# Chapter 31

# *Diabetes in African Americans*

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## SUMMARY

Among U.S. black children age <15 years, estimates of insulin-dependent diabetes mellitus (IDDM) incidence from population registries range from 3.3 to 11.8 per 100,000 per year. The almost fourfold variation in IDDM incidence may result from differential exposure to etiologic agents, differences in susceptibility due to white genetic admixture, and differing genetic and autoimmune phenomena including HLA, islet cell antibodies, and frequency of Asp-57. In contrast to diabetes in adults, the incidence of diabetes in children (predominantly IDDM) is lower in black than in white Americans. Rates for white American children are nearly twice as high as in blacks, ranging from 13.8 to 16.9 per 100,000 per year.

Based on the 1993 National Health Interview Survey (NHIS), the prevalence of known, physician-diagnosed diabetes among African Americans is 3.7%, rising from 1.3% at age 0-45 years to 17.4% at age 65-74 years. The rate of diabetes in blacks has tripled during the past 30 years. Prevalence of diagnosed diabetes in adults is now 1.4 times as frequent in blacks as in whites. This excess occurs for both black men and black women. Approximately 1.3 million African Americans have been diagnosed as having diabetes. In addition, based on the 1976-80 Second National Health and Nutrition Examination Survey (NHANES II), approximately half of both black and white adults who meet diagnostic criteria for non-insulin-dependent diabetes mellitus (NIDDM) are undiagnosed. The frequency of diabetes in black adults is influenced by the same factors that are associated with NIDDM in other populations, including obesity, physical inactivity, insulin resistance, and genetic factors.

Data on the frequency of diabetes complications in African Americans are limited but suggest that this population experiences considerable morbidity and excess frequency of many diabetic complications.

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## INTRODUCTION

In recent years, there has been much concern about the excess frequency and complications from diabetes in minority populations in the United States. In 1986, a Task Force on Black and Minority Health called attention to limitations in knowledge about diabetes in minorities and the need for increased research and intervention to reduce the excess burden of diabetes in these groups[1]. In this chapter, data on the frequency of diabetes and associated risk factors in the black population of the United States are reviewed and implications for this ethnic group are discussed. The African-American population includes many individuals who have immigrated to the United States from other parts of the Americas, particularly the Caribbean, for whom little is known of their diabetes status. Thus, whenever possible, data on diabetes in black Caribbean populations are provided.

## CLASSIFICATION OF DIABETES

Epidemiological studies conducted to assess the impact of diabetes in black populations have examined a number of syndromes of glucose intolerance, some of which appear to be more common in black than in white Americans. These include NIDDM, the major form of diabetes affecting all populations in the United States, IDDM, impaired glucose tolerance (IGT), gestational diabetes mellitus (GDM), and the malnutrition-related diabetes subtypes described by the World Health Organization (WHO)[2] as protein-deficient pancreatic diabetes (PDPD) and fibrocalculus pancreatic diabetes (FCPD).

Other atypical diabetes syndromes characterized by

**Table 31.1**
**Diagnostic Criteria and Description of Diabetes Subtypes**

| Type of diabetes | Diagnostic criteria | Description |
|---|---|---|
| NIDDM | FPG ≥140 mg/dl 2-hour OGTT ≥200 mg/dl | Also termed Type 2 diabetes; usually develops after age 40; associated with obesity and family history of diabetes |
| IDDM | FPG ≥140 mg/dl 2-hour OGTT ≥200 mg/dl | Also termed Type 1 diabetes; abrupt symptoms; insulinopenia and ketosis; may have subclinical period lasting many years; associated with HLA and autoimmunity |
| GDM | FPG ≥140 mg/dl 2-hour OGTT ≥200 mg/dl | Diabetes during pregancy with return to normal glucose status after delivery; associated with increased risk of developing NIDDM |
| IGT | FPG <140 mg/dl 2-hour OGTT 140-199 mg/dl | Increased risk of developing NIDDM; high frequency of cardiovascular risk factors |
| PDPD | FPG ≥140 mg/dl 2-hour OGTT ≥200 mg/dl | Cases present very thin; resistant to ketosis; shows phasic insulin dependence |
| FCPD | FPG ≥140 mg/dl | Characteristics similar to PDPD but with pancreatic calcification |

FPG, fasting plasma glucose; OGTT, oral glucose tolerance test; GDM, gestational diabetes mellitus; IGT, impaired glucose tolerance; PDPD, protein-deficient pancreatic diabetes; FCPD, fibrocalculus pancreatic diabetes. Diagnostic criteria are those recommended by the World Health Organization; other criteria for GDM more commonly used in the U.S. are based on a 3-hour OGTT and are described in Chapter 2.

*Source*: References 2-12

resistance to ketosis and periods of normoglycemic remission with subsequent hyperglycemic relapse have been described in black populations. These include atypical maturity-onset diabetes of the young (MODY) in African-American children[3] and the diabetic syndrome of phasic insulin dependence in Jamaica[4]. Similar atypical diabetes syndromes have been reported in the United States[5] and Africa[6]. Diagnosis and classification of these diabetes subtypes (see Chapters 2 and 5) are based on criteria of the National Diabetes Data Group (NDDG)[7] and the WHO[8]. A summary description of the different forms of diabetes is presented in Table 31.1[2-12].

## HISTORICAL ORIGINS OF AFRICAN AMERICANS

The sociodemographic characteristics of populations are formed by environmental and genetic influences that change throughout history. To understand how rates of diabetes vary among African Americans, it is important to examine the historical origins of black populations in the Americas. To a great extent, the sociodemographic characteristics that influence diabetes rates in African Americans have been shaped by the dynamics of European colonialization in the Americas. African Americans are descended from Africans whose parent populations were characterized by much cultural and genetic diversity[13]. The ships that brought Africans to the Americas contained individuals from a variety of ethnic groups of West and Central African origin (Figure 31.1)[14-16]. However, because of the system of slavery, ethnic distinctions did not persist in the New World[14]. Thus, the African-American population became a hybrid population formed from genetic admixture across African ethnic groups and with other racial groups, primarily European and North American Caucasians[17].

Today, variations in the degree of European admixture exist across African origin populations in the Americas[18-20] and by region within the United States[17]. Similar differences in culture have emerged that contribute to the environmental and lifestyle factors that influence variation in rates of diabetes in African-American populations. The African-American population includes many individuals who have immigrated to the United States from other parts of the Americas, among whom cultural beliefs may influence lifestyle factors such as dietary behavior, physical activity patterns, and attitude toward body size and weight.

**Figure 31.1**
**Origin of African Americans from West and Central Africa**
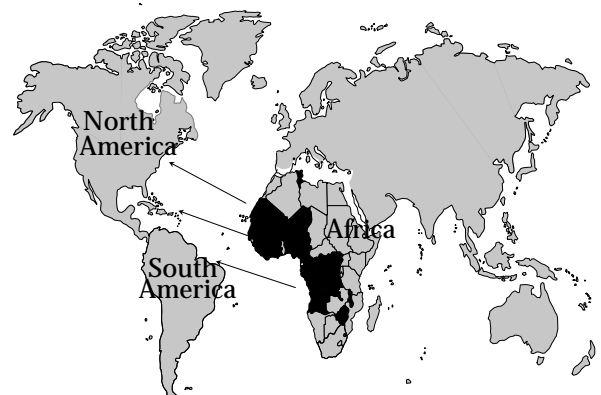


*Source*: References 14-16

**Figure 31.2**

**Incidence of Childhood IDDM in U.S. Black and White Populations**
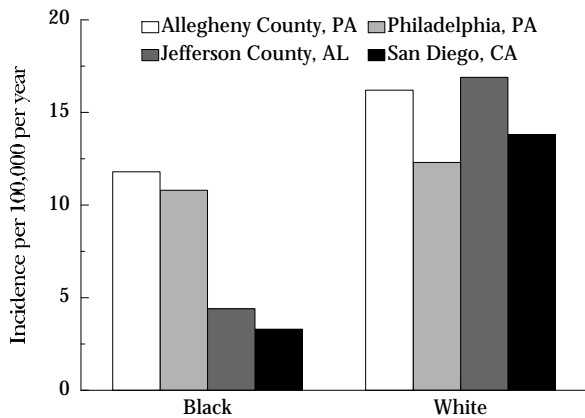


*Source*: References 23-26

## INCIDENCE OF DIABETES IN CHILDREN

In contrast to diabetes in adults, the incidence of diabetes in children (predominantly IDDM) is higher in white than in black Americans[21,22]. Among U.S. black children age <15 years, estimates of IDDM incidence from population registries range from 3.3 to 11.8 per 100,000 per year (Figure 31.2)[23-26]. Corresponding rates for white Americans are nearly twice as high, ranging from 13.8 to 16.9 per 100,000 per year. A racial difference also exists in the distribution of cases by gender, with a female excess in black children compared with a slight male preponderance in white children.

There have been few reports of the frequency of childhood diabetes in other black populations in the Americas. An IDDM incidence of 5.6 per 100,000 per year for children age 0-14 years was found in the U.S. Virgin Islands[27]. The incidence at age 0-14 years on the island of Barbados was reported to be 4.1 per 100,000 per year[28]. One report suggested that the incidence of IDDM on Martinique was lower than 2 per 100,000 per year, but an actual rate was not provided[19].

## RISK FACTORS FOR CHILDHOOD DIABETES IN AFRICAN AMERICANS

### RACIAL ADMIXTURE

The importance of genetic admixture in determining rates of IDDM in African-American children was first suggested by MacDonald[29], who observed that black American children had a frequency of IDDM that was lower than white American children but higher than black African children. He hypothesized that rates of childhood IDDM were higher in African-American than in black African children because IDDM susceptibility genes, which are more common in the U.S. white population, had become admixed into the African-American gene pool. Studies using genetic markers[30-32] and ancestral histories[27] have provided support for this hypothesis. When the association of European admixture with the frequency of childhood IDDM was assessed by grandparental race in the U.S. Virgin Islands, more admixture was found among those with IDDM than in those without diabetes, which supports the admixture hypothesis[27]. As with black populations in the United States, it is expected that the incidence of IDDM in African heritage peoples in the Americas will vary geographically, being influenced by environmental and lifestyle factors as well as the degree and type of European admixture[33].

It is possible that the almost fourfold variation in incidence seen in black children in IDDM registries in the United States, as well as gender differences, might result from differential exposure to etiologic agents. Another possible explanation is that the geographic variation might reflect differences in susceptibility due to white genetic admixture. This would be consistent with the observation that the incidence (11.8 per 100,000 per year) of childhood IDDM among African Americans in a northern area like Allegheny County, PA, where the degree of white admixture is 21.2%, is higher than the incidence (4.4 per 100,000 per year) in a southern location like Jefferson County, AL, where genetic admixture is 17.9%[23,24,30,34].

## HLA AND IDDM IN AFRICAN AMERICANS

Possible genetic factors that admixture may have increased are genes in the major histocompatibility region (the HLA complex) of chromosome 6. Genes of this complex are involved in immunological rejection of foreign cells and synthesis of complement components[35]. There is a strong association between the presence of HLA antigens, particularly DR3 and DR4, and the development of IDDM in a number of populations[36-38]. The highest risk for IDDM is associated with HLA DR3/DR4 heterozygosity[39]. African Americans with IDDM have HLA DR allelic associations that are similar to those in U.S. whites[36,40,41]. When HLA DR frequencies were examined in black Nigerian IDDM patients, an association with DR3 but not DR4 was found, as is characteristic of black and white Ameri-

cans with IDDM[42]. Thus, the susceptibility determinant derived from admixture with Caucasians may be DR4 associated[43].

An amino acid substitution for aspartic acid at position 57 (non-Asp 57) of the HLA-DQ beta chain was identified as a highly specific marker of IDDM susceptibility[44]. There is an almost 100% correlation of this marker with the incidence of IDDM in different ethnic populations[45]. The frequencies of these susceptibility phenotypes in the population vary among racial groups but tend to be higher among European and North American Caucasians[45,46]. However, no significant difference was found between black and white patients with IDDM in Allegheny County, PA in the frequency of non-Asp57 homozygosity (associated with the strongest risk of IDDM)[44].

Relationships between HLA alleles and IDDM among African Americans that differ from other ethnic groups may provide important insight into the etiology of the disease[47]. Research on the association of HLA-DQ genes and HLA-DR7 and DR9, which are associated with IDDM in black populations but not in Caucasians, have provided evidence that both DQ A1 and B1 genes convey susceptibility to IDDM[48,49]. In black populations, the HLA-DQ A1/B1 combination A3, DQw2 may be an important marker of IDDM susceptibility[49,50].

## IDDM AND AUTOIMMUNITY

Differences in autoimmune phenomena associated with IDDM exist for black and white individuals with the disease. The frequency of islet cell antibodies (ICA) and other organ-specific antibodies that characterize autoimmune beta cell destruction in IDDM is lower for black than white American cases (ICA in 40% versus 60% of cases, respectively)[23,51]. In Jamaica, ICA was not found in sera from 42 IDDM patients[52]. Similarly, only two of 24 sera from insulin-treated young Nigerian diabetic patients were ICA positive[53]. Diabetic syndromes resembling IDDM at clinical presentation but lacking the HLA associations occur in black populations and may possibly confound these ICA results. However, the tendency to be less prone to ketosis and show lower frequency of autoantibodies may indicate that black populations manifest a different form of IDDM from that which occurs in white individuals[52]. Additional research is needed to determine the reasons for the apparent differences in manifestations of autoimmune phenomena in black and white Americans with IDDM.

Table 31.2
**Percent of Persons Who Have Diagnosed Diabetes, U.S., 1991-92**

| Age (years) | 1991 Black | 1991 White | 1992 Black | 1992 White | Average, 1991-92 Black | Average, 1991-92 White |
|---|---|---|---|---|---|---|
| <45 | 0.85 | 0.87 | 0.91 | 0.74 | 0.88 | 0.81 |
| 45-64 | 9.77 | 5.35 | 8.18 | 5.36 | 8.98 | 5.36 |
| 65-74 | 21.94 | 9.12 | 22.32 | 10.44 | 22.13 | 9.78 |
| ≥75 | 11.11 | 9.02 | 15.85 | 9.92 | 13.48 | 9.47 |
| Total | 3.67 | 2.82 | 3.64 | 2.91 | 3.66 | 2.86 |

See Appendix 31.1 for 1993 prevalence rates.
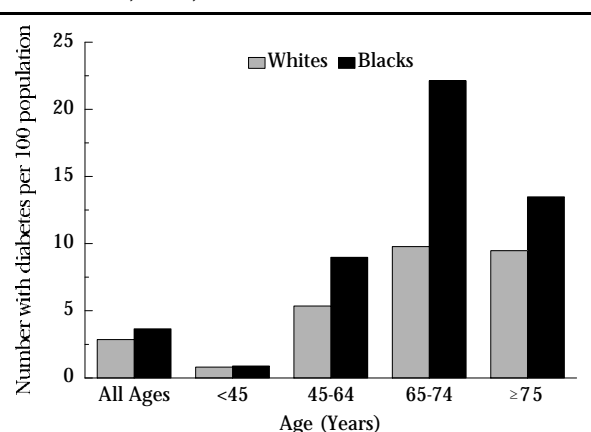
*Source*: References 58 and 59

## SOCIOECONOMIC STATUS

The relationship between socioeconomic status and childhood IDDM appears to be weak. Studies relating socioeconomic status to IDDM incidence have found positive[54] and negative[55] results and, in most research, no association at all[24,56,57]. Thus, it appears unlikely that racial differences in the frequency of childhood IDDM in the United States are significantly related to socioeconomic status.

## PREVALENCE OF DIABETES IN ADULTS

Data on the rate of diagnosed diabetes in black and white adults based on the 1991-92 NHIS are shown in Table 31.2 and Figure 31.3[58,59]. At age ≥45 years, the prevalence of known, physician-diagnosed diabetes is 1.4 to 2.3 times as frequent in blacks as in whites. This
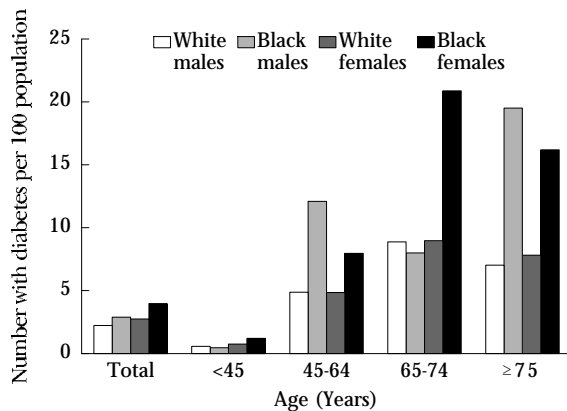
Figure 31.3
**Prevalence of Diagnosed Diabetes Among Blacks and Whites, U.S., 1991-92**



See Appendix 31.1 for 1993 prevalence rates.

*Source*: References 58 and 59

Figure 31.4
**Prevalence of Diagnosed Diabetes Among Black and White Males and Females, U.S., 1989-91**

*Source*: References 59-61



Figure 31.5
**Prevalence of Undiagnosed and Diagnosed NIDDM and IGT in Black Adults, U.S., 1976-80**

IGT, impaired glucose tolerance.

*Source*: Reference 62

excess occurs in both black men and black women (Figure 31.4)[59-61]. Approximately 1.14 million African Americans had been diagnosed as having diabetes in 1991-92 (Table 31.3). In 1993, the rate increased to 4.1% and the number of African Americans known to have diabetes was 1.31 million (Appendix 31.1).

In the 1976-80 NHANES II, it was found that approximately half of both black and white adults who met diagnostic criteria for NIDDM were undiagnosed[62]. Total prevalence of diagnosed and undiagnosed NIDDM in adults in 1976-80 is shown in Figure 31.5. Prevalence increased with age and reached 25% of blacks age 65-74 years. Rates were highest in black women, in whom one in four age ≥55 years had diabetes (Table 31.4). Because the rate of diagnosed diabetes ascertained in the NHIS has continued to increase over time, it is likely that the NHANES II rates are low. However, the excess prevalence in blacks versus whites seen in the NHIS is also seen when total prevalence of diabetes in NHANES II is examined[62].
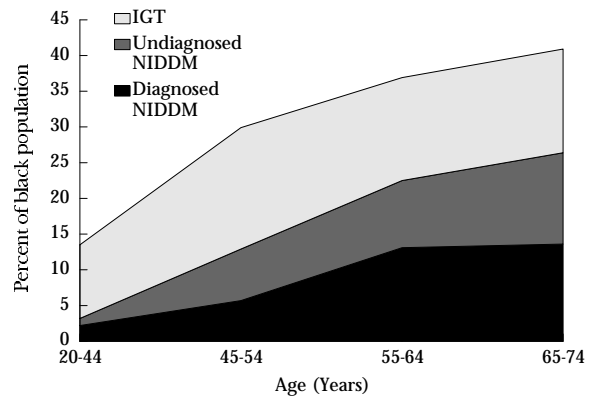
Estimates of the prevalence of diabetes from population-based studies of adult black Caribbean populations have ranged from 0.73% to 14.5%; rates were higher for females than males[63-70]. Unfortunately,

Table 31.3
**Number of Persons (in Thousands) with Diagnosed Diabetes, U.S., 1991-92**

| Age (years) | 1991 Black | 1991 White | 1992 Black | 1992 White | Average, 1991-92 Black | Average, 1991-92 White |
|---|---|---|---|---|---|---|
| <45 | 200 | 1,218 | 216 | 1,033 | 208 | 1,126 |
| 45-64 | 475 | 2,175 | 408 | 2,238 | 442 | 4,413 |
| 65-74 | 353 | 1,489 | 367 | 1,710 | 360 | 1,600 |
| ≥75 | 106 | 981 | 155 | 1,106 | 131 | 1,044 |
| Total | 1,134 | 5,863 | 1,146 | 6,087 | 1,140 | 5,975 |

See Appendix 31.1 for 1993 prevalence rates.

*Source*: References 58 and 59

Table 31.4
**Percent of Blacks and Whites Age 20-74 Years with Diagnosed and Undiagnosed Diabetes and IGT, U.S., 1976-80**

| | Age (years) | | | | |
|---|---|---|---|---|---|
| | 20-44 | 45-54 | 55-64 | 65-74 | 20-74 |
| **Black males** | | | | | |
| Diagnosed diabetes | 1.8 | 3.6 | 9.2 | 17.2 | 4.5 |
| Undiagnosed diabetes | 1.0 | 7.5 | 5.4 | 12.2 | 4.1 |
| IGT | 4.7 | 18.8 | 18.6 | 22.6 | 11.3 |
| Total glucose intolerance | 7.5 | 29.9 | 33.2 | 52.0 | 19.9 |
| **Black females** | | | | | |
| Diagnosed diabetes | 2.6 | 7.5 | 16.3 | 10.8 | 5.9 |
| Undiagnosed diabetes | 0.9 | 7.1 | 11.6 | 13.3 | 5.1 |
| IGT | 14.6 | 15.7 | 12.3 | 8.4 | 13.8 |
| Total glucose intolerance | 18.1 | 30.3 | 40.2 | 32.5 | 24.8 |
| **White males** | | | | | |
| Diagnosed diabetes | 0.5 | 4.5 | 5.3 | 9.1 | 2.8 |
| Undiagnosed diabetes | 0.5 | 3.3 | 4.1 | 10.0 | 2.7 |
| IGT | 4.6 | 12.6 | 17.2 | 22.8 | 10.2 |
| Total glucose intolerance | 5.6 | 20.4 | 26.6 | 41.9 | 15.7 |
| **White females** | | | | | |
| Diagnosed diabetes | 1.4 | 3.9 | 6.6 | 8.8 | 3.6 |
| Undiagnosed diabetes | 0.8 | 4.8 | 8.6 | 8.2 | 3.7 |
| IGT | 6.5 | 14.5 | 13.7 | 23.0 | 11.1 |
| Total glucose intolerance | 8.7 | 23.2 | 28.9 | 40.0 | 18.4 |

IGT, impaired glucose tolerance; diabetes status determined by medical history and results of oral glucose tolerance test using World Health Organization criteria, 1976-80 Second National Health and Nutrition Examination Survey.

*Source*: Reference 62

many of these studies used varying population age structures and screening and diagnostic methods, such as glycosuria, which have low sensitivity[63], thereby limiting comparisons among them. However, given the variation in degree of economic development throughout the Caribbean islands, it is possible that large differences in diabetes prevalence do exist within the region. It would be interesting to compare patterns of diabetes prevalence and risk factors between black populations in the United States and the Caribbean that are at various stages of economic development and epidemiologic transition.

## TIME TRENDS IN PREVALENCE OF DIABETES

Over the past 30 years, increases in the prevalence of chronic diseases such as NIDDM and heart disease have occurred in societies where economic development has resulted in decreased infant mortality, increased life expectancy, and adoption of a Western lifestyle in place of more traditional living patterns[71]. Data from the 1963-92 NHIS in Figure 31.6 provide some evidence of the influence of this epidemiologic transition on the changing frequency of NIDDM among African Americans. During this period, the percentage of U.S. blacks who had been diagnosed with diabetes rose from 1.2% to 3.6% and the number of black Americans with diagnosed diabetes rose from 230,000 to 1.15 million.

Although there has been an overall increase in the prevalence of diabetes in the United States, the change has not been identical for both blacks and whites.



*Figure 31.6*
**Prevalence and Number of Persons with Diagnosed Diabetes in Blacks, U.S., 1963-92**
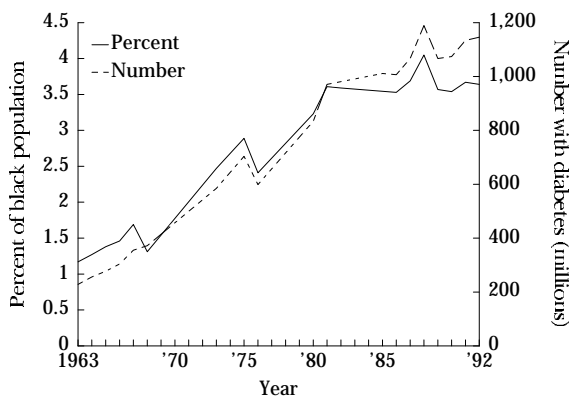
*Source*: 1963-92 National Health Interview Surveys



*Figure 31.7*
**Prevalence of Diagnosed Diabetes by Sex and Race, U.S., 1963-90**
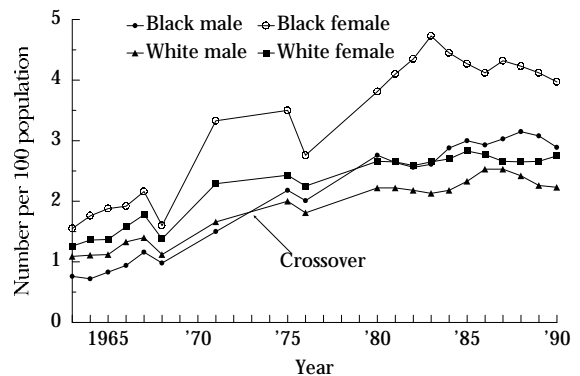
*Source*: 1963-90 National Health Interview Surveys

From 1963-85, the rates of known diagnosed diabetes doubled for whites but tripled for black Americans (Figure 31.7). An intriguing pattern emerges when these data are examined by sex and race. During 1963-85, diabetes rates for black females were consistently higher than rates for white females. Black males, however, had a lower rate than white males until 1973. After that year, there was a reversal such that the rate for black males became slightly higher than the rate for white males. It is possible that this crossover represents a true increase in the prevalence of diabetes among black males, with this change possibly being brought about by a concomitant increase in the prevalence of diabetes risk factors in the black male population. On the other hand, the observed pattern in diabetes prevalence for black males might only reflect an increase in the proportion of diagnosed to undiagnosed cases. Another possibility is that the increase in diabetes prevalence among black men resulted from increased survival, rather than an increase in the underlying rate of diabetes occurrence.

## INCIDENCE OF NIDDM

Additional evidence of the increased frequency of NIDDM in blacks in the United States is available from incidence data of the Epidemiologic Follow-up Study of the 1971-75 NHANES I. The patterns of race-sex differences in diabetes incidence were consistent with NHIS prevalence data. Of 11,097 individuals age 25-70 years in 1971-75 who were followed to 1987, 880 were diagnosed with diabetes. The age-adjusted incidence of diabetes diagnosis was 15% for black women, 10.9% for black men, and 7.0% and 6.9% for white men and women, respectively[72].

## NIDDM RISK FACTORS IN AFRICAN AMERICANS

A combination of factors, including lifestyle changes associated with the improving economic conditions of African Americans such as changes in diet, levels of physical activity, patterns of obesity, together with longer life expectancy and increased genetic susceptibility, may account for the observed racial patterns in diabetes prevalence over the past 30 years. This is only speculation, however. Unlike other nonwhite populations in which there is evidence of the relationship between economic development, lifestyle changes, and increased rates of NIDDM[73], little is known about changes in risk factors or diagnostic methods that may have precipitated the dramatic increase in the prevalence of NIDDM among African Americans.

The frequency of NIDDM in the African-American population is influenced by individual characteristics such as age and sex, which have been discussed above. Other factors associated with an increased risk of developing NIDDM include genetics and lifestyle factors such as socioeconomic status, obesity, and physical activity.

### GENETICS: THE THRIFTY GENE HYPOTHESIS

Neel suggested that populations exposed to periodic famines, which occur in Africa, would through natural selection increase the frequency of certain genetic trait(s), "thrifty genes," which would protect against starvation during times of famine[74]. These genes would allow for efficient energy conservation and fat storage during times of abundance. In circumstances of relative plenty, as in the United States in the absence of feast and famine cycles, these genes would become disadvantageous, predisposing to the development of obesity and an increased frequency of NIDDM. The higher rates of diabetes and obesity in African Americans and urban Africans compared with black Africans in traditional environments is consistent with this hypothesis[75]. An active search for NIDDM genes is being conducted (see Chapter 9 for a detailed discussion).

### OBESITY

The association of obesity as a major risk factor for NIDDM has been established in many ethnic groups, including African Americans[76-78]. In most studies, obesity is usually measured as body mass index (BMI),

Table 31.5
**Obesity in Blacks and Whites Age 20-74 Years, by Diabetes Status, U.S., 1976-80**

| | Black | | White | |
|---|---|---|---|---|
| | **Men** | **Women** | **Men** | **Women** |
| | percent with PDW ≥120% | | | |
| Previously diagnosed diabetes | 44.5 | 83.4 | 39.2 | 62.3 |
| Newly diagnosed diabetes | 64.4 | 78.1 | 38.5 | 78.7 |
| No diabetes | 32.1 | 55.8 | 27.2 | 35.0 |

PDW, percent desirable weight; diabetes status determined by medical history and results of oral glucose tolerance test using World Health Organization criteria, 1976-80 Second National Health and Nutrition Examination Survey.

*Source*: Reference 80

which relates weight in kilograms to height in meters squared or as percent desirable weight (PDW) based on the Metropolitan Life Insurance tables. In the U.S. population, rates of obesity (BMI >27.3 for women, >27.8 for men) are higher for African-American women compared with white women, white men, and black men[79]. The close association of obesity with diabetes can be seen in Table 31.5, where data from respondents age 20-74 years in the NHANES II cohort show the prevalence of obesity (PDW >120%) among diabetic black men and women to be substantially greater than their nondiabetic counterparts[80].

In addition to the degree of overweight, regional distribution of body fat (truncal versus peripheral) is also associated with increased risk of developing NIDDM, with the risk being greater for individuals with truncal (central) obesity[81]. Thus, it is possible that a greater tendency for African Americans to store fat centrally[82], together with high rates of total obesity, may partly explain their higher prevalence of NIDDM compared with white Americans.

The excess risk of NIDDM in blacks relative to whites increases with increasing level of obesity, particularly for black females[72,83]. Obesity cannot account for all the excess prevalence of NIDDM in black compared with white Americans, however. Rates of diabetes are higher for African Americans relative to whites, even after controlling for age, adiposity, and socioeconomic status[83,84]. It appears that other factors, such as genetics, contribute to the observed racial differences in the frequency of NIDDM in the United States.

### SOCIOECONOMIC STATUS

In the United States, an inverse relationship has been noted for socioeconomic status (education and income) and the prevalence of diabetes in adults for

both black and white Americans. Data from the NHIS show that for both black and white Americans diabetes frequency decreases with increasing level of education and family income[85]. However, rates for the African-American population are higher than for whites at each level of education and income. If age and obesity are controlled for, the association of income and education with NIDDM prevalence is significantly reduced[80,83]. Thus, whether socioeconomic status has any direct role in the etiology of NIDDM is unclear.

## PHYSICAL ACTIVITY

Physical inactivity is an independent risk factor for NIDDM, and physical activity is a strong protective factor against the development of NIDDM[86,87]. However, data on levels of physical activity based on validated measures are not available for the African-American population. Given the general inverse relationship between physical activity and obesity, it is likely that, relative to black males and white Americans, African-American females have lower levels of physical activity, which may contribute to their higher rates of obesity and diabetes. It is important that studies using validated measures of activity[88] be conducted on representative samples of African Americans to evaluate the role of physical activity in the development and prevention of diabetes in the black population.

## INSULIN RESISTANCE

Elevated levels of fasting insulin are associated with an increased risk of NIDDM[89]. Hyperinsulinemia can predate the development of diabetes for years[90], and black adolescents are more hyperinsulinemic than white children[91]. Although insulin resistance characterizes several atypical diabetic syndromes occurring in African heritage populations[4,5], there are no prospective data on the relationship of insulin resistance and/or hyperinsulinemia to subsequent development of NIDDM in African Americans. Clearly, more research is needed in this important area.

## IMPAIRED GLUCOSE TOLERANCE

IGT, a category of glucose intolerance in which post-challenge values are between diabetic and normal, is a strong risk factor for NIDDM. IGT rates are higher for black than white Americans (Table 31.4). While IGT prevalence rates increase with age for black men, white men, and white women, they decrease for black women at age $\geq 55$ years[92]. If IGT is a stage in the natural history of diabetes, then higher rates of NIDDM risk factors (such as obesity) among black females may contribute to this decrease by precipitating rapid conversion of IGT to overt diabetes[92]. However, comparison of the rates of total glucose intolerance (IGT plus diabetes) for the race-sex groups shows that the total intolerance rate remains lower for black females at age 65-74 years. This suggests that conversion from IGT to diabetes cannot completely account for the age pattern of IGT rates seen in black women[92]. One possible explanation for the decrease in IGT rates for black women at age $\geq 55$ years is increased mortality in the older age groups[80]. However, further research in this area is needed.
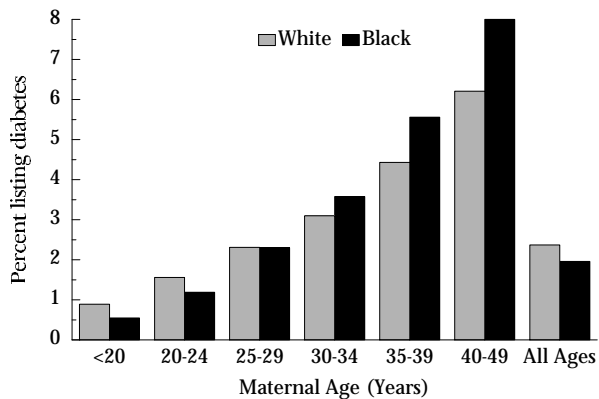
## ATYPICAL DIABETES

Atypical diabetic syndromes that display insulin and ketosis resistance and intermittent periods of normoglycemic remission have been reported in African-American patients[4,5]. An insulin-resistant variant of NIDDM associated with HLA-DQW7 has led to suggestions that NIDDM in African Americans occurs in insulin-sensitive and insulin-resistant forms that differ genetically[93,94]. An atypical diabetes that presents with features of IDDM but lacks the characteristic HLA associations has been found in young African Americans[3]. This syndrome may be more common in black than white Americans[95] and may account for 10% of cases of youth-onset diabetes among African Americans in the southeastern United States. In the Caribbean, a ketosis-resistant diabetic syndrome displaying phasic insulin dependence and associated with malnutrition has been described in Jamaica[96]. It will be useful to obtain population-based prevalence estimates of these atypical diabetes. Future research into the genetic basis for the occurrence of atypical diabetes among black populations in the Americas may provide important clues about the etiology of NIDDM.

## GESTATIONAL DIABETES

GDM is defined as glucose intolerance that develops during pregnancy and returns to normal tolerance after delivery. Among 3,744 patients screened for GDM at Northwestern University Medical School, the relative risk of developing GDM was 1.81 (95% confidence interval (CI) 1.13-2.99) for black compared with white women[97].

**Figure 31.8**
**Percent of Birth Certificates Listing Diabetes in the Mother, U.S., 1991**

**Figure 31.9**
**Prevalence of Retinopathy in Adults with Diagnosed NIDDM, Age ≥40 Years, U.S., 1988-91**

The U.S. birth certificate has a section in which diabetes in the mother can be recorded. Figure 31.8 shows the percent of birth certificates in which diabetes was recorded[98]. However, it is not possible to determine whether the diabetes was IDDM, NIDDM, or GDM. In addition, there may be underrecording of maternal diabetes on these records.

It is estimated that 50% of women who develop GDM will subsequently develop overt diabetes over a 20-year period[99]. Among African-American women, risk factors for GDM include older age, gravidity, hypertension, obesity, and family history of diabetes[100]. These are also risk factors for GDM in other racial/ethnic groups.
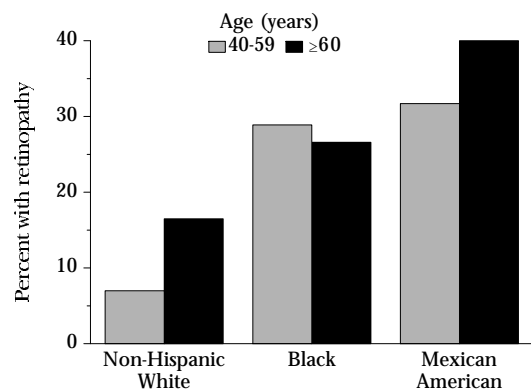
## DIABETIC COMPLICATIONS IN AFRICAN AMERICANS

Data on the frequency of diabetes complications in African Americans are limited. However, evidence suggests that African Americans experience considerable morbidity and excess frequency of many diabetic complications compared with the U.S. white population[1,75,80,101].

## DIABETIC EYE DISEASE (RETINOPATHY)

Diabetic retinopathy, which is characterized by alterations in the small blood vessels in the retina, is the leading cause of new cases of blindness in the United States in individuals age 20-74 years[102]. Studies on the frequency of complications of diabetes affecting the

eyes have reported the prevalence of blindness secondary to diabetic retinopathy to be twice as high in black compared with white individuals[103]. The frequency of severe visual impairment has also been reported to be 40% higher among African Americans with diabetes than their white counterparts[80]. The prevalence of retinopathy in a sample of U.S. blacks with diagnosed NIDDM in the 1988-91 phase of NHANES III was substantially higher than the rate in non-Hispanic whites but was similar to the rate in Mexican Americans (Figure 31.9)[104]. Diabetic retinopathy may be more frequent among U.S. blacks than whites because of higher rates of hypertension and inadequate metabolic control[105].

## DIABETIC KIDNEY DISEASE (NEPHROPATHY)

Diabetes is the second leading cause of end-stage renal disease (ESRD) in the black population, accounting for 32.5% of new ESRD cases in 1988-91, with the leading cause, hypertension, accounting for 37.9%[106]. During this 4-year period, an annual average of 4,036 new cases of diabetic ESRD occurred in blacks; the average number of black diabetic ESRD patients was 11,411 during 1988-91[106].

The increased frequency of diabetic nephropathy including ESRD in black compared with white Americans with diabetes ranges from 2.6 to 5.6 times excess[107-110]. However, it appears that survival after the development of ESRD may be better for black than white individuals with diabetes[111]. Prevalence of nephropathy among individuals with diabetes has been associated with hyperglycemia and hyperten-

sion[112]. Therefore, it is possible that higher rates of these factors may contribute to the excess prevalence of clinically diagnosed nephropathy in diabetic African Americans.

## AMPUTATION

Based on a sample of all hospital discharges in the United States in 1990, the rate of lower extremity amputations was 8.2 per 1,000 diabetic population for blacks versus 6.9 per 1,000 for whites[113].

## CARDIOVASCULAR DISEASE

African Americans with diabetes are at increased risk of macrovascular disease, including heart disease and stroke, relative to those without diabetes[114,115]. However, the prevalence of cardiovascular disease in diabetic patients appears to be lower in blacks than in whites. The frequency of angina and myocardial infarction in the 1976-80 NHANES II cohort was 2.3 and 3.0 times as great among newly diagnosed diabetic whites, and 50% and 20% higher, respectively, among previously diagnosed diabetic whites compared with diabetic African Americans[80]. Most diabetic African-Americans may have an insulin-sensitive form of diabetes that is associated with reduced levels of cardiovascular disease risk factors, and this may partially account for the lower rates of angina and myocardial infarction in the black population[116].

### RISK FACTORS FOR DIABETES COMPLICATIONS

Many of the factors that influence the frequency of diabetic complications in African Americans and contribute to the excess morbidity seen in this ethnic group are amenable to intervention. A list of some important factors is presented in Table 31.6. The type of diabetes may be an important determinant of the severity of diabetes complications in black Americans. Among African Americans, the probability of developing ESRD is greater for individuals who have IDDM compared with those with NIDDM[105]. Individuals who have insulin-resistant diabetes have higher levels of cardiovascular disease risk factors, including LDL-cholesterol and triglycerides[116].

Delay in diagnosis and treatment for diabetic complications may increase the likelihood of more severe morbidity and disability. For 51 African Americans with diabetes who received an initial examination for

*Table 31.6*
**Factors That Influence Risk of Diabetes Complications**

- Type of diabetes (IDDM versus NIDDM; insulin-sensitive versus insulin-resistant)
- Delay in diagnosis and treatment
- Socioeconomic conditions (limited education, no insurance)
- Personal lifestyle factors (smoking, alcoholism, etc.)
- Psychosocial factors (mental illness, denial of disease)

retinopathy, the mean duration between diagnosis of diabetes and time of examination was 11.5 years; 37.3% of these individuals had severe retinopathy at the initial examination[117]. A higher frequency of hospital readmissions (mainly for diabetic ketoacidosis) in African-American patients was associated with socioeconomic factors, including being from a one-parent home and lacking third-party insurance[118]. Overall, however, medical care for diabetes appears to be similar for blacks and whites with NIDDM (Table 31.7)[119-121].

Personal and lifestyle factors may also increase the risk of diabetic complications in African Americans. In the NHANES II cohort there was an almost 50% greater frequency of cigarette smoking, a risk factor for cardiovascular disease and diabetic neuropathy,
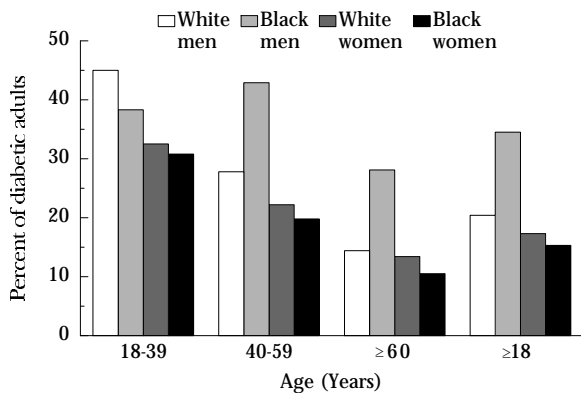
*Table 31.7*
**Medical Care for Black and White Adults with NIDDM, U.S., 1989**

| | Black | White |
|---|---|---|
| One physician for regular care of diabetes (%) | 87.3 | 92.7 |
| ≥4 visits to regular physician per year (%) | 62.4 | 58.9 |
| Mean no. of visits to regular physician in past year | 6.9 | 5.8 |
| Insulin treated (%) | 51.9 | 35.9 |
| Oral agent treated (%) | 50.1 | 39.9 |
| Following a diet for diabetes (%) | 88.9 | 88.2 |
| Self-monitors blood glucose ≥1/day (%) | | |
|   Insulin-treated | 14.0 | 29.8 |
|   Not insulin-treated | 4.0 | 5.1 |
| Seen a dietitian in past year (%) | 27.5 | 18.9 |
| Patient education in managing diabetes (%) | 43.3 | 31.5 |
| Mean no. of health checks by a professional in past year | | |
|   Blood pressure | 10.9 | 8.0 |
|   Blood glucose | 4.5 | 3.7 |
|   Sores on feet | 1.9 | 1.6 |
| Visit to ophthalmologist in past year (%) | 43.6 | 44.7 |
| Eye examination in past year (%) | 64.0 | 60.0 |
| Dilated eye examination in past year (%) | 47.3 | 47.5 |
| Visit to podiatrist in past year (%) | 19.1 | 16.2 |
| Visit to cardiologist in past year (%) | 26.7 | 21.5 |

*Source*: References 119-121

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Figure 31.10

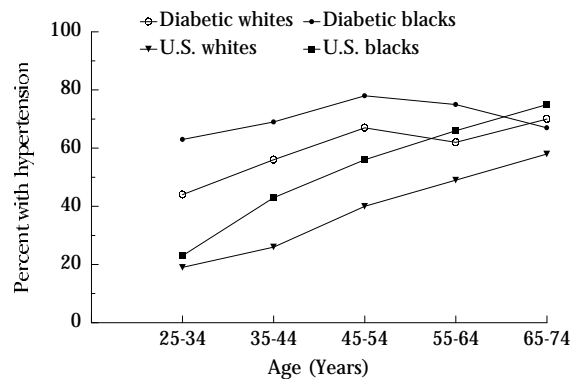**Frequency of Cigarette Smoking in Black and White Adults with NIDDM, U.S., 1989**

*Source*: 1989 National Health Interview Survey Diabetes Supplement



Figure 31.11

**Prevalence of Hypertension in Black and White Adults with NIDDM, U.S., 1976-80**

*Source*: Reference 80

among newly diagnosed black versus white diabetic subjects (42% versus 28.7%, respectively)[80]. This differential was also found for males in the 1989 NHIS, where 34% of black men with diagnosed diabetes were current smokers compared with 20% of white men; rates for women with diagnosed diabetes were 15% and 17%, respectively (Figure 31.10). Psychosocial factors including personal and family denial of the disease and limited education may lead to less compliance and poorer metabolic control of diabetes in African Americans[122].

## HYPERTENSION

Hypertension is a major risk factor for micro- and macrovascular disease in diabetes. In the United States, hypertension occurs more frequently among black than white Americans with diabetes[80] (Figure 31.11). About 60% of hypertension in diabetic blacks is controlled (Table 31.8). Hypertension also occurs frequently among African-heritage populations with diabetes in the Caribbean[123,124]. The consistency of higher rates of hypertension among individuals of African decent in the Americas compared with other ethnic groups in the United States and Caribbean has led to the hypothesis that Western Hemisphere blacks are descendants of a highly selected group of Africans who were able to survive the long sea voyages from Africa by efficiently retaining salt, thereby maintaining blood volume homeostasis[125]. The high rates of hypertension among African Americans might be related to hyperinsulinemia and abnormal renal sodium transport[126].

## DYSLIPIDEMIA

Figure 31.12 shows the prevalence of dyslipidemia in blacks and whites with NIDDM in the 1976-80 NHANES II cohort[127]. For each lipid, the frequency of an abnormal value is lower in blacks than in whites. Compared with nondiabetic blacks, diabetic blacks had a lower frequency of total cholesterol >240 mg/dl (men), a lower frequency of low-density lipoprotein (LDL) cholesterol >160 mg/dl (both sexes), a higher frequency of high-density lipoprotein (HDL) cholesterol <35 mg/dl (both sexes), and a higher frequency of fasting triglycerides >250 mg/dl (women)[127].

Table 31.8

**Hypertension in Persons with Diabetes Age 20-74 Years, U.S., 1976-80**

|  | Black | White |
|---|---|---|
| Hypertensive (%) | 70.3 | 63.2 |
| Diagnosed hypertension | 63.7 | 53.7 |
| Controlled | 39.9 | 32.1 |
| Not controlled | 23.8 | 21.6 |
| Using antihypertensive medications | 31.9 | 33.1 |
| Undiagnosed hypertension | 6.6 | 9.6 |
| Not hypertensive (%) | 29.7 | 36.8 |

Hypertension is defined as a medical history of physician-diagnosed hypertension and/or systolic blood pressure ≥160 mmHg and/or diastolic blood pressure ≥95 mmHg.

*Source:* Reference 80

623

*Figure 31.12*
**Dyslipidemia in Black and White Adults with NIDDM, U.S., 1976-80**

*Source*: Reference 127
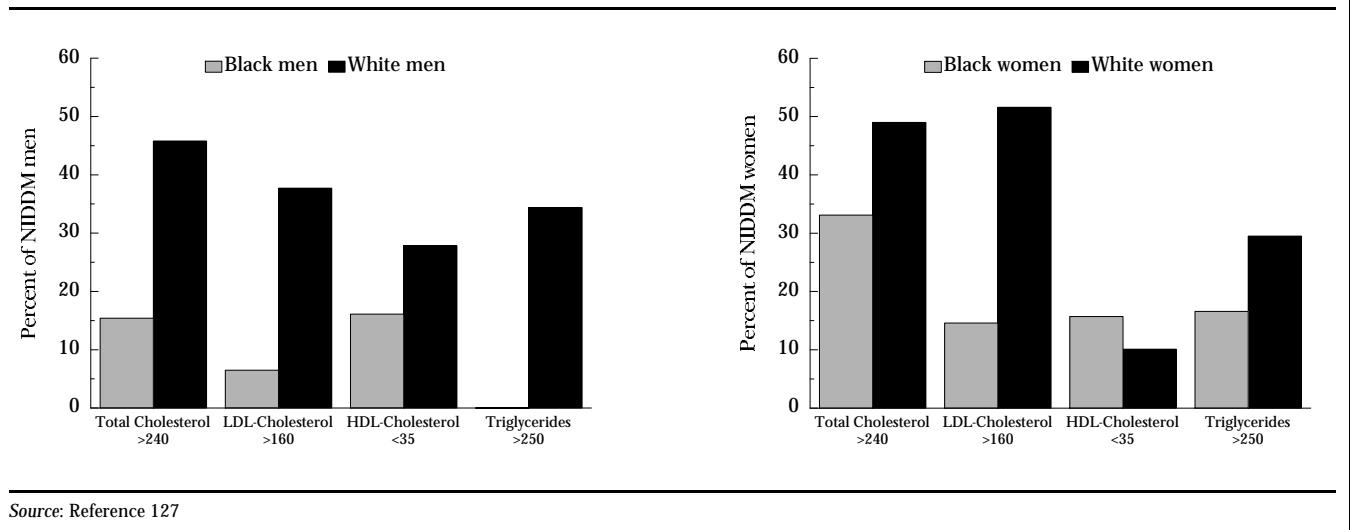
## DIABETES MORTALITY IN AFRICAN AMERICANS

Unfortunately, there is no study of diabetes mortality in a population of African Americans. To assess mortality from diabetes, death certificate data can be used, but there is substantial underreporting of diabetes on the death certificates of people known to have had diabetes. For example, in a national sample of deaths in 1986, only 36.2% of blacks with diabetes and 38.6% of whites with diabetes had diabetes listed anywhere on their death certificates[128]. Data using diabetes as the underlying cause of death are even more problematic: Only 12.5% of blacks and 9.2% of whites with diabetes had diabetes listed as the underlying cause of death[128]. Despite this underreporting on death certificates and their serious inaccuracy, death certificates are frequently used to assess diabetes mortality.

Prior to World War II, diabetes was identified more frequently on death certificates as a cause of death among whites than among blacks in the United States[75]. However, since about 1950, diabetes mortality rates for African Americans have been consistently higher than for whites. In 1993, diabetes was the ninth most frequently listed underlying cause of death in African-American males (3,620 deaths) and the fourth most frequently listed underlying cause in African-American females (6,170 deaths)[129]. The death rate per 100,000 population based on diabetes listed as the underlying cause of death was 23.7 for black males and 36.5 for black females.

Mortality rates based on death certificates in which diabetes was listed as either the underlying cause of

death or as a contributing cause are shown in Figure 31.13[113]. Rates are based on the diabetic population, estimated from the NHIS. It appears that mortality rates may be higher for blacks at age <75 years and lower at age ≥75 years, but these data must be viewed with caution because of the documented substantial underreporting of diabetes on death certificates[128] and the differential reporting by black and white race[128].

Among other black populations in the Americas, mortality rates based on diabetes as the underlying cause listed on death certificates range from 8 per 100,000 to 63 per 100,000[130-132]. This wide range includes low

*Figure 31.13*
**Diabetes Mortality Based on Death Certificates Listing Diabetes as the Underlying or Contributing Cause of Death, U.S., 1989**
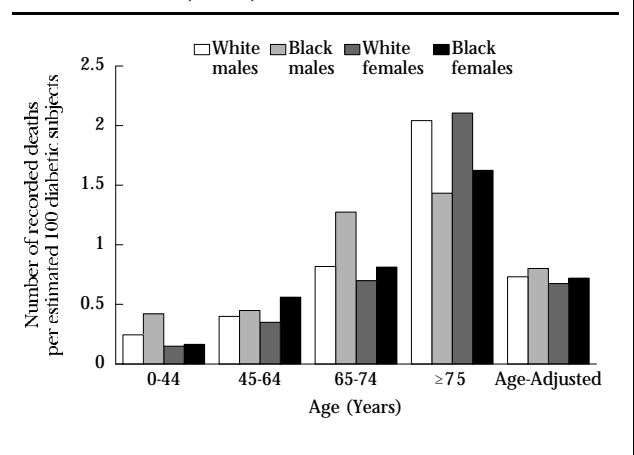


These data probably include only 36% of deaths of blacks with diabetes, based on the study in Reference 128.

*Source*: Reference 113

rates that are similar to those of developing African countries and rates that are nearly twice as high as for African Americans in the United States. Because diabetes death rates may depend on factors such as the physician's decision concerning what to assign as cause of death, the prevalence of diabetes, access to medical care, and the adequacy of medical care, comparison of these rates is questionable.

The vast majority of the deaths attributed to diabetes relate to the more prevalent NIDDM subtype, and little is known of IDDM-specific diabetes mortality rates in African Americans. In an evaluation of the 20-year mortality experience of IDDM cases in Allegheny County, PA, black subjects experienced a mortality rate nearly 2.5 times greater than whites (9.6 per 1,000 person-years versus 3.9 per 1,000 person-years, respectively)[133]. Data from death certificates show a similar diabetes mortality rate for blacks and whites (0.1 per 100,000 population) at age <15 years, where IDDM is the predominant form of diabetes[113]. Little is known of IDDM-specific mortality rates in black Caribbean populations, although it has been estimated that the diabetes mortality rate at age 0-14 years in Jamaica may be as much as 20 times that of African Americans in the United States[134]. Much of the IDDM-associated mortality in African Americans may be preventable[133,134].

## CONCLUSION

Diabetes is of public health importance for all ethnic groups in the United States. However, there is a need to address this problem specifically in the black population. Over the past 30 years, the prevalence of diabe-

tes in African Americans has more than tripled. The recent focus on diabetes in African Americans has led to new insights concerning the variability in clinical manifestations of the disease in black populations (e.g., insulin-resistant NIDDM and insulin-sensitive NIDDM, which have different cardiovascular disease risk profiles). Such discoveries suggest the potential for improved diabetes treatment and care among African Americans. However, new intervention strategies developed to reduce current levels of diabetes complications among African Americans must consider the socioeconomic and psychosocial factors that contribute to poor compliance to diabetes management strategies, in addition to smoking, diet, hypertension, and other risk factors for diabetes complications.

Data on the epidemiology and impact of diabetes in African Americans suggest several major needs, including: 1) identifying factors responsible for the increasing frequency of NIDDM in African Americans; 2) determining the etiology of the unusual types of diabetes in black populations; 3) addressing the high rates of morbidity and mortality associated with diabetes in blacks; 4) determining reasons for the high prevalence of diabetes-associated risk factors in blacks, particularly obesity and hypertension, and developing effective intervention programs; and 5) increasing awareness in the black community of the problem of diabetes.

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*Appendix 31.1*
**Number and Percent of Persons Who Have
Diagnosed Diabetes, U.S., 1993**

| Age (years) | Black No. (thousands) | Percent | White No. (thousands) | Percent |
|---|---|---|---|---|
| <45 | 304 | 1.26 | 1,151 | 0.82 |
| 45-64 | 578 | 11.25 | 2,413 | 5.63 |
| 65-74 | 292 | 17.44 | 1,576 | 9.54 |
| ≥75 | 141 | 14.11 | 1,161 | 10.16 |
| Total | 1,315 | 4.11 | 6,300 | 2.98 |

*Source*: Reference 135