Chapter 4

Prevalence and Incidence of Non-Insulin-Dependent Diabetes

Susan J. Kenny, PhD; Ronald E. Aubert, PhD; and Linda S. Geiss, MA

SUMMARY

Diabetes is a prevalent disease in the U.S. population. In 1993, ~7.8 million people had been diagnosed as having diabetes. This represents a prevalence rate of 3.1% of the U.S. population. However, rates range from ~1.3% of those age 18-44 years to ~10.4% of those age ≥65 years. Both the prevalence rate for diabetes and the number of people with diabetes have increased steadily since a national system for ascertaining diagnosed diabetes was established in 1958. Diabetes is more prevalent in U.S. blacks, Mexican Americans, and Native Americans, compared with non-Hispanic whites.

In 1990-92, there was an average of ~625,000 new cases of diabetes diagnosed annually in the United States. This represents an incidence rate of 2.42 per 1,000 people per year. This incidence rate has been approximately constant during the past 20 years.

For all ages, ~90% of people with diabetes have non-insulin-dependent diabetes mellitus (NIDDM), but at age >45 years virtually all people with diabetes have NIDDM. In addition to known cases of NIDDM, there is about one undiagnosed case of NIDDM for every diagnosed case, based on oral glucose tolerance testing in U.S. population samples. About 11% of U.S. adults had impaired glucose tolerance (IGT) in national surveys in 1976-80 and 1982-84. Rates of total glucose intolerance (diabetes plus IGT) range from ~7%-14% at age 20-44 years to ~28%-44% at age 45-74 years, depending on the racial/ethnic group studied.

• • • • • • •

INTRODUCTION

NIDDM is a chronic disease that affects the lives of millions of Americans. Monitoring of national trends in the prevalence and incidence of NIDDM is needed so that the burden of diabetes can be assessed, the impact of risk factors can be described, interventions can be developed and their impacts determined, and needs for future health services can be projected. This chapter summarizes estimates of the prevalence and incidence of diagnosed NIDDM in the United States. Data from national surveys and community-based surveys are presented. The prevalence of undiagnosed diabetes and IGT is also included.

METHODS FOR DETERMINING NATIONAL PREVALENCE AND INCIDENCE RATES

NATIONAL HEALTH INTERVIEW SURVEY

Estimates of the prevalence and incidence of self-reported diabetes in the United States can be determined from the National Health Interview Survey (NHIS). The first NHIS was conducted in 1935-36 and >2.5 million people were interviewed. The survey was not initiated again until 1957 but has been conducted continuously since then. Each year the civilian, noninstitutionalized population residing in the United States is sampled using a multistage probability design. From each of the 36,000 to 49,000 randomly selected households, all occupants are interviewed by

personnel of the U.S. Census Bureau. This yields an annual probability sample of ~127,000 individuals. If an individual in the household is unavailable at the time of the interview, proxy responses are obtained from related adults. Details of the sampling methods have been described[1].

Each year since 1982, a one-sixth subsample of survey participants is asked questions about diabetes. Specifically, the following questions are asked: 1) During the past 12 months did anyone in the family have diabetes?, 2) Who was this?, and 3) During the past 12 months did anyone else have diabetes? If a person is reported as having diabetes, he or she is asked when the condition was first noticed. Prior to 1982, the size of the subsample varied and, for some years, no questions about diabetes were asked.

SECOND NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY

Additional estimates of the prevalence of previously diagnosed diabetes, undiagnosed diabetes, and IGT were obtained in the 1976-80 Second National Health and Nutrition Examination Survey (NHANES II)[2,3]. This survey was designed to investigate several medical conditions. Like the NHIS, NHANES II collected self-reported data but, unlike the NHIS, for targeted conditions NHANES II involved a medical examination, detailed clinical assessments, and measurements of blood and urine. In NHANES II, all participants were asked whether they had ever been diagnosed by a physician as having diabetes. Oral glucose tolerance tests (OGTTs) were performed on 66% of a random half sample of the examined adult participants in NHANES II, excluding persons with a medical history of diabetes.

HISPANIC HEALTH AND NUTRITION EXAMINATION SURVEY

As a complement to NHANES II, the Hispanic Health and Nutrition Examination Survey (HHANES) was conducted in 1982-844-6. This survey consisted of probability samples of three Hispanic populations: Mexican Americans in the southwestern United States, Cuban Americans in the Miami, FL area, and Puerto Ricans in the New York City area. Ascertainment of undiagnosed diabetes was obtained by OGTTs as in NHANES II. Previously diagnosed diabetes was based on self-report of a physician diagnosis of diabetes.

ANALYSIS OF SURVEY DATA

In published reports based on the national surveys cited in this chapter, prevalence of known diabetes was based on the number of persons in the survey who reported having physician-diagnosed diabetes. In these reports, the survey data were weighted based on U.S. Census data to reflect the number of U.S. residents that each survey participant represented by age, race, sex, geographic location, and income. Thus, the weighted data provided estimates that were representative of the U.S. population. Using these weights and the survey sample, the number of people reporting diabetes in the survey was extrapolated to reflect a national estimate of diabetes prevalence.

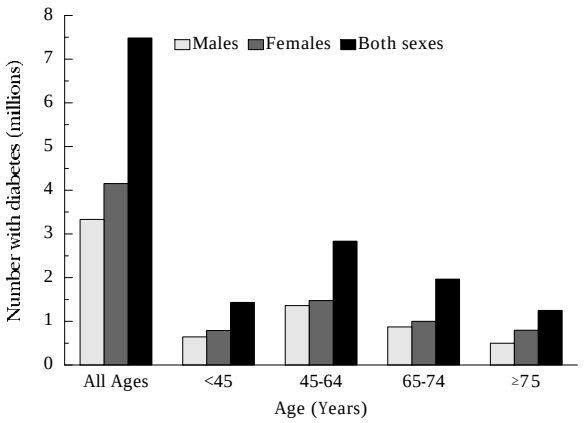
Since the number of people in the NHIS who indicate they have diabetes is small, yearly estimates of prevalence and incidence in this survey tend to have large relative standard errors. This is especially true for estimates from the 1980-92 NHIS, when the sample size of the survey was reduced. Consequently, new analyses were performed for this chapter wherein 3-year average estimates were calculated to produce more stable estimates for 1980-92. Annual incidence of diabetes in the United States was calculated based on the weighted number of people who reported that they were diagnosed with this condition within the past year, divided by the weighted estimate of the survey sample size.

INTERPRETATION OF SURVEY DATA

When interpreting data from any survey sample, the potential for inaccurate or biased data must be considered. Of most importance is the fact that the NHIS and the interview components of NHANES II and HHANES ascertain only cases of diagnosed NIDDM. About half of all people with NIDDM are undiagnosed in the United States[2,4,5], and these people are therefore not included in the NHIS or in the HANES self-report data. However, a number of studies indicate excellent agreement between self-report and medical records concerning a person's diabetes status[7-11]. Further, a study of the Rochester, MN population found that almost all persons with diagnosed diabetes met National Diabetes Data Group (NDDG) criteria for diabetes[12].

Definitions and diagnostic criteria for NIDDM are presented in Chapter 2. Unfortunately, the questions asked of individuals in the national surveys do not generally allow for distinction between insulin-dependent diabetes mellitus (IDDM) and NIDDM. It is estimated, however, that only ~7% of all cases of dia-

Figure 4.1
Number of People with Diagnosed Diabetes (in Millions), by Age and Sex, U.S., 1991-93



Data are the average for the 3 years 1991-93.

Source: References 15-17, National Health Interview Surveys

betes and an even smaller proportion of those age >45 years are due to IDDM[12-14]. Thus, many researchers equate diabetes in adults in population surveys with NIDDM. For these reasons, the results of the national surveys are interpreted as reflecting trends in the prevalence and incidence of NIDDM for persons age ≥25 years.

COMMUNITY SURVEYS

Numerous studies in the United States have estimated the prevalence and incidence of NIDDM in local populations, and summaries of the results of these studies are presented in this chapter (see Chapters 31-34 for detailed data by racial/ethnic group). Comparisons among studies are difficult because they often differ in the study protocol and diagnostic criteria used to define NIDDM. In addition, there are large differences among populations in the presence of genetic, environmental, and lifestyle factors that contribute to development of NIDDM. With these issues in mind, the results of community surveys are presented in this chapter to provide a perspective on the range of NIDDM prevalence and incidence in a variety of U.S. populations.

PREVALENCE OF DIAGNOSED DIABETES

Based on the NHIS, an estimated 7.2 million persons in the United States in 1991, 7.4 million in 1992, and 7.8 million in 1993 were known to have diabetes[15-17]. The total number of people with diagnosed diabetes is shown by age and sex in Figure 4.1 and Table 4.1. About 19% of cases are age <45 years, 38% age 45-64 years, 26% age 65-74 years, and 17% age ≥75 years. About 45% of people with diagnosed diabetes are males, and 55% are females. Estimated rates of diabetes in 1991-93 based on the NHIS are shown in Figure 4.2 and Table 4.2. On average, 2.97% of the U.S. population were known to have diagnosed diabetes in 1991-93. Rates increased from 1.3% at age 18-44 years to >10% at age ≥65 years. In each age group, rates of diagnosed diabetes were equal to or slightly higher for women than for men.

TIME TRENDS IN THE PREVALENCE OF DIABETES

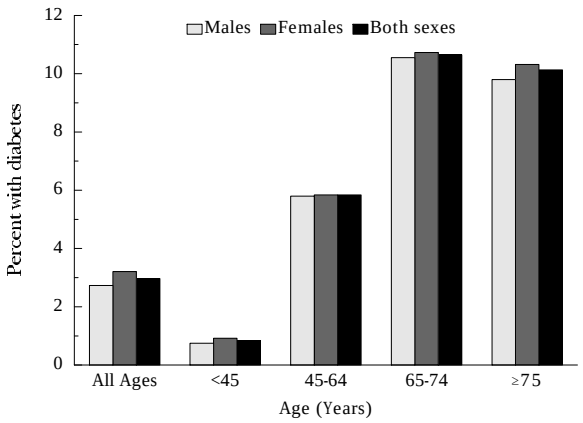
Figure 4.3 shows trends in the prevalence of diagnosed diabetes based on NHIS data since 1958[15-27]. There has been a steady increase in both the number of people with diabetes and the prevalence rate during the past 35 years. The 1991-93 average rate of 2.97% is more than three times the rate in 1960 (0.91%) and eight times the rate in 1935 (0.37%). The steep increase in prevalence over time is partly due to aging of the U.S. population and the higher rates of diabetes in

Table 4.1
Number of People with Diagnosed Diabetes (in Thousands), by Age and Sex, U.S., 1991-93

Age	1991			1992			1993			Average 1991-93		
(years)	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
<45	646	860	1,506	524	777	1,301	761	733	1,494	644	790	1,434
<18			72			87			104			88
18-44			1,433			1,214			1,389			1,345
45-64	1,310	1,398	2,708	1,223	1,492	2,716	1,553	1,528	3,081	1,362	1,473	2,835
65-74	796	1,103	1,899	990	1,113	2,103	833	1,064	1,897	873	1,093	1,966
≥75	425	685	1,110	447	849	1,297	487	854	1,341	453	796	1,249
All ages	3,177	4,046	7,223	3,185	4,232	7,417	3,634	4,179	7,813	3,332	4,152	7,484

Source: References 15-17, National Health Interview Surveys

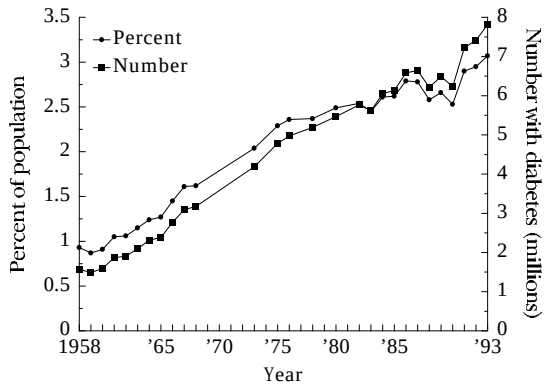
Figure 4.2
Percent of the Population with Diagnosed Diabetes, by Age and Sex, U.S., 1991-93



Data are the average for the 3 years 1991-93.

Source: References 15-17, National Health Interview Surveys

Figure 4.3
Time Trends in the Number and Percent of the Population with Diagnosed Diabetes, U.S., 1958-93



Source: References 15-27, National Health Interview Surveys

older adults. During the past 50 years, the proportion of the population age ≥65 years has risen from 8% to 12%. During the 1980s and also in 1991-93, the prevalence of diabetes in persons age ≥65 years was ~3.5 times the rate for people of all ages. Figure 4.4 shows time trends by age group in the prevalence rate of known diabetes based on NHIS data. Detailed NHIS data on prevalence of diagnosed diabetes by age, sex, and race for the individual years 1958-93 are provided in Appendices 4.1-4.4, and 3-year average rates are shown in Appendix 4.5.

Another reason for the increase in prevalence over time may be a reduction in mortality of persons with diabetes since the early 1970s[28]. During 1968-79, there was a major decline in mortality attributed to diabetes as the underlying cause of death on U.S. death certificates[29]. Between 1980 and 1986, there was a 12% decrease in the age-standardized mortality rate for diabetes as the cause of death, with the largest decrease in individuals age ≥75 years[30,31]. In this age group, there was a 23% decline in the annual mortality rate for deaths attributed to diabetes on death certificates[31]. This decline may be associated with reduction of mortality from cardiovascular diseases, which are the cause of death in 60%-70% of deaths of people with diabetes[30-32]. However, as discussed in Chapter 11, only about 10%-15% of deaths of people with diabetes have diabetes recorded as the underlying cause of death on their death certificates, and it is difficult to assess diabetes mortality from death certificate data.

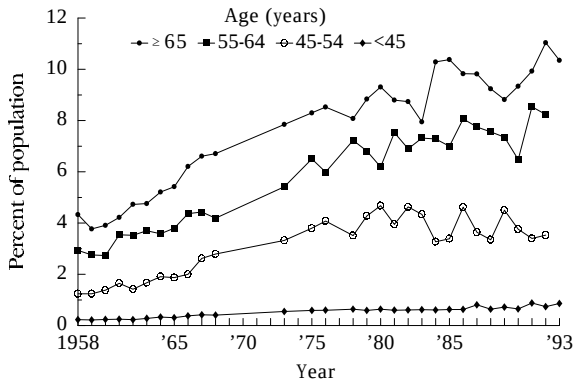
Changes in the criteria used to diagnose diabetes may also have contributed to the increase in prevalence over time. Prior to the mid-1950s, diabetes was often detected and diagnosed on the basis of glycosuria. This method, however, has poor sensitivity and specificity[33], which prompted the American Diabetes Association[34] and the World Health Organization (WHO)[35]

Table 4.2
Percent of the Population with Diagnosed Diabetes, by Age and Sex, U.S., 1991-93

Age	1991			1992			1993			Average 1991-93		
(years)	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
<45	0.76	1.00	0.88	0.61	0.90	0.76	0.88	0.85	0.86	0.75	0.92	0.83
<18			0.11			0.13			0.15			0.13
18-44			1.36			1.15			1.31			1.27
45-64	5.79	5.70	5.74	5.25	5.92	5.60	6.48	5.91	6.19	5.84	5.84	5.84
65-74	9.73	10.90	10.38	11.96	10.92	11.39	9.96	10.37	10.19	10.55	10.73	10.65
≥75	9.51	9.11	9.26	9.68	11.02	10.53	10.21	10.83	10.60	9.80	10.32	10.13
All ages	2.63	3.16	2.90	2.61	3.27	2.95	2.94	3.20	3.07	2.73	3.21	2.97

Source: References 15-17, National Health Interview Surveys

Figure 4.4
Time Trends in the Percent of the Population with Diagnosed Diabetes, by Age, U.S., 1958-93



Source: References 15-27, National Health Interview Surveys

to recommend the use of blood glucose criteria for diabetes diagnosis. The OGTT was soon recognized as being a more sensitive method[36] and became a standard procedure. In addition, in 1979-80, recommendations for diagnostic criteria for diabetes based on blood glucose were promulgated by the NDDG and a WHO expert committee[37,38]. Since the 1960s, availability and use of automated multichannel biochemical blood testing has increased. The net effect of improving the sensitivity of the biochemical measures used for detection of diabetes and the accelerated effort of screening may be an increase in the reported prevalence of diabetes since 1960. However, the increase may very well be real and not an artifact, as the prevalence of risk factors for diabetes, such as overweight and physical inactivity, has also increased over the past decades (see Chapters 7 and 9).

SEX DIFFERENCES IN THE PREVALENCE OF DIAGNOSED DIABETES

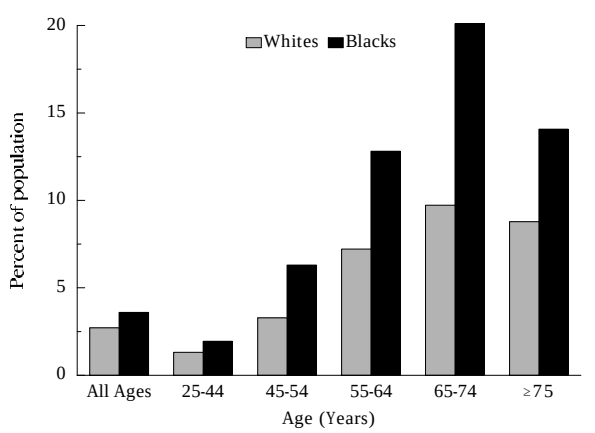
Estimates of the prevalence of diabetes obtained from the NHIS indicate that women have slightly higher rates of diagnosed diabetes than men (Figure 4.2). Based on data from HHANES and NHANES II, the age-standardized rate of total diabetes (diagnosed and undiagnosed combined) in women relative to the rate in men is 1.3 for whites, 1.2 for blacks, 1.1 for Mexicans, and 1.0 for Puerto Ricans[4]. This differential in rates for women versus men was also found for diagnosed and undiagnosed NIDDM separately[2]. However, prevalence rates for men and women obtained from community surveys are not consistently higher for women (see below, Table 4.5). It is likely that differences among studies represent differing distributions of risk factors among the populations, such as body mass index, physical activity, and genetic differences. A review of global estimates of the prevalence of diabetes indicated that the ratio of prevalence in women versus men varied among populations, with no discernable trend[39].

RACIAL DIFFERENCES IN THE PREVALENCE OF DIAGNOSED DIABETES

The prevalence of NIDDM varies substantially among different racial groups in the United States[4,5,28,39]. The NHIS does not permit calculation of reliable prevalence rates for diagnosed diabetes for all racial groups. Rates are available, however, for racial groups categorized as white and black in the NHIS. Age-specific rates for whites and blacks in 1990-92 are shown in Figure 4.5. These data clearly indicate that diabetes is more prevalent in blacks at all ages. Appendix 4.1 shows the number of blacks and whites with diagnosed diabetes in 1991-93.

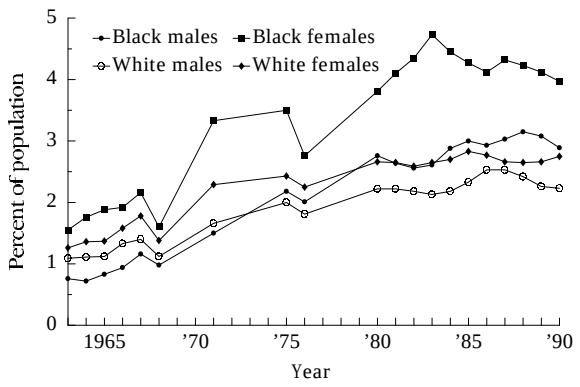
Figure 4.6 shows time trends in the prevalence of diagnosed diabetes for black and white men and women for 1963-90. The difference in prevalence rates for these two racial groups has been increasing since the late 1960s. Prevalence rates for black and white women are consistently higher than rates for black and white men. It is important to recognize that these apparent racial differences may reflect population differences in risk factors, such as obesity, physical activity, genetics, and other factors. Prevalence rates by age and race for the individual years 1983-93 are included in Appendix 4.4, and 3-year average rates

Figure 4.5
Percent of Whites and Blacks with Diagnosed Diabetes, by Age, U.S., 1990-92



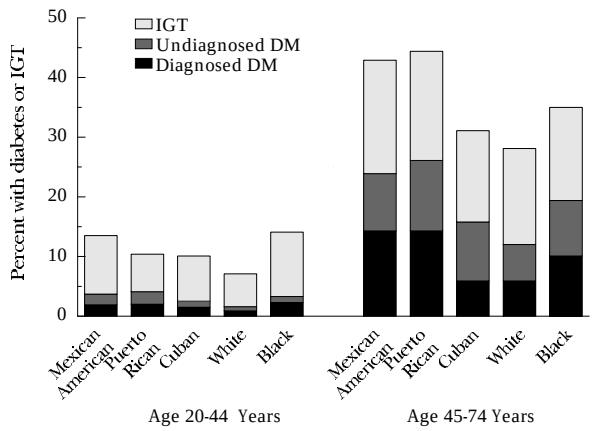
Source: Unpublished analyses of the 1990-92 National Health Interview Surveys

Figure 4.6
Time Trends in the Percent of Black and White Men and Women with Diagnosed Diabetes, U.S., 1963-90



Source: References 15-27, National Health Interview Surveys

Figure 4.7
Percent of U.S. Populations with Diagnosed and Undiagnosed Diabetes and IGT, U.S., 1976-80 and 1982-84



IGT, impaired glucose tolerance; DM, diabetes mellitus.

Source: References 2, 4, and 5; 1976-80 Second National Health and Nutrition Examination Survey and the 1982-84 Hispanic Health and Nutrition Examination Survey

by age for blacks and whites are shown in Appendix 4.5. The epidemiology of diabetes in blacks is reviewed in further detail in Chapter 31.

Estimates of the prevalence of diagnosed diabetes in Hispanics in the U.S. population are available from the HHANES[5]. These data indicate that rates of diagnosed diabetes are higher for persons of Mexican and Puerto Rican descent at age 45-74 years compared with non-Hispanic whites and blacks (Table 4.3). This is also seen for rates of total diabetes (sum of diagnosed and undiagnosed), as shown in Figure 4.7. Community studies complement the HHANES results and also indicate an increased prevalence of NIDDM in Hispanic populations in the United States. Chapter 32 reviews diabetes in the U.S. Hispanic population.

No national survey data provide stable diabetes prevalence estimates for the Native American population. Evidence from community surveys (see Table 4.5) indicates that rates for this ethnic group are very high. The highest rates of NIDDM in the United States, as

Table 4.3
Prevalence of Diabetes and IGT in U.S. Whites, Blacks, and Hispanics, 1976-80 and 1982-84

Race/ethnicity	Age (years)	Diagnosed diabetes (%)	Undiagnosed diabetes (%)	Total diabetes (%)	Impaired glucose tolerance (%)	Total glucose intolerance (%)
Non-Hispanic white	20-44	0.9	0.7	1.6	5.5	7.1
	45-74	5.9	6.1	12.0	16.1	28.1
Non-Hispanic black	20-44	2.3	1.0	3.3	10.8	14.1
	45-74	10.1	9.3	19.3	15.6	34.9
Mexican American	20-44	1.9	1.8	3.8	9.8	13.6
	45-74	14.3	9.6	23.9	19.0	42.9
Puerto Rican	20-44	2.0	2.1	4.1	6.3	10.4
	45-74	14.3	11.8	26.1	18.3	44.4
Cuban American	20-44	1.5	1.0	2.4	7.6	10.0
	45-74	5.9	9.9	15.8	15.3	31.1

IGT, impaired glucose tolerance. Data for whites and blacks are from the 1976-80 Second National Health and Nutrition Examination Survey; data for the three Hispanic groups are from the 1982-84 Hispanic Health and Nutrition Examination Survey of the National Center for Health Statistics. In both, diagnosed NIDDM was ascertained by medical history interview, and undiagnosed NIDDM and IGT were determined by results of a 2-hour, 75 g oral glucose tolerance test in subjects with no medical history of diabetes, using World Health Organization criteria.

Source: References 2, 4, and 5, 1976-80 Second National Health and Nutrition Examination Survey and the 1982-84 Hispanic Health and Nutrition Examination Survey

well as in the world, occur in the Pima Indians of Arizona[40]. The epidemic of NIDDM is not limited to the Pima Indians, however, but is widespread and increasing in other Native American groups[41-45]. Chapter 34 provides details on the epidemiology of diabetes in Native Americans.

INCIDENCE OF DIAGNOSIS OF NIDDM

Based on the 1990-92 NHIS, an estimated ~625,000 people in the United States are diagnosed with diabetes each year. The average annual number of new cases of diabetes in 1990-92 is shown by age and sex in Table 4.4 and Figure 4.8. About 49% of new cases occur in persons age ≥55 years and 9% in people age ≥75 years. About 58% of new cases of diabetes are diagnosed in females and 42% in males.

Age-specific incidence rates per 1,000 population for 1990-92 are shown in Table 4.4 and Figure 4.9. The average annual incidence rate was 2.42 per 1,000 U.S. population, but rates ranged from 1.79 per 1,000 per year at age 25-44 years to 8.63 per 1,000 per year at age 65-74 years. This increase with age is also found in community surveys, and three sources of incidence data are compared in Figure 4.10[46]. Women have slightly higher incidence rates for diagnosis of diabetes than men. Despite this, as discussed in Chapter 9, there is conflicting evidence as to whether gender independently influences the risk for development of NIDDM[28,47].

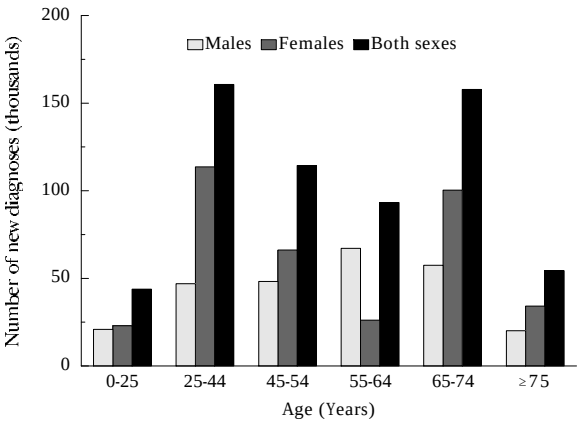
Table 4.4
Average Annual Number of Newly Diagnosed Cases of Diabetes, and Average Annual Number per 1,000 Population, by Age and Sex, U.S., 1990-92

Age (years)	Males	Females	Total
Number per year			
0-24	20,926	22,956	43,882
25-44	46,969	113,665	160,634
45-54	48,246	66,193	114,439
55-64	67,142	26,143	93,285
65-74	57,443	100,386	157,829
≥75	20,157	34,170	54,326
All ages	260,883	363,513	624,396
Number per 1,000 population			
0-24			
25-44		2.76	1.79
45-54	3.79	4.90	4.36
55-64	6.70	2.35	4.41
65-74	7.02	9.93	8.63
≥75	4.51	4.54	4.53
All ages	1.97	2.84	2.42

In cells with no entry, data have been omitted because of small sample size and unreliable estimate.

Source: Unpublished analyses of the 1990-92 National Health Interview Surveys

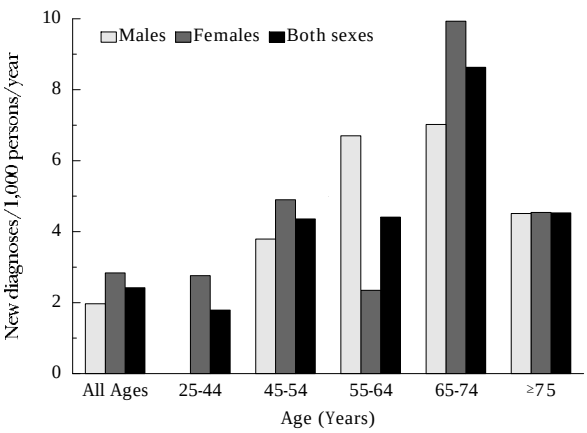
Figure 4.8
Average Annual Number of New Cases of Diagnosed Diabetes (in Thousands), by Age and Sex, U.S., 1990-92



Source: Unpublished analyses of the 1990-92 National Health Interview Surveys

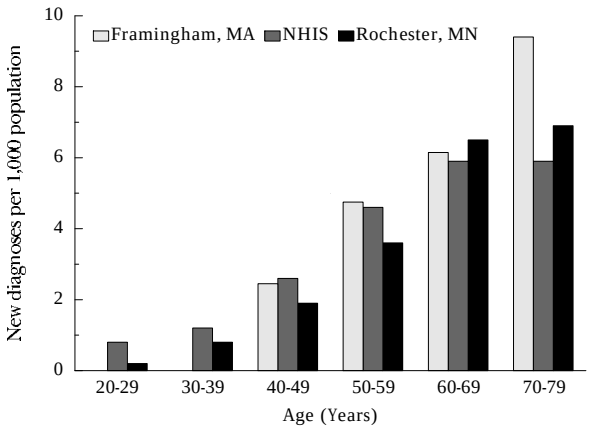
Figure 4.11 illustrates time trends in diabetes incidence based on the 1964-92 NHIS. Incidence rates increased during the 1960s but were relatively constant during 1968-92, with some year-to-year variation that is probably attributable to sampling variability. The estimated incidence rate for diagnosed

Figure 4.9
Average Annual Number of New Diagnoses of Diabetes per 1,000 Population, by Age and Sex, U.S., 1990-92



Source: Unpublished analyses of the 1990-92 National Health Interview Surveys

Figure 4.10
Incidence of Diagnosis of NIDDM in Middle-Aged Men in Studies in the U.S.



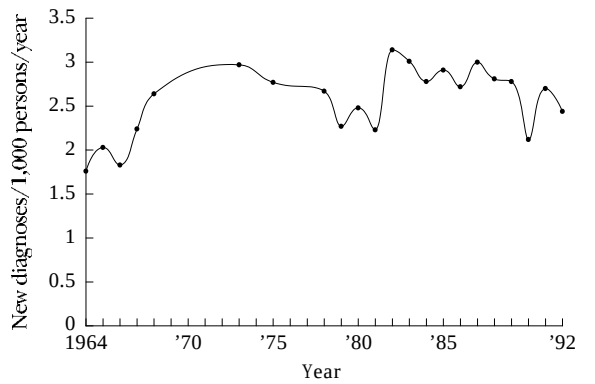
NHIS, National Health Interview Survey.

Source: Reference 46

diabetes in 1990-92 (2.42 per 1,000) is 1.4 times the rate in 1964 (1.76 per 1,000) and 6.4 times the rate in 1935-36 (0.38 per 1,000). Numbers and rates for the total population based on the NHIS surveys of 1964-92 are shown in Appendix 4.6, and 3-year average annual incidence rates for men and women by age for 1979-92 are presented in Appendix 4.7.

Sample sizes for incident cases of diagnosed diabetes in the NHIS are not large enough to compute reliable incidence rates for different racial groups. Community surveys, however, indicate a wide diversity of incidence rates for differing racial groups (see Table 4.6). As with prevalence, incidence rates for blacks, Hispanics, and Native Americans are higher than for whites. It has been hypothesized that the high rates of diabetes for Native Americans are associated with a genetic predisposition to insulin resistance and obesity that evolved as a survival strategy in response to fluctuating food supplies[48-50]. About 31% of the Hispanic gene pool is derived from Native American genes, and this genetic admixture has been associated with increased rates of diabetes in the U.S. Hispanic population[51-54]. Lifestyle factors such as decreased physical activity, change in diet including increased caloric intake, and rapid modernization into Western society are strong contributors to increased diabetes in these populations[55]. The specifics of risk factors for NIDDM are summarized in Chapter 9, and racial differences in NIDDM for African Americans, Hispanics, Native Americans, and Asian Americans are reviewed in Chapters 31-34.

Figure 4.11
Time Trends in the Annual Number of New Diagnoses of Diabetes per 1,000 Population, U.S., 1964-92

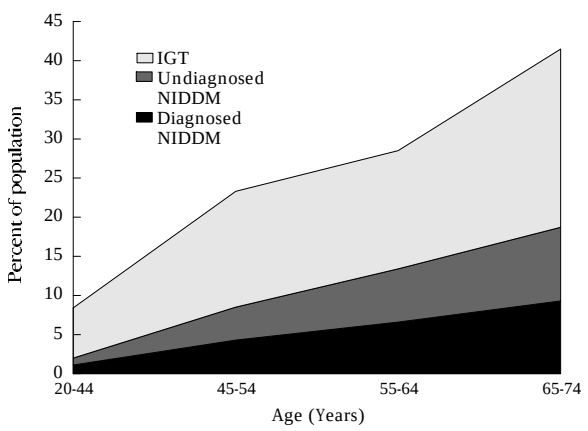


Source: Reference 30 and unpublished analyses of the 1990-92 National Health Interview Surveys

UNDIAGNOSED NIDDM

Data from the 1976-80 NHANES II and the 1982-84 HHANES provide estimates of the prevalence of undiagnosed NIDDM, i.e., people who meet diagnostic criteria for diabetes but who have never been diagnosed. These results are presented in Table 4.3 and Figures 4.7 and 4.12. Based on these surveys, the prevalence of undiagnosed NIDDM was as great as that of diagnosed diabetes in the United States[2,5]. The

Figure 4.12
Prevalence of Undiagnosed and Diagnosed Diabetes and IGT in the U.S. Population, 1976-80



IGT, impaired glucose tolerance.

Source: Reference 2, 1976-80 Second National Health and Nutrition Examination Survey

true prevalence of diabetes in the United States was therefore twice the rate of self-reported, physician-diagnosed diabetes.

The prevalence of undiagnosed diabetes increases with age for both men and women, and 10%-15% of the adult population age ≥50 years have undiagnosed NIDDM, depending on race/ethnicity[2,5]. The percentage of diabetes that is undiagnosed is 50% for whites, 44% for blacks, and 42% for Mexican Americans[4]. When the prevalence of undiagnosed diabetes is age-standardized, rates for blacks and for Mexican Americans are, respectively, 1.5 and 1.7 times the rate for whites[4,56]. Therefore, not only do these racial groups have a higher incidence and prevalence of known diabetes, but they also have higher rates of undiagnosed diabetes. Combining estimates of previously diagnosed and undiagnosed diabetes yields prevalences of 16%-26% for persons age ≥45 years in minority populations (Table 4.3).

Two population-based studies have shown that undiagnosed NIDDM is associated with substantial morbidity. Data from southern Wisconsin indicate that the prevalence of retinopathy at clinical diagnosis of diabetes is ~21% and that the onset of NIDDM may occur 9-12 years before its clinical diagnosis[57]. In NHANES II, persons with undiagnosed diabetes had unfavorable risk factor profiles and had prevalences of angina, stroke, and history of myocardial infarction that were two to three times those of people with normal glucose tolerance[58].

IMPAIRED GLUCOSE TOLERANCE

In 1979-80, the NDDG and the WHO recommended that the term impaired glucose tolerance (IGT) be used to characterize persons with abnormal glucose tolerance previously categorized as borderline, asymptomatic, or chemical diabetes[37,38]. The NDDG defines IGT as fasting plasma glucose <140 mg/dl and, after 75 g oral glucose, a 1-hour midtest value of ≥200 mg/dl and a 2-hour value of 140-199 mg/dl. The WHO criteria omit the 1-hour value and are in wider use in the United States and internationally. The use of WHO criteria classifies more people as IGT compared with NDDG criteria. Using WHO criteria, the prevalence of IGT in the U.S. adult population in 1976-80 was estimated to be 11.2%, ranging from 6.4% at age 20-44 years to 22.8% at age 65-74 years[2] (Figure 4.12). Epidemiologic studies have shown that IGT is associated with increased risk for cardiovascular disease and subsequent development of NIDDM but not for microvascular complications.

The prevalence of IGT follows similar trends seen for the prevalence of NIDDM. Based on data from NHANES II and HHANES, the prevalence of IGT increases with age and varies with race (Figures 4.7 and 4.12). For persons age 20-44 years, the prevalence of IGT ranges from 5.5% in non-Hispanic whites to 10.8% in blacks (Table 4.3). Differences among the racial groups were less evident in older persons, ranging from 15.3% in Cuban Americans to 19.0% in Mexican Americans age 45-74 years. The standard errors for these estimates, however, are large enough for these racial differences not to be statistically significant.

COMMUNITY STUDIES

PREVALENCE OF NIDDM

Numerous community-based surveys have been conducted in the United States to estimate the prevalence of NIDDM (Table 4.5)[59-69]. The target population, sampling methodology, and diagnostic criteria used to define diabetes differ among studies, making comparison of community rates difficult. In addition, genetic, socioeconomic, environmental, and other risk factors associated with diabetes are different in each community and may contribute to differences in estimated prevalence rates. Prevalence rates from community surveys, however, are similar to those from the national surveys when similar methodologies are used.

INCIDENCE OF NIDDM

Longitudinal and retrospective community-based studies have been conducted by independent researchers in the United States to estimate the incidence of NIDDM (Table 4.6)[13,40,61,69-73]. As with community studies of prevalence, study characteristics of sampling methodology and diagnostic criteria differ among studies. In addition, populations under study differ in genetics, environment, and socioeconomic factors that may influence the development of NIDDM.

Dr. Susan J. Kenny is Senior Biostatistician, Quintiles Inc., Research Triangle Park, NC; Dr. Ronald E. Aubert is Epidemiologist, Prudential Insurance Co. of America, Atlanta, GA; and Linda S. Geiss is Statistician, Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA.

Table 4.5

Community Surveys of Diabetes Prevalence

Year and Ref.	Population and methodology	Sample size	Diagnostic criteria	Prevalence per 1,000
1979-82 Ref. 59	A population-based study of 1,288 Mexican Americans (MA) and 929 non-Hispanic whites (NHW) was conducted in three San Antonio, TX neighborhoods: a low-income barrio, a middle-income neighborhood, and a high-income suburb. The study population included men and non-pregnant women age 25-65 years. Equal numbers of both ethnic groups were sampled using stratified random sampling. Non-Hispanic whites were not sampled in the barrio. Each neighborhood was sampled over a period of ~1 year.	496 (low income) 927 (mid income) 963 (high income) 2,386 total 64% response rate	NDDG; known diabetes was defined as current use of insulin or oral antidiabetic drugs	Neighborhood Low / Mid / High MA Men 25-34: 40 / 16 / 0 35-44: 94 / 78 / 31 45-54: 152 / 225 / 109 55-64: 300 / 306 / 120 Age-adj.: 137 / 132 / 65 MA Women 25-34: 14 / 11 / 38 35-44: 110 / 77 / 14 45-54: 173 / 83 / 37 55-64: 342 / 184 / 63 Age-adj.: 164 / 70 / 31 NHW Men 25-34: 17 / 0 35-44: 37 / 0 45-54: 122 / 49 55-64: 115 / 110 Age-adj.: 70 / 46 NHW Women 25-34: 0 / 0 35-44: 47 / 26 45-54: 93 / 0 55-64: 179 / 72 Age-adj.: 73 / 22
1981 Ref. 60	Three areas of densest population in Starr County, TX (pop. 27,266) were randomly sampled. These areas constituted 50% of the county population and 97% were Mexican American. Approximately 10% of the county population was targeted.	2,498	Presence of symptoms, fasting glucose ≥140 mg/dl or 2-hour OGTT ≥200 mg/dl at midtest	Age / Men / Women 15-24: 0.0 / 4.0 25-34: 26.0 / 4.0 35-44: 33.0 / 57.0 45-54: 126.0 / 108.0 55-64: 165.0 / 190.0 65-74: 167.0 / 170.0 ≥75: 176.0 / 80.0 Total: 69.0 / 67.0
1979-82 Ref. 61	All individuals with physician-diagnosed diabetes living in the cities of Wadena (pop. 4,699), Marshall (pop. 11,131), and Grand Rapids (pop. 7,934), MN were identified by medical chart review. Secondary sources such as pharmacies, nursing homes, and civic organizations were used for patient identification.	595 (91% were NIDDM)	Physican-diagnosed diabetes determined from chart review	Age / Men / Women ≤15: 1.2 / 0.8 15-29: 3.7 / 1.9 30-39: 7.0 / 9.2 40-49: 10.8 / 14.3 50-59: 30.7 / 33.4 60-69: 50.5 / 50.9 ≥70: 93.8 / 50.9 Age-adj.: 14.4 / 17.5
1986-88 Ref. 62	All known physician-diagnosed diabetic individuals and all other residents age ≥20 years (n=4699) residing in Wadena, MN were targeted. The adult resident population was sampled using a stratified random sample based on age, gender, and use of prescription medication, with 50 persons sampled in each stratum.	87 known diabetic (71% of diabetic pop.) 389 sampled (65% of pop.)	NDDG and WHO criteria. NIDDM was defined by C-peptide >0.2 pmol/ml at 90 minutes after an Ensure challenge test	NDDG criteria Age / Men / Women / Total 20-39: 8.2 / 8.2 / 8.2 40-59: 100.3 / 87.4 / 91.3 ≥60: 140.9 / 249.1 / 194.1 Total: 90.3 / 107.0 / 99.5 Age-adj.: 64.3 / 95.4 / 77.6 WHO criteria Age / Men / Women / Total 20-39: 8.2 / 8.2 / 8.2 40-59: 104.4 / 87.4 / 93.2 ≥60: 140.9 / 272.1 / 206.8 Total: 74.3 / 101.6 / 104.8 Age-adj.: 65.7 / 101.6 / 81.1

Table 4.5—Continued next page

Table 4.5 Continued

Year and Ref.	Population and methodology	Sample size	Diagnostic criteria	Prevalence per 1,000
1979-80 Ref. 63	All primary care physicians practicing in an 11-county area in southern Wisconsin were invited to participate by allowing chart review. All patients with diabetes were identified from physicians' lists and their charts were reviewed.	8,135	Physician-diagnosed diabetes	Age / Men / Women / Total 30-39 / 3.8 / 4.1 / 3.9 40-49 / 9.0 / 8.9 / 9.0 50-59 / 20.0 / 19.8 / 19.9 60-69 / 35.1 / 33.2 / 34.0 70-79 / 44.1 / 45.2 / 44.7 ≥80 / 36.4 / 30.1 / 32.2 Age-adj. / 10.1 / 9.8 / 9.9
1945-70 Ref. 64	Medical records for all residents of Rochester, MN were reviewed for diagnosis of diabetes. Medical exam followup was done for identified patients.	1,470	Postprandial glucose values and current age were used to determine diabetes in 81% of patients. GTT was used for remaining 19%	Age / Men / Women / Total <15 / 0.6 / 0.5 / 0.6 15-29 / 3.7 / 2.1 / 2.7 30-39 / 5.5 / 5.7 / 5.6 40-49 / 13.4 / 11.8 / 12.6 50-59 / 36.7 / 22.0 / 28.5 60-69 / 72.3 / 50.7 / 59.3 ≥70 / 83.8 / 77.5 / 79.6 Age-adj. / 18.6 / 14.3 / 16.1
1972-84 Ref. 65	All adults age 30-95 years residing in Rancho Bernardo, CA (pop. 6,029) were invited to participate. This target population was predominately white and upper-middle class. Nearly one-half were retirees.	4,944 (82% of pop.)	Known diabetes was defined by history as diagnosed by personal physician. Previously unknown diabetes was defined as fasting plasma glucose ≥140 mg/dl	Known diabetes Age / Men / Women 30-39 / 3.4 / 17.8 40-49 / 37.9 / 6.7 50-59 / 54.1 / 32.6 60-69 / 80.6 / 36.3 ≥70 / 74.6 / 47.3 Total / 60.1 / 32.2 Fasting hyperglycemia Age / Men / Women 30-39 / 11.4 / 6.5 40-49 / 47.8 / 22.0 50-59 / 86.5 / 27.6 60-69 / 41.9 / 31.1 ≥70 / 32.6 / 21.8 Total / 42.8 / 24.4
1984-86 Ref. 66	This geographically based case-control study was conducted in two southern Colorado counties, which consisted of 44% Hispanic and 55% Anglo persons. Diabetic cases were identified by review of medical records in all health care facilities. Nondiabetic controls were selected using a two-stage random sample of households.	343 cases 607 controls	Confirmed diabetes had to have self-report of disease and meet WHO criteria. Undiagnosed diabetes had no prior history but met WHO criteria.	Confirmed NIDDM, Hispanic Age / Men / Women 30-39 / 8 / 6 40-49 / 36 / 26 50-59 / 74 / 110 60-69 / 82 / 124 70-74 / 67 / 190 Age-adj. / 33 / 49 Confirmed NIDDM, Anglo Age / Men / Women 30-39 / 1 / 5 40-49 / 9 / 6 50-59 / 46 / 20 60-69 / 53 / 25 70-74 / 29 / 62 Age-adj. / 18 / 12 Previously undiagnosed, Hispanic Age / Men / Women 30-39 / 0 / 0 40-49 / 0 / 40 50-59 / 83 / 53 60-69 / 65 / 111 70-74 / 0 / 294 Age-adj. / 22 / 43 Previously undiagnosed, Anglo Age / Men / Women 30-39 / 0 / 0 40-49 / 0 / 0 50-59 / 19 / 56 60-69 / 65 / 57 70-74 / 0 / 105 Age-adj. / 12 / 21

Table 4.5—Continued next page

Table 4.5 Continued

Year and Ref.	Population and methodolgy	Sample size	Diagnostic criteria	Prevalence per 1,000
1946 Ref. 67	All inhabitants of Oxford, MA (pop. 4,983) were invited to participate in population screening. Capillary blood samples were tested in the field. Venous blood samples were subsequently taken 1-1.5 hours after eating for measurement of glucose. Persons with blood glucose levels >160 mg/dl were retested and 100-g OGTT was performed on borderline cases.	3,518 (71% of pop.)	Newly diagnosed was defined as blood glucose >170 mg/dl or capillary blood glucose >200 mg/dl. History of diabetes was confirmed.	Previous history: 11 Newly diagnosed: 9
1964 Ref. 68	Medical questionnaires were mailed to most legal residents of Sudbury, MA who were age ≥15 years. A 2-hour postprandial venous glucose was measured. People >110 mg/dl were retested postprandially and persons >130 mg/dl were given a 100-g OGTT. A random sample of 5% of the population received an OGTT also.	4,626 (76% of pop.)	Confirmed history used chart review or diagnostic OGTT and/or postprandial values ≥200 mg/dl. New cases used postprandial values that equate to NDDG criteria for IGT and diabetes combined.	Confirmed diabetes Age / Men / Women / Total 15-24: 0.0 / 0.0 / 0.0 25-34: 6.0 / 3.0 / 4.0 35-44: 11.0 / 0.0 / 6.0 45-54: 34.0 / 7.0 / 21.0 55-64: 36.0 / 23.0 / 29.0 65-74: 139.0 / 33.0 / 82.0 ≥75: 53.0 / 59.0 / 57.0 Total: 18.0 / 6.0 / 11.0 Newly diagnosed diabetes (plus IGT) Age / Men / Women / Total 15-24: 0.0 / 0.0 / 0.0 25-34: 4.0 / 0.0 / 2.0 35-44: 0.0 / 3.0 / 1.0 45-54: 22.0 / 7.0 / 14.0 55-64: 7.0 / 29.0 / 19.0 65-74: 38.0 / 33.0 / 35.0 ≥75: 53.0 / 98.0 / 86.0 Total: 6.0 / 7.0 / 7.0
1959-65 Ref. 69	During 1959-60, 88% of the population of Tecumseh, MI participated in a comprehensive exam. A second exam was conducted in 1962-65. Only participants age ≥20 years were included in prevalence estimates.	2,749 men 2,986 women	Physician diagnosis of diabetes, use of insulin or oral hypoglycemic agents	Age / Men / Women 20-39: 5.0 / 7.0 40-54: 23.0 / 31.0 ≥55: 57.0 / 89.0 Total: 20.0 / 29.0

NDDG, National Diabetes Data Group; OGTT, oral glucose tolerance test; WHO, World Health Organization; IGT, impaired glucosed tolerance.

Source: References are listed within the table

Table 4.6
Community Surveys of Diabetes Incidence

Year and Ref.	Population and methodology	Sample size	Diagnostic criteria	Annual incidence rate per 1,000
1979-87 Ref. 70	A population-based baseline study was conducted in 1979-82. Households from several San Antonio, TX census tracts were randomly sampled and the sampling was stratified to include equal numbers of Mexican Americans (MA) and non-Hispanic whites (NHW). All men and nonpregnant women age 25-64 years were eligible. In 1987, an 8-year follow-up study was conducted to ascertain the incidence of NIDDM.	671 MA 306 NHW	NDDG at baseline; WHO at followup	Men Age: 25-34: MA 3.5, NHA 0.0; 35-44: 8.5, 0.0; 45-54: 5.4, 3.6; 55-64: 16.0, 0.0; Total: 7.5, 1.0 Women Age: 25-34: MA 5.6, NHA 0.0; 35-44: 6.5, 2.3; 45-54: 14.5, 2.9; 55-64: 9.4, 8.5; Total: 8.6, 3.5 Total Age: 25-34: MA 4.9, NHA 0.0; 35-44: 7.4, 1.4; 45-54: 10.4, 3.2; 55-64: 12.2, 5.1; Total: 8.1, 2.5
1965-90 Ref. 40	Since 1965, a longitudinal study of diabetes has been conducted among residents (Pima and Papago Indians) of the Gila River Indian Community, AZ. Each resident age >4 years is invited for a biennial examination.	41,844 person-years of followup	WHO criteria	A total of 736 cases of diabetes developed during 41,844 person-years of followup, resulting in an incidence of 17.6
1954-68 Ref. 71	Participants age 33-67 years in the 3rd biennial exam of the Framingham, MA study who were not diagnosed as glucose intolerant were chosen. The development of glucose intolerance from the 4th through the 10th biennial exam was the measurement of interest	2,272 men 2,810 women 5,082 total	100 g OGTT with 1-hour value >205 mg/dl; 2-hour value >140; insulin use; oral drug use with glucose >150 mg/dl	Age: <40: Men 3.4, Women 2.1; 40-49: 4.9, 3.5; 50-59: 5.8, 4.9; ≥60: 4.3, 5.9; Total: 4.8, 3.9
1972-87 Ref. 72	Between 1972 and 1974, 82% of all residents of a geographically defined upper-middle class white community of Rancho Bernardo, CA participated in a baseline study in which the presence of NIDDM was established All participants were invited to attend the 1984-87 follow-up exam, during which progression to diabetes was established.	1,847	NIDDM was defined as fasting plasma glucose ≥140 mg/dl, 2-hour glucose ≥200 mg/dl, or a reported history of diabetes	Age: 40-49: Men 5.2, Women 2.1; 50-59: 6.0, 6.8; 60-69: 11.0, 8.6; 70-79: 9.9, 13.9; Total: 8.5, 7.4; Age-adj.: 8.5, 7.5
1979-82 Ref. 61	All individuals with physician-diagnosed diabetes living in the three-city area of Wadena (pop. 4,699), Marshall (pop. 11,131), and Grand Rapids (pop. 7,934), MN were identified by medical chart review. Secondary sources such as pharmacies and nursing homes were used to obtain information on diabetic cases.	595 (91% were NIDDM)	Physician-diagnosed diabetes in the medical chart. NIDDM was defined as not ketosis prone and not using insulin for duration of disease	All cities combined, age-standardized rates: Men 2.9, Women 3.8, Total 3.3
1973-81 Ref. 73	Participants who were randomized into the Usual Care group in the MRFIT and who were free from symptoms of diabetes at baseline exam (1973-76) were included in this followup study (1978-81). Participants were men age 35-57 years from several ethnic backgrounds from 22 clinical centers in the United States	6,000	Documented use of insulin or oral hypoglycemic drugs, two consecutive annual fasting glucose values ≥140 mg/dl	Yearly incidence: Year 1: 5.1; Year 2: 6.1; Year 3: 9.1; Year 4: 9.9; Year 5: 14.4 Average annual incidence, 8.2

Table 4.6—Continued next page

Table 4.6 Continued

Year and Ref.	Population and methodology	Sample size	Diagnostic criteria	Annual incidence rate per 1,000		
1973-81 Ref. 13	This population-based study conducted in Rochester, MN identified all residents with diabetes through a central medical index. Medical records were reviewed for diagnosis of diabetes. Results were stratifed by presence/absence of obesity (relative weight ≥1.2) at diagnosis.	1,031 NIDDM	Fasting blood glucose >110 mg/dl; 2-hour postchallenge glucose 110-140 mg/dl; or medical chart review	Obese NIDDM		
				Age	Men	Women
				30-39	3.1	2.3
				40-49	8.5	8.3
				50-59	25.7	19.2
				60-69	30.6	31.5
				70-79	32.2	31.5
				≥80	21.5	24.5
				Age-adj.	8.6	8.0
				Non-obese NIDDM		
				Age	Men	Women
				30-39	2.6	1.2
				40-49	5.7	2.1
				50-59	12.8	3.9
				60-69	23.0	13.0
				70-79	28.0	23.5
				≥80	34.3	23.5
				Age-adj.	6.4	4.6
1977-79 Ref. 69	During 1959-60, 88% of the population of Tecumseh, MI participated in a comprehensive health exam. A second series of exams were given in 1962-65. During 1977-79, the health status of persons classified as nondiabetic in previous exams was ascertained. Information about these individuals was obtained from either a clinic visit or death certificates. Blood glucose measurements were not done.	1,832 men 2,049 women	Direct question to patient about diabetes; listing of diabetes on the death certificate	Age	Men	Women
				20-39	1.8	1.7
				40-54	3.8	4.0
				≥55	4.6	6.5
				Total	2.8	3.0
				Age-adj.	4.3	5.5

NDDG, National Diabetes Data Group; WHO, World Health Organization; OGTT, oral glucose tolerance test; MRFIT, Multiple Risk Factor Intervention Trial.

Source: References are listed within the table

REFERENCES

1. Adams PF, Benson V: Current estimates from the National Health Interview Survey. National Center for Health Statistics. *Vital and Health Statistics*, Vol. 10, no. 181, 1991
2. Harris MI, Hadden WC, Knowler WC, Bennett PH: Prevalence of diabetes and impaired glucose tolerance and plasma glucose levels in the U.S. population aged 20-74 yr. *Diabetes* 36:523-34, 1987
3. National Center for Health Statistics: Plan and operation of the Second National Health and Nutrition Examination Survey. *Vital and Health Statistics*, Series 1, no. 15, 1981
4. Harris MI: Epidemiological correlates of NIDDM in Hispanics, whites, and blacks in the U.S. population. *Diabetes Care* 14 (Suppl. 3):639-48, 1991
5. Flegal KM, Ezzati TM, Harris MI, Haynes SG, Juarez RZ, Knowler WC, Perez-Stable EJ, Stern MP: Prevalence of diabetes in Mexican Americans, Cubans, and Puerto Ricans for the Hispanic Health and Nutrition Examination Survey, 1982-1984. *Diabetes Care* 14 (Suppl. 3):628-38, 1991
6. National Center for Health Statistics: Plan and operation of the Hispanic Health and Nutrition Examination Survey 1982-84. *Vital and Health Statistics*, Series 1, no. 19, 1985
7. Paganini-Hill A, Ross RK: Reliability of recall of drug usage and other health-related information. *Am J Epidemiol* 116:114-22, 1982
8. Bush TL, Miller SR, Golden AL, Hale WE: Self-report and medical record report agreement of selected medical conditions in the elderly. *Am J Public Health* 79:1554-56, 1989
9. Kehoe R, Wu SY, Leske MC, Chylack LT: Comparing self-reported and physician-reported medical history. *Am J Epidemiol* 139:813-18, 1994
10. Heliovaara M, Aromaa A, Klaukka T, Knekt P, Joukamaa M, Impivaara O: Reliability and validity of interview data on chronic diseases. *J Clin Epidemiology* 46:181-91, 1993
11. Midthjell K, Holmen J, Bjorndal A, Lund-Larsen PG: Is questionnaire information valid in the study of a chronic disease such as diabetes. The Nord-Trondelag diabetes study. *J Epidemiol Community Health* 46:537-42, 1992
12. Melton LJ, Ochi JW, Palumbo PJ, Chu CP: Sources of disparity in the spectrum of diabetes at incidence and prevalence. *Diabetes Care* 6:427-31, 1983
13. Melton LJ, Palumbo PJ, Chu DP: Incidence of diabetes mellitus by clinical type. *Diabetes Care* 6:75-86, 1983
14. Harris MI, Robbins DC: Prevalence of adult-onset IDDM in the U.S. population. *Diabetes Care* 17:1337-40, 1994
15. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1991. *Vital and Health Statistics*, Series 10, no. 184, 1992
16. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1992. *Vital and Health Statistics*, Series 10, no. 189, 1994
17. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1993. *Vital and Health Statistics*, Series 10, no. 190, 1994
18. Harris MI: Prevalence of noninsulin-dependent diabetes and impaired glucose tolerance. Chapter VI in *Diabetes in America*, Harris MI, Hamman RF, eds. NIH publ. no. 85-1468, 1985
19. Drury TF, Powell AL: Prevalence, impact, and demography of known diabetes in the United States. National Center for Health Statistics, *Advance Data*, no. 114, February 12, 1986
20. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1983. *Vital and Health Statistics*, Series 10, no. 154, 1986
21. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1984. *Vital and Health Statistics*, Series 10, no. 156, 1986
22. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1985. *Vital and Health Statistics*, Series 10, no. 160, 1986
23. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1986. *Vital and Health Statistics*, Series 10, no. 164, 1987
24. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1987. *Vital and Health Statistics*, Series 10, no. 166, 1988
25. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1988. *Vital and Health Statistics*, Series 10, no. 173, 1989
26. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1989. *Vital and Health Statistics*, Series 10, no. 176, 1990
27. National Center for Health Statistics: Current estimates from the National Health Interview Survey, 1990. *Vital and Health Statistics*, Series 10, no. 181, 1991
28. Nelson RG, Everhart JE, Knowler WC, Bennett PH: Incidence, prevalence, and risk factors for non-insulin-dependent diabetes mellitus. *Primary Care* 15:227-50, 1988
29. Harris MI, Entmacher P: Mortality from diabetes. Chapter XXIX in *Diabetes in America*, Harris MI, Hamman RF, eds. NIH publ. no. 85-1468, 1985
30. Centers for Disease Control: *Diabetes Surveillance 1993*. U.S. Dept. of Health and Human Services, Centers for Disease Control, Atlanta, GA, 1993
31. Wetterhall SF, Olson DR, DeStefano F, Stevenson JM, Ford ES, German RR, Will JC, Newman JM, Sepe SJ, Vinicor F: Trends in diabetes and diabetic complications, 1980-1987. *Diabetes Care* 15:960-67, 1992
32. Kleinman, JS, Donahue RP, Harris MI, Finucane FF, Madans JH, Brock DB: Mortality among diabetics in a national sample. *Amer J Epidemiology* 128:389-401, 1988
33. Keen H: The presymptomatic diagnosis of diabetes. *Proc Royal Society Medicine* 59:1169-74, 1966
34. American Diabetes Association Committee on Statistics: Standardization of the oral glucose tolerance test. *Diabetes* 18:299-307, 1969
35. World Health Organization Expert Committee: Report on diabetes mellitus. *Technical Report Series*, no. 310. Geneva, Switzerland, 1965
36. Unger RH: The standard two-hour oral glucose tolerance test in the diagnosis of subjects without fasting hyperglycemia. *Annals Internal Medicine* 47:1138, 1957
37. National Diabetes Data Group: Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. *Diabetes* 28:1039-57, 1979
38. World Health Organization: Second report of the Expert Committee on Diabetes. Technical Report Series, no. 646.

Geneva, Switzerland, 1980

39. King H, Rewers M: Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. *Diabetes Care* 16:157-77, 1993
40. Knowler WC, Saad MF, Pettitt DJ, Nelson RG, Bennett PH: Determinants of diabetes mellitus in the Pima Indians. *Diabetes Care* 16 (Suppl. 1):216-27, 1993
41. Gohdes DM: Diabetes in American Indians: A growing problem. *Diabetes Care* 9:609-13, 1986
42. Gohdes D, Kaufman S, Valway S: Diabetes in American Indians: An overview. *Diabetes Care* 16 (Suppl. 1):239-43, 1993
43. Sugarman JR, Hickey M, Hall T, Gohdes D: The changing epidemiology of diabetes mellitus among Navajo Indians. *Western Journal of Medicine* 153:140-45, 1990
44. Carter J, Horowitz R, Wilson R, Sava S, Sinnock P, Gohdes D: Tribal differences in diabetes: Prevalence among American Indians in New Mexico. *Public Health Reports* 104:665-69, 1989
45. Schraer CD, Lanier AP, Boyko EJ, Gohdes D, Murphy NJ: Prevalence of diabetes mellitus in Alaskan Eskimos, Indians, and Aleuts. *Diabetes Care* 11:693-700, 1988
46. Wilson PWF, Anderson KM, Kannel WB: Epidemiology of diabetes in the elderly: The Framingham study. *Am J Medicine* 80 (Suppl. 5A):3-8, 1986
47. Cowie CC, Harris MI, Silverman RE, Johnson EW, Rust KF: Effect of multiple risk factors on differences between blacks and whites in the prevalence of non-insulin-dependent diabetes mellitus in the United States. *Am J Epidemiol* 137:719-32, 1993
48. Neel JV: The thrifty genotype revisited. In *The Genetics of Diabetes Mellitus*, Serono Symposia Vol. 47, Kobberling J, Tattersal R., eds. Academic Press, London, England, 1982
49. Wendorf M, Goldfine ID: Archaeology of NIDDM: Excavation of the "thrifty" genotype. *Diabetes* 40:161-65, 1991
50. Knowler WC, Pettitt DJ, Bennett PH, Williams RC: Diabetes mellitus in the Pima Indians: Genetic and evolutionary considerations. *Am J Physical Anthropology* 62:107-14, 1983
51. Gardner LI, Stern MP, Harrner WM, Gaskill SP, Hazuda HP, Relethford JH, Eifler CW: Prevalence of diabetes in Mexican Americans: Relationship to percent of gene pool derived from Native American sources. *Diabetes* 33:86-92, 1984
52. Stern MP, Gonzalez C, Mitchell BD, Villalpando E, Haffner SM, Hazuda HP: Genetic and environmental determinants of type II diabetes in Mexico City and San Antonio. *Diabetes* 14:484-92, 1992
53. Chakraborty R, Ferrell RE, Stern MP, Haffner SM, Hazuda HP, Rosenthal M: Relationship of prevalence of non-insulin-dependent diabetes mellitus to Amerindian admixture in the Mexican Americans of San Antonio, Texas. *Genetic Epidemiology* 3:435-54, 1986
54. Harris CL, Hewett-Emmett D, Bertin TK, Schull WJ: Origins of U.S. Hispanics: Implications for diabetes. *Diabetes Care* 14 (Suppl. 3):618-27, 1991
55. Stern MP, Knapp JA, Hazuda HP, Haffner SM, Patterson JK, Mitchell BD: Genetic and environmental determinants of type II diabetes in Mexican Americans: Is there a "descending limb" to the modernization/diabetes relationship? *Diabetes Care* 14 (Suppl. 3):649-54, 1991
56. Harris MI: Noninsulin-dependent diabetes mellitus in black and white Americans. *Diabetes/Metabolism Reviews* 6:71-90, 1990
57. Harris MI, Klein R, Welborn TA, Knuiman MW: Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis. *Diabetes Care* 15:815-19, 1992
58. Harris MI: Undiagnosed NIDDM: Clinical and public health issues. *Diabetes Care* 16:642-52, 1993
59. Stern MP, Rosenthal M, Haffner SM, Hazuda HP, Franco LJ: Sex difference in the effects of sociocultural status on diabetes and cardiovascular risk factors in Mexican Americans: The San Antonio Heart Study. *Am J Epidemiol* 120:834-51, 1984
60. Hanis CL, Ferrell RE, Barton SA, Aguilar L, Garza-Ibarra A, Tulloch BR, Garcia CA, Schull WJ: Diabetes among Mexican Americans in Starr County, Texas. *Am J Epidemiol* 118:659-72, 1983
61. Bender AP, Sprafka JM, Jagger HG, Muckala KH, Martin CP, Edwards TR: Incidence, prevalence, and mortality of diabetes mellitus in Wadena, Marshall, and Grand Rapids, Minnesota: The three-city study. *Diabetes Care* 9:343-50, 1986
62. French LR, Boen JR, Martinez AM, Bushhouse SA, Sprafka JM, Goetz FC: Population-based study of impaired glucose tolerance and type II diabetes in Wadena, Minnesota. *Diabetes* 39:1131-37, 1990
63. Klein R, Klein BE, Moss SE, DeMets DL, Kaufman I, Voss PS: Prevalence of diabetes mellitus in southern Wisconsin. *Am J Epidemiol* 119:54-61, 1984
64. Palumbo PJ, Elveback LR, Chu CP, Connolly DC, Kurland LT: Diabetes mellitus: Incidence, prevalence, survivorship, and causes of death in Rochester, Minnesota, 1945-1970. *Diabetes* 25:566-73, 1976
65. Barrett-Connor E: The prevalence of diabetes mellitus in an adult community as determined by history or fasting hyperglycemia. *Am J Epidemiol* 11:705-12, 1980
66. Hamman RF, Marshall JA, Baxter J, Kahn LB, Mayer EJ, Orleans M, Murphy JR, Lezotte DC: Methods and prevalence of non-insulin-dependent diabetes mellitus in a biethnic Colorado population: The San Luis Valley diabetes study. *Am J Epidemiol* 129:295-311, 1989
67. Wilkerson HLC, Krall LP: Diabetes in a New England town: A study of 3,516 persons in Oxford, Mass. *JAMA* 135:209-16, 1947
68. O'Sullivan JB, Williams RF, McDonald GW: The prevalence of diabetes mellitus and related variables—a population study in Sudbury, Massachusetts. *Journal of Chronic Disease* 20:535-43, 1967
69. Butler WJ, Ostrander LD, Carman WJ, Lamphiear DE: Diabetes mellitus in Tecumseh, Michigan. *Am J Epidemiol* 116:971-80, 1982
70. Haffner SM, Hazuda HP, Mitchell BD, Patterson JK, Stern MP: Increased incidence of type II diabetes mellitus in Mexican Americans. *Diabetes Care* 14:102-08, 1991
71. Wilson PW, McGee DL, Kannel WB: Obesity, very low density lipoproteins, and glucose intolerance over fourteen years: The Framingham study. *Am J Epidemiol* 114:697-704, 1981
72. McPhillips JB, Barrett-Connor E, Wingard DL: Cardiovascular disease risk factors prior to the diagnosis of impaired glucose tolerance and non-insulin-dependent diabetes mellitus in a community of older adults. *Am J Epidemiol* 131:443-53, 1990
73. Shaten BJ, Smith GD, Kuller LH, Neaton JD: Risk factors for the development of type II diabetes among men enrolled in the Usual Care group of the Multiple Risk Factor Intervention Trial. *Diabetes Care* 16:1331-39, 1993

APPENDICES

Appendix 4.1

Number of Persons (in Thousands) with Diagnosed Diabetes, U.S., 1991-93

	1991			1992			1993		
Age (years)	Black	White	All races	Black	White	All races	Black	White	All races
<45	200	1,218	1,506	216	1,033	1,301	304	1,151	1,494
45-64	475	2,175	2,708	408	2,238	2,716	578	2,413	3,081
65-74	353	1,489	1,899	367	1,710	2,103	292	1,576	1,897
≥75	106	981	1,110	155	1,106	1,297	141	1,161	1,341
Total	1,134	5,863	7,223	1,146	6,087	7,417	1,315	6,301	7,813

Source: References 15-17

Appendix 4.2

Prevalence of Diagnosed Diabetes and Rate per 1,000 Population, U.S., 1935-93

Year	Number with diabetes (millions)	Number per 1,000 U.S. residents (all ages)
1935-36	0.510	3.7
1958	1.575	9.3
1959	1.485	8.7
1960	1.594	9.1
1961	1.867	10.5
1962	1.908	10.6
1963	2.101	11.5
1964	2.313	12.4
1965	2.385	12.7
1966	2.772	14.5
1967	3.091	16.1
1968	3.175	16.2
1973	4.191	20.4
1975	4.780	22.9
1976	4.974	23.6
1978	5.193	23.7
1979-81	5.466	24.9
1982	5.767	25.4
1983	5.613	24.5
1984	6.053	26.1
1985	6.134	26.2
1986	6.585	27.9
1987	6.641	27.8
1988	6.221	25.8
1989	6.489	26.6
1990	6.232	25.3
1991	7.223	29.0
1992	7.417	29.5
1993	7.813	30.7

Source: References 15-27, National Health Interview Surveys

Appendix 4.3

Percent of the Population with Diagnosed Diabetes, by Age and Sex, U.S., 1935-81

Sex and age (years)	1935	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1973	1975	1976	1978	1979-81
All persons																	
All ages	0.37	0.93	0.87	0.91	1.05	1.06	1.15	1.24	1.27	1.45	1.61	1.62	2.04	2.29	2.36	2.37	2.47
<45	0.10	0.23	0.22	0.24	0.25	0.23	0.28	0.33	0.31	0.38	0.42	0.41	0.55	0.59	0.60	0.64	0.59
<25	0.05	0.08	0.09	0.08	0.13	0.10	0.13	0.13	0.13	0.16	0.19	0.20	0.22	0.22	0.29	0.23	0.18
25-44	0.18	0.46	0.42	0.52	0.48	0.48	0.55	0.70	0.65	0.80	0.89	0.85	1.16	1.23	1.31	1.29	1.20
45-54	0.66	1.24	1.24	1.38	1.65	1.42	1.67	1.91	1.87	2.00	2.62	2.79	3.32	3.80	4.08	3.51	4.28
55-64	1.43	2.93	2.76	2.73	3.54	3.52	3.70	3.58	3.80	4.37	4.43	4.19	5.42	6.50	5.99	7.23	6.81
≥65	1.84	4.33	3.77	3.91	4.22	4.73	4.76	5.21	5.42	6.21	6.61	6.71	7.85	8.30	8.53	8.08	8.84
65-74	1.99	4.49	4.09	4.14	4.34	4.64	4.75	5.26	5.57	6.44	6.89	6.78	7.74	8.17	8.99	8.18	8.77
≥75	1.46	3.99	3.15	3.48	4.01	4.90	4.79	5.12	5.15	5.79	6.13	6.58	8.04	8.52	7.73	7.86	8.94
Males																	
All ages	0.28	0.82	0.78	0.84	1.00	0.94	1.05	1.07	1.09	1.29	1.37	1.42	1.63	2.01	2.11	2.00	2.22
<45	0.09	0.27	0.23	0.24	0.25	0.20	0.29	0.28	0.30	0.37	0.33	0.39	0.42	0.51	0.53	0.59	0.49
<25	0.05	0.10	0.12	0.08	0.11	0.10	0.12	0.10	0.13	0.15	0.14	0.17	0.17	0.19	0.27	0.21	0.16
25-44	0.15	0.55	0.43	0.51	0.49	0.40	0.60	0.63	0.64	0.82	0.72	0.84	0.91	1.09	0.99	1.21	1.01
45-54	0.45	1.11	1.13	1.45	1.75	1.36	1.71	1.88	1.62	2.15	2.55	2.27	3.22	3.44	4.01	2.95	4.19
55-64	1.00	2.57	2.45	2.65	3.64	3.38	3.44	3.05	3.29	4.04	4.39	3.80	5.13	6.45	6.14	6.80	6.93
≥65	1.46	3.33	3.39	3.42	3.80	4.18	4.13	4.69	4.85	5.12	5.49	6.51	6.03	7.79	8.27	6.92	8.52
65-74	1.51	3.26	3.65	3.54	3.84	4.30	3.93	4.69	4.85	5.16	5.82	6.35	6.33	7.72	8.50	6.81	8.79
≥75	1.31	3.52	2.84	3.17	3.66	3.93	4.53	4.70	4.89	5.09	4.84	6.80	5.46	7.92	7.79	7.05	7.93
Females																	
All ages	0.45	1.05	0.95	0.98	1.10	1.17	1.24	1.41	1.43	1.61	1.83	1.80	2.41	2.54	2.59	2.71	2.70
<45	0.12	0.19	0.20	0.25	0.26	0.26	0.27	0.38	0.32	0.38	0.51	0.44	0.68	0.66	0.80	0.68	0.69
<25	0.05	0.07	0.08	0.08	0.14	0.09	0.14	0.17	0.14	0.17	0.23	0.22	0.28	0.25	0.13	0.24	0.21
25-44	0.20	0.37	0.41	0.53	0.47	0.55	0.50	0.77	0.66	0.79	1.05	0.85	1.40	1.36	1.62	1.36	1.38
45-54	0.86	1.37	1.35	1.31	1.55	1.48	1.62	1.94	2.08	1.87	2.69	3.27	3.42	4.14	4.14	4.03	4.37
55-64	1.82	3.25	3.05	2.80	3.45	3.65	3.94	4.08	4.26	4.67	4.48	4.53	5.68	6.55	5.84	7.63	6.69
≥65	2.15	5.16	4.09	4.32	4.57	5.18	5.27	5.62	5.87	7.04	7.47	6.76	9.13	8.66	8.71	8.89	9.07
65-74	2.38	5.59	4.48	4.65	4.74	4.93	5.45	5.72	6.17	7.49	7.74	7.13	8.82	8.53	9.36	9.22	8.77
≥75	1.48	4.39	3.38	3.72	4.27	5.62	4.95	5.43	5.36	6.29	7.05	6.43	9.62	8.88	7.68	8.33	9.53

Source: Reference 18, National Health Interview Surveys

Appendix 4.4

Percent of the Population with Diagnosed Diabetes, by Age, Sex, and Race, U.S., 1983-93

Sex and age (years)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
All persons											
All ages	2.45	2.61	2.62	2.79	2.78	2.58	2.66	2.53	2.90	2.95	3.07
<45	0.62	0.61	0.63	0.63	0.81	0.65	0.73	0.65	0.88	0.76	0.86
<18	0.18	0.14	0.19	0.24	0.20	0.22	0.18	0.06	0.11	0.13	0.15
18-44	0.90	0.90	0.91	0.87	1.19	0.92	1.07	1.01	1.36	1.15	1.31
45-64	5.82	5.32	5.19	6.37	5.64	5.46	5.82	5.04	5.74	5.60	6.19
≥65	7.95	10.29	10.38	9.83	9.82	9.24	8.82	9.34	9.93	11.04	10.35
65-74	7.92	10.50	10.89	9.19	9.83	9.52	8.97	10.22	10.38	11.39	10.19
≥75	8.00	9.95	9.55	10.85	9.82	8.78	8.57	7.97	9.26	10.53	10.60
Males											
All ages											2.94
<45	0.56	0.45	0.59	0.44	0.81	0.73	0.55	0.56	0.76	0.61	0.88
45-64	5.28	4.94	5.24	6.85	5.95	5.68	6.49	4.86	5.79	5.25	6.48
≥65	7.61	9.47	10.11	9.92	10.83	9.08	7.39	9.65	9.64	11.15	10.05
65-74	6.75	9.70	10.40	9.63	10.76	8.86	7.40	10.20	9.73	11.96	9.96
≥75	9.29	9.05	9.57	10.53	10.97	9.50	7.39	8.63	9.51	9.68	10.21
Females											
All ages											3.20
<45	0.67	0.76	0.66	0.81	0.81	0.58	0.90	0.74	1.00	0.90	0.85
45-64	6.31	5.67	5.14	5.94	5.35	5.25	5.21	5.21	5.70	5.92	5.91
≥65	8.18	10.85	10.55	9.76	9.11	9.35	9.83	9.11	10.14	10.97	10.57
65-74	8.81	11.12	11.27	8.86	9.09	10.06	10.25	10.23	10.90	10.92	10.37
≥75	7.26	10.46	9.55	11.05	9.15	8.36	9.26	7.59	9.11	11.02	10.83
Whites											
All ages											
<45	0.60	0.58	0.65	0.65	0.78	0.61	0.70	0.64	0.87	0.74	0.82
45-64	5.08	4.79	4.56	5.97	5.12	4.78	5.26	4.46	5.35	5.36	5.63
≥65	7.40	9.25	9.72	9.14	9.13	8.39	8.02	8.70	9.08	10.23	9.79
65-74	7.07	9.26	10.20	8.46	9.42	8.63	8.20	9.57	9.12	10.44	9.54
≥75	7.93	9.25	8.97	10.22	8.69	8.01	7.73	7.35	9.02	9.92	10.16
Blacks											
All ages											
<45	0.82	0.81	0.65	0.64	0.98	1.02	0.83	0.88	0.85	0.91	1.26
45-64	12.07	10.41	11.21	10.51	10.25	11.05	10.02	10.03	9.77	8.18	11.25
≥65	14.05	22.04	16.55	17.23	16.28	18.74	16.59	15.65	17.91	19.91	16.21
65-74	16.42	23.84	17.20	17.02	13.05	18.55	14.82	15.86	21.94	22.32	17.44
≥75	10.01	19.02	15.32	17.60	21.85	19.05	19.60	15.27	11.11	15.85	14.11

Source: References 15-27, National Health Interview Surveys

Appendix 4.5

Three-Year Average Number of Persons with Diagnosed Diabetes per 1,000 Population, U.S., 1979-92

Sex and age (years)	1979-81	1980-82	1981-83	1982-84	1983-85	1984-86	1985-87	1986-88	1987-89	1988-90	1989-91	1990-92
Both sexes												
All ages	25.2	25.2	24.9	25.2	25.6	26.7	27.3	27.0	26.6	25.8	26.9	27.8
<45	6.2	6.2	6.1	6.1	6.2	6.2	6.9	6.9	7.2	6.7	7.5	7.6
<25	1.9	2.0	2.0	2.1	2.0	2.5	2.9	3.1	2.8	2.2	1.9	1.9
25-44	12.5	12.2	11.9	11.5	11.5	10.9	11.7	11.5	12.3	11.9	13.7	13.9
45-54	42.8	43.9	43.0	40.8	36.7	37.7	38.8	38.6	38.4	38.7	38.8	35.6
55-64	68.7	68.8	72.5	71.7	72.0	74.5	76.1	78.0	75.6	71.3	74.5	77.5
≥65	90.5	89.4	84.9	89.7	95.2	101.3	99.7	95.9	92.5	91.3	93.7	101.1
65-74	91.4	92.4	86.3	92.8	97.8	101.8	99.0	94.5	93.8	95.8	98.6	106.5
≥75	88.9	84.5	82.6	84.7	91.0	100.5	100.8	98.0	90.5	84.3	86.0	92.7
Male												
All ages	22.8	22.6	22.1	21.6	22.3	23.8	25.8	26.0	25.3	23.8	24.3	25.0
<45	5.2	5.3	5.6	5.2	5.4	5.0	6.2	6.6	7.0	6.1	6.2	6.4
<25	1.7	1.7	1.5	1.3	1.3	1.5	2.6	2.8	2.7	1.7	1.4	1.3
25-44	10.5	10.7	11.5	10.6	10.8	9.4	10.7	11.2	12.1	11.3	11.9	12.2
45-54	41.6	41.9	36.1	34.2	32.0	37.8	42.3	42.1	42.9	38.4	38.7	31.2
55-64	70.8	70.6	75.5	72.0	71.9	76.8	79.1	81.7	79.2	76.6	78.5	79.5
≥65	88.3	84.7	79.6	83.0	90.9	98.4	102.5	98.9	90.3	87.1	89.1	101.4
65-74	94.3	87.8	77.6	80.0	89.7	99.0	101.9	96.7	89.2	88.3	91.2	106.1
≥75	76.2	78.6	83.4	88.8	93.0	97.2	103.6	103.2	92.5	84.9	85.2	92.8
Female												
All ages	27.5	27.7	27.6	28.6	28.6	29.3	28.6	27.9	27.8	27.7	29.4	30.5
<45	7.2	7.0	6.6	7.0	7.0	7.4	7.6	7.3	7.5	7.3	8.7	8.7
<25	2.1	2.2	2.4	2.9	2.8	3.5	3.3	3.4	3.0	2.6	2.5	2.5
25-44	14.4	13.8	12.2	12.4	12.2	12.2	12.7	11.7	12.6	12.4	15.5	15.5
45-54	43.8	45.8	49.5	47.0	41.0	37.6	35.6	35.3	34.1	39.0	38.8	39.8
55-64	66.9	67.3	69.8	71.3	72.1	72.5	73.4	74.7	72.3	66.7	71.0	75.6
≥65	92.0	92.7	88.6	94.4	98.3	103.3	97.7	93.7	94.0	94.3	96.9	100.8
65-74	89.3	95.9	93.0	102.7	104.1	104.0	96.7	92.8	97.4	101.8	104.6	106.9
≥75	96.3	87.9	82.1	82.3	89.9	102.4	99.1	95.0	89.3	84.0	86.5	92.7
White												
All ages	24.3	24.2	23.7	23.8	24.2	25.6	26.3	25.7	25.1	24.4	25.9	27.2
<45	5.9	6.1	6.1	6.1	6.1	6.3	6.9	6.7	6.9	6.4	7.3	7.4
<25	2.0	2.1	2.2	2.2	2.2	2.7	3.2	3.4	3.0	2.3	2.2	2.1
25-44	11.5	11.6	11.3	11.0	11.0	10.5	11.2	10.6	11.2	10.8	12.9	13.1
45-54	36.5	37.7	37.0	35.5	31.4	33.6	35.0	34.5	33.4	33.6	35.1	32.9
55-64	63.8	61.9	64.2	63.0	64.0	67.1	68.5	70.2	68.0	64.1	67.8	72.2
≥65	87.3	84.9	79.2	82.0	87.9	93.3	92.7	88.1	84.7	83.8	86.1	93.5
65-74	88.4	86.7	78.5	82.3	88.8	93.0	92.6	87.4	86.9	88.4	89.9	97.3
≥75	85.6	82.0	80.4	81.5	86.4	93.7	92.8	89.2	81.4	76.7	80.2	87.8
Black												
All ages	33.3	34.3	35.1	37.2	37.1	36.9	36.0	37.6	37.7	36.9	35.2	36.0
<45	9.1	7.8	7.0	7.2	7.6	7.0	7.6	8.8	9.4	9.1	8.5	8.8
<25	1.8	1.4						2.1	2.5	1.8	1.4	1.4
25-44	23.1	19.7	18.4	16.9	18.0	15.7	17.2	19.1	19.8	19.7	18.9	19.5
45-54	93.0	96.3	92.8	85.8	80.3	73.5	74.9	72.6	79.0	77.8	72.0	63.0
55-64	117.0	126.9	145.1	150.6	149.2	146.1	143.2	145.4	134.5	131.7	130.1	128.1
≥65	125.9	139.0	147.4	175.5	175.6	185.5	166.8	174.3	172.1	169.7	167.2	178.6
65-74	122.2	148.9	165.6	202.0	191.3	192.7	157.4	162.2	155.0	164.0	176.0	201.0
≥75	133.2	120.2	115.3	130.4	148.9	173.2	182.9	195.0	201.3	179.3	152.3	140.7

In cells with no entry, data have been omitted because of small sample size and unreliable estimates.

Source: Unpublished analyses of the 1979-92 National Health Interview Surveys

Appendix 4.6

Average Annual Number of Newly Diagnosed Cases of Diabetes, U.S., 1935-92

Year	Number of cases (thousands)	Number of cases per 1,000 population	Year	Number of cases (thousands)	Number of cases per 1,000 population
1935-36	50	0.38	1980-82	601	2.62
1964	328	1.76	1981-83	647	2.79
1965	383	2.03	1982-84	696	2.98
1966	348	1.83	1983-85	685	2.91
1967	430	2.24	1984-86	669	2.81
1968	517	2.64	1985-87	693	2.89
1973	612	2.97	1986-88	691	2.85
1975	574	2.77	1987-89	701	2.87
1978	570	2.67	1988-90	633	2.57
1979-81	536	2.36	1989-91	607	2.53
			1990-92	624	2.42

Source: References 18 and 30, unpublished analyses of the 1990-92 National Health Interview Surveys

Appendix 4.7

Three-Year Average Annual Number of Newly Diagnosed Cases of Diabetes per 1,000 Population, U.S., 1980-92

Sex and age (years)	1979-81	1980-82	1981-83	1982-84	1983-85	1984-86	1985-87	1986-88	1987-89	1988-90	1989-91	1990-92
All persons												
All ages	2.35	2.62	2.79	2.98	2.90	2.80	2.88	2.84	2.86	2.57	2.53	2.42
<45	1.09	1.19	1.13	1.14	0.99	1.10	1.21	1.43	1.50	1.31	1.24	1.06
<25	0.39	0.41	0.31	0.33	0.35	0.74	0.79	0.78	0.54	0.45	0.34	0.41
25-44	2.12	2.31	2.26	2.23	1.82	1.56	1.72	2.20	2.60	2.30	2.25	1.79
45-54	4.34	4.36	5.48	5.22	5.44	5.03	5.15	5.15	5.83	6.00	5.80	4.36
55-64	5.57	7.84	9.22	10.62	9.25	8.08	6.32	5.68	5.98	5.79	5.65	4.41
≥65	5.65	5.44	5.25	5.84	7.05	6.88	8.14	7.05	5.99	4.52	4.86	7.00
65-74	5.20	5.97	5.62	5.92	6.95	5.40	7.01	5.39	5.74	5.00	5.29	8.63
≥75	6.42	4.55	4.65	5.71	7.22	9.25	9.96	9.71	6.38	3.77	4.19	4.53
Males												
All ages	2.21	2.47	2.55	2.32	2.11	1.95	2.22	2.35	2.53	2.25	2.07	1.97
<45	0.89	1.06	0.91	0.63	0.40	0.69	0.92	1.21	1.06	0.78	0.53	0.53
<25	0.25	0.38					0.79	0.66				
25-44	1.86	2.08	1.73	1.21	0.66	0.78	1.07	1.88	2.03			
45-54	6.68	6.26	6.18	4.67	3.88	2.88	4.37	5.13	6.99	6.34	6.20	3.79
55-64	4.88	8.18	10.02	10.86	8.59	7.77	6.14	5.82	6.22	7.19	7.62	6.70
≥65	4.67	3.40	3.84	4.31	6.78	4.83	5.91	4.66	5.28	4.20	4.04	6.13
65-74	3.90				5.89			5.89	5.80	4.08	4.20	7.02
≥75	6.22	5.04	5.27	7.05	8.50	6.35	5.47	4.90	4.30	4.43	3.72	4.51
Females												
All ages	2.49	2.76	3.02	3.59	3.64	3.60	3.49	3.31	3.17	2.87	2.96	2.84
<45	1.29	1.31	1.34	1.65	1.58	1.51	1.50	1.65	1.92	1.84	1.96	1.59
<25	0.52	0.43	0.28	0.45	0.49	0.85	0.79	0.91	0.83	0.72	0.58	0.51
25-44	2.37	2.53	2.75	3.19	2.93	2.32	2.34	2.50	3.15	3.09	3.46	2.76
45-54	2.17	2.59	4.83	5.73	6.90	7.04	5.88	5.17	4.74	5.67	5.43	4.90
55-64	6.18	7.54	8.53	10.42	9.83	8.35	6.49	5.56	5.77	4.54	3.89	2.35
≥65	6.33	6.87	6.24	6.89	7.24	8.30	9.71	8.74	6.49	4.74	5.44	7.63
65-74	6.19	8.58	7.55	8.23	7.77	6.46	7.70	6.06	5.70	5.73	6.16	9.93
≥75	6.54				6.48	10.92	12.57	12.51	7.60	3.39	4.46	4.54

In cells with no entry, data have been omitted because of small sample sizes and unreliable estimates

Source: Unpublished analyses of the 1979-92 National Health Interview Surveys