)</p>
<p>b. Was this diet ordered by a doctor?</p>	<p>(298) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>c. Do you NOW follow this diet?</p>	<p>(299) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>d. How many years (have you been/were you) on a diet for your (diabetes/ . . .)?</p>	<p>(300) _____ Years 0 <input type="checkbox"/> Less than 1 year</p>
<p>35. Do you carry or wear anything which identifies you as a (diabetic/ . . .)?</p>	<p>(301) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p>
<p>36. When did you last see or talk to a doctor about your (diabetes/ . . .)?</p>	<p>(302) _____ Days (303) _____ Weeks (304) _____ Months (305) _____ Years</p>
<p>37a. During the past 12 months did your (diabetes/ . . .) cause you to cut down on the things you usually do?</p>	<p>(306) 1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No (Check Item G)</p>
<p>b. During the past 12 months, about how many days did you cut down on your activity for all or most of the day?</p>	<p>(307) _____ Days 0 <input type="checkbox"/> None (Check Item G)</p>
<p>c. During the past 12 months, about how many days did this condition keep you from work or school, not counting work around the house?</p>	<p>(308) _____ Days 0 <input type="checkbox"/> None</p>
<p>d. During the past 12 months, about how many days did your condition limit the kind or amount of work around the house you could do?</p>	<p>(309) _____ Days 0 <input type="checkbox"/> None</p>
<p>e. During the past 12 months, about how many days has this condition kept you in bed all or most of the day?</p>	<p>(310) _____ Days 0 <input type="checkbox"/> None</p>
<p style="text-align: center;">CHECK ITEM G</p>	<p>(311) 1 <input type="checkbox"/> Under 25 (38) 2 <input type="checkbox"/> 25+ (43)</p>
<p>Notes</p>	<p>(312) _____ (313) _____</p>

Vital and Health Statistics series descriptions

- SERIES 1. Programs and Collection Procedures**—Reports describing the general programs of the National Center for Health Statistics and its offices and divisions and the data collection methods used. They also include definitions and other material necessary for understanding the data.
- SERIES 2. Data Evaluation and Methods Research**—Studies of new statistical methodology including experimental tests of new survey methods, studies of vital statistics collection methods, new analytical techniques, objective evaluations of reliability of collected data, and contributions to statistical theory. Studies also include comparison of U.S. methodology with those of other countries.
- SERIES 3. Analytical and Epidemiological Studies**—Reports presenting analytical or interpretive studies based on vital and health statistics, carrying the analysis further than the expository types of reports in the other series.
- SERIES 4. Documents and Committee Reports**—Final reports of major committees concerned with vital and health statistics and documents such as recommended model vital registration laws and revised birth and death certificates.
- SERIES 5. Comparative International Vital and Health Statistics Reports**—Analytical and descriptive reports comparing U.S. vital and health statistics with those of other countries.
- SERIES 10. Data From the National Health Interview Survey**—Statistics on illness, accidental injuries, disability, use of hospital, medical, dental, and other services, and other health-related topics, all based on data collected in the continuing national household interview survey.
- SERIES 11. Data From the National Health Examination Survey and the National Health and Nutrition Examination Survey**—Data from direct examination, testing, and measurement of national samples of the civilian noninstitutionalized population provide the basis for (1) estimates of the medically defined prevalence of specific diseases in the United States and the distributions of the population with respect to physical, physiological, and psychological characteristics and (2) analysis of relationships among the various measurements without reference to an explicit finite universe of persons.
- SERIES 12. Data From the Institutionalized Population Surveys**—Discontinued in 1975. Reports from these surveys are included in Series 13.
- SERIES 13. Data on Health Resources Utilization**—Statistics on the utilization of health manpower and facilities providing long-term care, ambulatory care, hospital care, and family planning services.
- SERIES 14. Data on Health Resources: Manpower and Facilities**—Statistics on the numbers, geographic distribution, and characteristics of health resources including physicians, dentists, nurses, other health occupations, hospitals, nursing homes, and outpatient facilities.
- SERIES 15. Data From Special Surveys**—Statistics on health and health-related topics collected in special surveys that are not a part of the continuing data systems of the National Center for Health Statistics.
- SERIES 20. Data on Mortality**—Various statistics on mortality other than as included in regular annual or monthly reports. Special analyses by cause of death, age, and other demographic variables; geographic and time series analyses; and statistics on characteristics of deaths not available from the vital records based on sample surveys of those records.
- SERIES 21. Data on Natality, Marriage, and Divorce**—Various statistics on natality, marriage, and divorce other than as included in regular annual or monthly reports. Special analyses by demographic variables; geographic and time series analyses; studies of fertility; and statistics on characteristics of births not available from the vital records based on sample surveys of those records.
- SERIES 22. Data From the National Mortality and Natality Surveys**—Discontinued in 1975. Reports from these sample surveys based on vital records are included in Series 20 and 21, respectively.
- SERIES 23. Data From the National Survey of Family Growth**—Statistics on fertility, family formation and dissolution, family planning, and related maternal and infant health topics derived from a periodic survey of a nationwide probability sample of women 15–44 years of age.

For answers to questions about this report or for a list of titles of reports published in these series, contact:

Scientific and Technical Information Branch
National Center for Health Statistics
Public Health Service
Hyattsville, Md. 20782
301-436-8500

U.S. DEPARTMENT OF HEALTH AND
HUMAN SERVICES
Public Health Service
National Center for Health Statistics
3700 East-West Highway
Hyattsville, Maryland 20782

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300

THIRD CLASS MAIL
BULK RATE
POSTAGE & FEES PAID
PHS/NCHS
PERMIT No. G-281