Chapter 33

Diabetes in Asian and Pacific Islander Americans

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SUMMARY

Asian and Pacific Islander Americans, although constituting <3% of the total U.S. population in 1990, comprise a very diverse group, with >20 population groups. The majority (~95%) are Asian, with the major categories being Chinese, Filipino, Japanese, Asian Indian, Korean, and Vietnamese. These numbered almost 7 million in the 1990 U.S. Census. The major categories of Pacific Islanders are Hawaiian, Samoan, and Guamanian, numbering ~323,000 in the same census. Fifty-six percent of the Asian and Pacific Islander population lived in the West in 1990, and ~73% lived in just seven states (California, New York, Hawaii, Texas, Illinois, New Jersey, and Washington).

The number of Asians and Pacific Islanders in the United States has increased rapidly in recent years, a nearly 2.5-fold increase from 1970 to 1980 and another nearly twofold increase from 1980 to 1990. Immigration after the adoption of the Immigration Act of 1965 was a major factor in this increase, as well as the large number of Southeast Asian refugees who arrived after 1975 under the Refugee Resettlement Program. Since many of the Asians in the United States are fairly recent immigrants, the majority are foreign-born. Among the main Asian-American groups, only the Japanese had a majority who were born in the United States.

Insulin-dependent diabetes mellitus (IDDM) is relatively rare in this population. Among Japanese, a lower frequency of those genes that are associated with IDDM has been offered as possible explanation for the low incidence of the disease. Limited data suggest, however, that IDDM may be higher in migrant Japanese and Asian-Indian children.

Diabetes in the Asian and Pacific Islander population is predominantly of the non-insulin-dependent type (NIDDM). Among Asian Americans, data on prevalence of NIDDM are available only for Japanese, Chinese, Korean, and Filipino populations. Information is available, however, for migrant Asian populations in other countries (Singapore, Mauritius, Brazil, South Africa, Fiji, Trinidad, and England). Information is also available for several native nonmigrant Asian populations (Japanese, Chinese, Asian Indian, Korean, and Filipino). Taken together, these data show prevalence of NIDDM to be higher in migrant Asians than in native nonmigrant Asians. For Pacific Islanders, the limited data available for Hawaiians and Samoans show prevalence rates for NIDDM to be high in these groups.

Since NIDDM is considered to be one of the diseases associated with lifestyle changes seen with westernization, research in this population may lead to a better understanding of factors mediating this association. A possible explanation of this is the "thrifty" genotype hypothesis, which proposes that in populations that were subject to periods of famine, a survival advantage was given those with a metabolism that stored energy with maximum efficiency. In periods of abundance, however, this leads to obesity and to development of the insulin resistance syndrome, or "Syndrome X."

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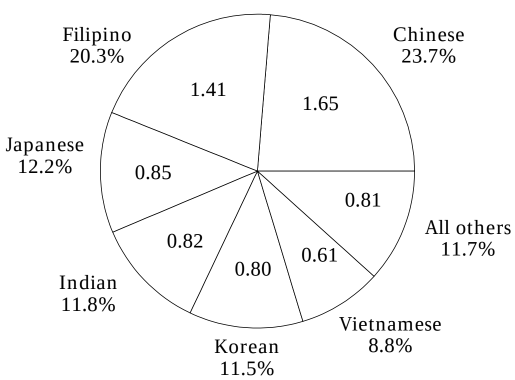
INTRODUCTION

Data compiled on estimates of abnormal glucose tolerance in adults from diverse populations worldwide have shown diabetes in adults to be a global health problem[1]. The risk for development of diabetes, however, is not uniform among populations. At greatest risk appear to be minority populations living in industrialized countries. This increase is especially troubling since many high-risk migrant populations have been traditionally believed to have low diabetes prevalence in their homelands. Data on diabetes prevalence in Asian and Pacific Islander Americans are, however, sparse. For this reason, this chapter includes a review of diabetes prevalence in native and migrant Asian and Pacific Islander populations that emphasizes the major health problem this disease already is in Asian and Pacific Islander Americans, a segment of the U.S. population that has grown tremendously since 1970.

DEFINITION OF ASIAN AND PACIFIC ISLANDER

Asian and Pacific Islander Americans include all persons residing in the United States who have originated from Asian and Pacific Island areas. Within this ethnic grouping, ~7.3 million in the 1990 U.S. Census, the vast majority (~95%) are Asian. The major categories of Asians in the United States are Chinese, Filipino, Japanese, Asian Indian, Korean, and Vietnamese (Figure 33.1)[2]. The major categories of Pacific Islanders in the United States are Hawaiian, Samoan, and Guamanian, who numbered ~323,000 in the same census.

Figure 33.1
Ethnic Origin of the Asian-American Population in the 1990 U.S. Census



Data within the circle are numbers in millions.

Source: Reference 2

Table 33.1
Distribution of Resident Asian and Pacific Islander Population in the U.S., by Ethnic Origin, 1990

Race	No. (1,000)	Percent
Total	7,274	100.0
Chinese	1,645	22.6
Filipino	1,407	19.3
Japanese	848	11.7
Asian Indian	815	11.2
Korean	799	11.0
Vietnamese	615	8.5
Laotian	149	2.0
Cambodian	147	2.0
Thai	91	1.3
Hmong	90	1.2
Pakistani	81	1.1
Hawaiian	211	2.9
Samoan	63	0.9
Guamanian	49	0.7
Other	264	3.6

Source: Reference 2

U.S. CENSUS

Ethnic Distribution of Asians and Pacific Islanders

Asian and Pacific Islander Americans comprise a diverse group, with >20 population subgroups (Table 33.1). Asians and Pacific Islanders are, however, a small portion of the U.S. population, constituting <3% of the total population in 1990 (Table 33.2).

The number of Asians and Pacific Islanders in the United States has increased rapidly since 1970. Asians and Pacific Islanders numbered ~1.5 million in 1970, >3.7 million in 1980, and 7.3 million in 1990[2-4]. This growth represents an increase of nearly 2.5-fold from 1970 to 1980, and another nearly twofold increase from 1980 to 1990. Over the same period, the proportion of Asians and Pacific Islanders in the total population increased from 0.8% in 1970 to 1.6% in 1980

Table 33.2
Resident Population in the U.S., by Race, 1990

Race	No.	Percent
Total	248,709,873	100.0
White	199,686,070	80.3
Black	29,986,060	12.1
Asian or Pacific Islander	7,273,662	2.9
American Indian, Eskimo, Aleut	1,959,234	0.8
Other races	9,804,847	3.9

Source: Reference 2

Table 33.3
Resident Asian and Pacific Islander Population in the U.S., by Ethnic Origin, 1980 and 1990 Census

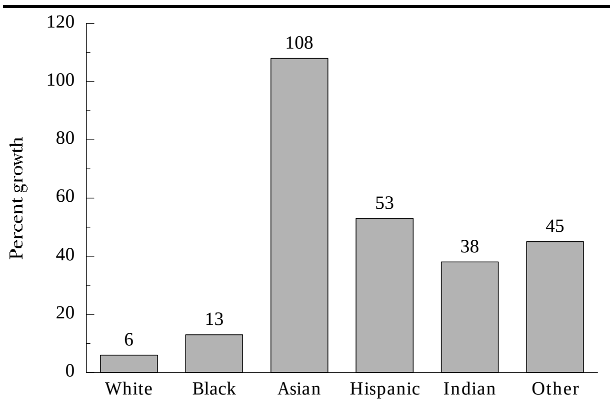
Race	Number (1,000) 1980	1990	Percent growth 1980-90
Total	3,726	7,274	95.2
Chinese	812	1,645	102.2
Filipino	782	1,407	79.9
Japanese	716	848	18.4
Asian Indian	387	815	110.6
Korean	357	799	123.8
Vietnamese	245	615	151.0
Laotian	48	149	210.4
Cambodian	16	147	818.8
Thai	45	91	102.2
Hmong	5	90	1,700.0
Pakistani	16	81	406.3
Hawaiian	172	211	22.7
Samoan	40	63	57.5
Guamanian	31	49	58.1
Other	54	264	388.9

Source: References 2 and 4

and 2.9% in 1990. The percent change in resident Asian and Pacific Islander populations in the United States by ethnic origin is shown in Table 33.3. Asians showed the greatest percent change between 1980 and 1990 when compared with other major ethnic groups in the United States (Figure 33.2).

Immigration after the adoption of the Immigration Act of 1965 was a major factor for the increase, as well as the large number of Southeast Asian refugees who came to the United States after 1975 under the Refugee Resettlement Program. In addition to immigration and natural increases, part of the growth has also been attributable to changes in the census race definition to include more groups (there were only five population groups in the 1970 Census).

Figure 33.2
U.S. Population Growth Between 1980 and 1990, by Race and Ethnicity



Source: References 2 and 4

Since many of the Asians in the United States are fairly recent immigrants, the majority are foreign-born. Among the main Asian-American groups, only the Japanese have a majority who were born in the United States.

Geographic Distribution of Asians and Pacific Islanders

Nearly 56% of the Asian and Pacific Islander population lived in the western region of the United States in 1990, compared with just over 21% of the total population (Table 33.4)[2]. Of the six largest Asian groups (Chinese, Filipino, Japanese, Asian Indian, Korean, and Vietnamese), the heaviest population concentrations were in the West, except for Asian Indians, who resided primarily in the Northeast. The majority of all Pacific Islanders lived in the West.

Approximately 73% of Asians and Pacific Islanders lived in just seven states: California, New York, Hawaii, Texas, Illinois, New Jersey, and Washington (Table 33.5). The Asian population was concentrated in California, New York, and Hawaii, while the overwhelming majority of Pacific Islanders lived in Hawaii and California.

IDDM IN ASIAN AND PACIFIC ISLANDER POPULATIONS

The age-adjusted annual incidence rates (per 100,000 persons per year) of childhood-onset (<15 years) IDDM in the United States, although ranging about twofold from 9.4 (95% confidence interval (CI) 6.9-12.5) in San Diego, CA (estimate of ascertainment unavailable) to 20.8 (95% CI 14.1-29.6) in Rochester, MN (virtually 100% ascertainment), are considerably greater than rates reported in Japan[5]. A nationwide survey in Japan reported a rate of 0.6 (95% CI 0.5-0.7, about 60% ascertainment), while in a survey of Hokkaido, Japan (~100% ascertainment), the incidence rate was 1.7 (95% CI 1.3-2.2), the lowest incidence of IDDM reported by a diabetes registry having virtually complete ascertainment. A lower frequency of those genes that are associated with IDDM has been offered as a possible explanation for the low frequency of the disease among Japanese[6-8].

Reliable incidence rates for IDDM in other Asian populations are not available, nor are they available

Table 33.4
U.S. Resident Population, by Region and Race, 1990

Race	Percent distribution Northeast	Midwest	South	West
Total	20.4	24.0	34.4	21.2
White	21.1	26.0	32.8	20.0
Black	18.7	19.1	52.8	9.4
American Indian, Eskimo, Aleut	6.4	17.2	28.7	47.6
Asian, Pacific Islander	18.4	10.6	15.4	55.7
Chinese	27.0	8.1	12.4	52.4
Filipino	10.2	8.1	11.3	70.5
Japanese	8.8	7.5	7.9	75.9
Asian Indian	35.0	17.9	24.0	23.1
Korean	22.8	13.7	19.2	44.4
Vietnamese	9.8	8.5	27.4	54.3
Laotian	10.7	18.6	19.6	51.0
Cambodian	20.5	8.8	13.1	57.7
Thai	12.9	14.2	26.0	46.8
Hmong	1.9	41.3	1.8	55.0
Pakistani	34.3	18.9	26.5	20.4
Hawaiian	2.0	2.6	5.8	89.6
Samoan	2.4	3.6	6.4	87.6
Guamanian	7.3	6.4	16.8	69.5
Other races	17.0	8.5	24.0	50.6

Source: Reference 2

for Pacific Islander populations. However, for the incidence of IDDM in the different Asian and Pacific Islander groups in the United States, an epidemiologic study of IDDM patients age 0-19 years in San Diego, CA has reported IDDM incidence rates in Asians, as well as in Mexicans and blacks, to be significantly less than among Caucasians[9]. This suggests that among multiple racial groups living in the same environment, Caucasians may be at higher risk of developing IDDM than Asians.

Data showing that risk for IDDM is increased among Japanese children in Hawaii when compared with children in Tokyo would suggest that environmental factors may also be important in etiology, although this study was severely limited by the very small number of incident cases[10]. Data collected in England have also suggested that IDDM may be more common among Asian children of Indian origin in England than in India[11].

Table 33.5
States with Largest Number of Asian and Pacific Islander Populations, 1990

	No. (1,000)	Percent
Total	7,274	100.0
California	2,846	39.1
New York	694	9.5
Hawaii	685	9.4
Texas	319	4.4
Illinois	285	3.9
New Jersey	273	3.8
Washington	211	2.9
All others	1,961	27.0

Source: Reference 2

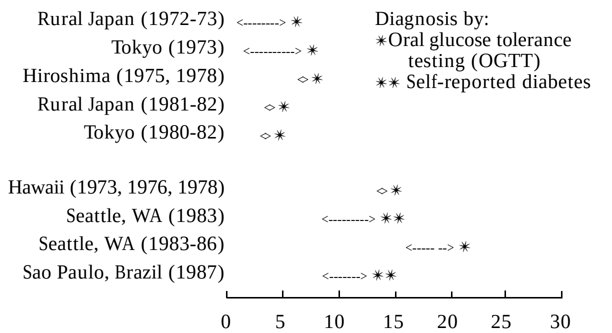
NIDDM IN ASIAN AND PACIFIC ISLANDER POPULATIONS

ASIANS

Diabetes mellitus is less frequent in Asian than in western countries and is usually of the non-insulin-dependent type. Since NIDDM is considered to be one of the diseases associated with the lifestyle changes seen with westernization, research among immigrant Asian populations may lead to better understanding of factors mediating this association.

Various methods have been used to diagnose diabetes, often making difficult direct comparisons of diabetes rates among studies. Nonetheless, differences in diabetes rates between native Asian populations and migrant Asian populations are quite striking. Some of the data illustrating these differences are given for Japanese (Figure 33.3), Chinese (Figure 33.4), and Asian Indians (Figure 33.5), and are discussed in

Figure 33.3
Prevalence of Diabetes in Selected Japanese Populations



Diagnosis of diabetes was based on either self-report or oral glucose tolerance testing. Age range was ~40-75 years.

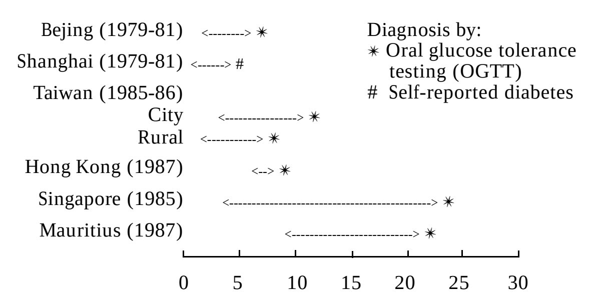
Source: References 13-15, 19, 20, 22, 36, 46, and 47

greater detail in subsequent sections.

Asian Americans

Within the United States, Hawaii has the highest percentage of individuals of Asian ancestry. Hawaii offers an excellent opportunity to examine the effects of lifestyle change on the frequency of diabetes among different racial groups. From a survey conducted in 1958 and 1959, Sloan[12] reported the ethnic distribution of diabetes among 38,103 adults on the Island of Oahu. Capillary blood samples were obtained at between 2 to 2.5 hours after a meal containing at least 50 g carbohydrate. Persons with blood glucose >130 mg/dl were referred to their physicians, who were asked to determine whether the subject was diabetic and to indicate whether the diagnosis had been previously known. Age-adjusted prevalence rates, both for total cases and for newly diagnosed diabetes, were at least twofold greater in each of the four major Asian groups (Chinese, Filipino, Japanese, and Korean) than in Caucasians (Figure 33.6).

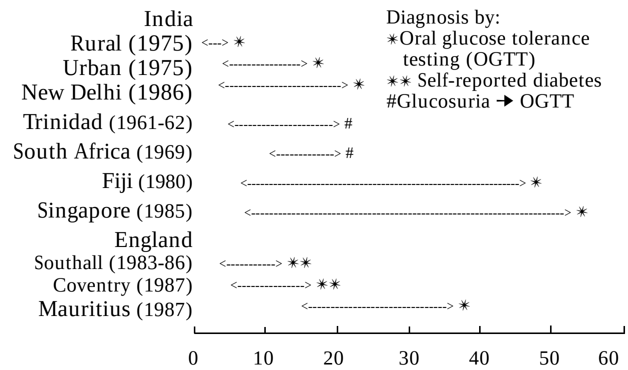
Figure 33.4
Prevalence of Diabetes in Selected Chinese Populations



Diagnosis of diabetes was based on oral glucose tolerance testing. Age range was ~50-70 years.

Source: References 32, 34, 50, 51, 53, 54, and 57

Figure 33.5
Prevalence of Diabetes in Selected Asian-Indian Populations



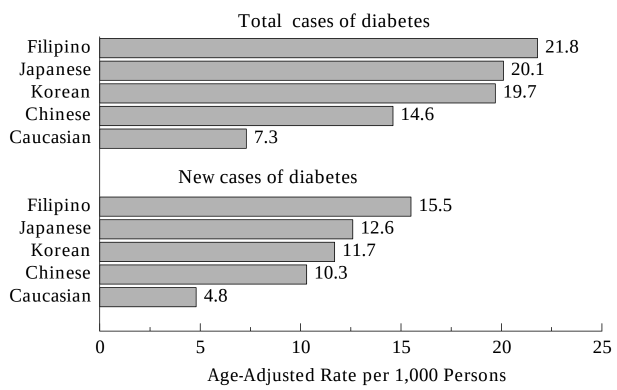
Diagnosis of diabetes was based on either self-report or oral glucose tolerance testing. Age range was ~50-70 years.

Source: References 32, 34, 37, 39-42, 59, and 60

Japanese

The data collected by Sloan[12] in Hawaii showed an increased age-adjusted prevalence of diabetes in Japanese when compared with Caucasians, 20.1% versus 7.3% for total cases and 12.6% versus 4.8% for new cases. Several other studies have also reported an increased prevalence of NIDDM in Japanese Americans.

Figure 33.6
Age-Adjusted Prevalence of New Cases of Diabetes and Total Cases of Diabetes on the Island of Oahu, 1958-59



Capillary blood samples were obtained at 2-2.5 hours after a meal containing at least 50 g carbohydrate, and persons with blood glucose >130 mg/dl were referred to their physicians, who were asked to determine whether the person was diabetic and whether the diagnosis had been previously known.

Source: Reference 12

In the Hiroshima University Study, surveys were done of individuals who were originally from Hiroshima prefecture and their offspring living on the Island of Hawaii (in 1973, 1976, and 1978), and in Los Angeles (in 1978), and of Japanese living in Hiroshima prefecture (in 1975 and 1978)[13-15]. Since the majority of Japanese migrants to the United States were from rural areas of Japan, agricultural areas of Hiroshima prefecture were selected. Prevalence of diabetes was ascertained from either known treatment with insulin or oral hypoglycemic agents, or serum glucose ≥200 mg/dl at 2 hours after a 50-g oral glucose tolerance test (OGTT). Prevalence rates for diabetes were similar between Hawaii and Los Angeles. Gender- and age-specific diabetes prevalence rates were about two-fold higher among Japanese Americans than among native Japanese (Table 33.6).

The Ni-Hon-San Study coordinated studies carried out in three populations of Japanese men: in Japan (Hiroshima and Nagasaki); Honolulu, HI; and eight San Francisco Bay area (CA) counties[16,17]. In Japan, the sample group was drawn from a population of about 100,000 persons under study by the Atomic Bomb Casualty Commission and the Japanese National Institute of Health; 3,322 had an OGTT. In Honolulu, the sample group was identified by the Honolulu Heart Program through World War II Selective Service records of 14,426 men of pure Japanese ancestry born between 1900 and 1919 and living on the Island of Oahu in 1965. Of these, 9,878 were studied, among whom an OGTT was done in 8,006. California subjects were persons born in Japan who had immigrated to the United States before 1925 and their children, selected from a roster of Japanese-American households drawn from a variety of sources. In this cohort were 3,809 men age 30-69 years; an OGTT was done in 2,319 of them. Greater glucose intolerance was observed 1 hour after 50 g oral glucose among both migrant Japanese populations than among the population residing in Japan (Table 33.7).

Table 33.6

Prevalence of Diagnosed Diabetes in Japanese Americans in Hawaii and Los Angeles, CA and Native Japanese in Hiroshima Prefecture

	Age (years)	Diabetes prevalence (%) Men	Women
Hawaii (1973, 1976, 1978)	40-59	10.1	2.9
and Los Angeles (1978)	60-96	19.4	7.6
Age- and sex-adjusted		13.9	
Hiroshima (1975, 1978)	40-59	9.8	4.8
	60-96	21.0	10.3
Age- and sex-adjusted		6.5	

Diagnosis of diabetes was based on treatment for diabetes or serum glucose ≥200 mg/dl at 2 hours after 50 g oral glucose.

Source: References 13-15

Table 33.7

Mean Serum Glucose (mg/dl) 1 Hour After an Oral 50-g Glucose Load in Japanese and Japanese-American Men

Age (years)	Japan (1965-66)	Hawaii (1965-68)	California (1969-70)
45-49	137.0	151.4	155.0
50-54	147.8	158.6	155.0
55-59	140.6	164.0	162.2
60-64	147.8	173.0	158.6
65-69	153.2	182.1	171.2

In California, oral glucose was not given to men with known diabetes.

Source: References 16 and 17

In the Oahu component of this study, known diabetes was present in 5.9% of participants, while an additional 6.7%, who had 1-hour serum glucose ≥225 mg/dl following 50 g oral glucose, were considered to have asymptomatic hyperglycemia[18]. Rates for known diabetes in the Japanese-American men were about twice that for all U.S. men in comparable age groups.

The Seattle Japanese-American Community Diabetes Study, conducted in the Japanese population of King County, WA, found self-reported diabetes in 1983 present in 13.2% of 189 second-generation men and 8.3% of 157 second-generation women age 45-74 years. Based on these rates of self-reported diabetes plus results of a 75-g OGTT performed in a study sample of 420 subjects (mean age 62 years, age range 45-74 years) from this population (diabetes diagnosed by fasting plasma glucose ≥140 mg/dl or 2-hour plasma glucose ≥200 mg/dl), diabetes prevalence was estimated to be 20% (CI 18-22%) in second-generation men and 16% (CI 14-18%) in second-generation

Table 33.8

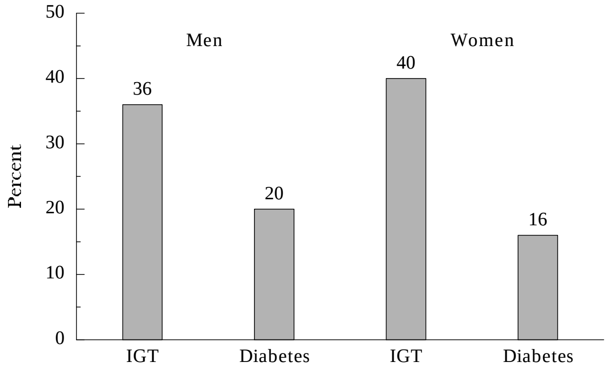
Age-Specific Prevalence of Diabetes in U.S., Tokyo, and Seattle Nisei

	Years	Age (years)	Prevalence (%) Men	Women
U.S. white	1976-80	45-74	12	14
Tokyo	1981-82	≥40	5	4
Seattle Nisei	1983-85	45-74	20	
	1986-88	45-74		16

Diagnosis of diabetes was based on treatment for diabetes, fasting serum glucose ≥140 mg/dl, or 2-hour serum glucose ≥200 mg/dl after 75 g oral glucose.

Source: References 19-22

Figure 33.7
Prevalence of IGT and Diabetes Among Second-Generation Japanese-American Men and Women in Seattle, WA

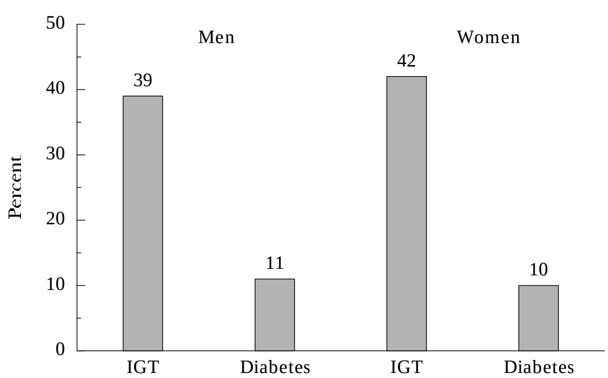


IGT, impaired glucose tolerance. Subject had a 75-g OGTT. Diagnosis of IGT was based on fasting plasma glucose <140 mg/dl and 2-hour plasma glucose ≥140 mg/dl and <200 mg/dl; diagnosis of diabetes was based on treatment for diabetes or fasting plasma glucose ≥140 mg/dl or 2-hour plasma glucose ≥200 mg/dl.

Source: References 19 and 20

women[19,20]. These rates are higher than reported for the U.S. white population in 1976-80 National Health and Nutrition Examination Survey II[21] or in Tokyo in 1981-82[22] for persons of similar age (Table 33.8). The prevalence of impaired glucose tolerance (IGT) was also estimated in this study to be 36% (CI 33-39%) in second-generation men and 40% (CI 37-43%) in second-generation women (Figure 33.7). Of interest were the high prevalence of diabetes and of IGT

Figure 33.8
Prevalence of IGT and Diabetes Among Second-Generation Japanese-American Men and Women in Seattle, WA with Self-Reported Absence of Diabetes



IGT, impaired glucose tolerance. Subjects had a 75-g OGTT. Diagnosis of IGT was based on fasting plasma glucose <140 mg/dl and 2-hour plasma glucose ≥140 mg/dl and <200 mg/dl; diagnosis of diabetes was based on fasting plasma glucose ≥140 mg/dl or 2-hour plasma glucose ≥200 mg/dl.

Source: References 19 and 20

Table 33.9
Baseline and Follow-Up Diagnoses in 5-Year Follow-Up of Second-Generation Japanese-American Men in Seattle, WA

	Follow-up diagnosis		
Baseline diagnosis	Normal	IGT	Diabetes
Normal (n=71)	44 (62%)	26 (37%)	1 (1%)
IGT (n=66)	24 (36%)	30 (46%)	12 (18%)

Subjects had a 75-g OGTT and diagnosis of normal glucose tolerance was based on fasting and 2-hour plasma glucose <140 mg/dl, IGT on fasting plasma glucose <140 mg/dl and 2-hour plasma glucose ≥140 mg/dl and <200 mg/dl, and diabetes on fasting plasma glucose ≥140 mg/dl or 2-hour plasma glucose ≥200 mg/dl. IGT, impaired glucose tolerance.

Source: Seattle Japanese-American Community Diabetes Study

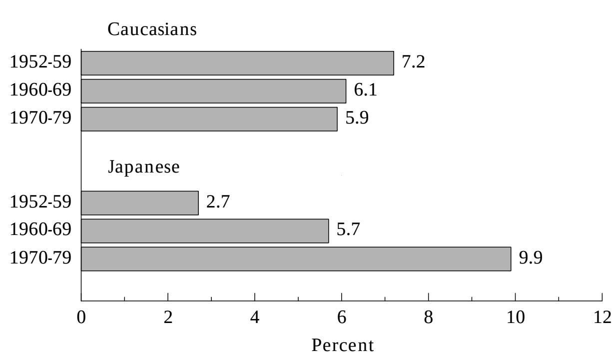
among self-reported nondiabetic second-generation men and women, indicating that abnormal glucose tolerance occurred frequently (Figure 33.8). Furthermore, during a 5-year follow-up period, conversion to diabetes occurred much more often in individuals who had IGT at baseline than in those with normal glucose tolerance at baseline (Table 33.9). This study has also shown NIDDM to be related to visceral adiposity, measured by computed tomography, and fasting hyperinsulinemia (insulin resistance)[23-27]. Some metabolic variables for the diabetic subjects in this study are shown in Appendix 33.1.

From an examination of death certificates, mortality rates attributed to diabetes have been ascertained for Japanese and Caucasians in Hawaii from 1952-79[28]. Over this period, there was a marked secular increase in diabetes death rates in Japanese while diabetes death rates fell in Caucasians (Figure 33.9).

Chinese

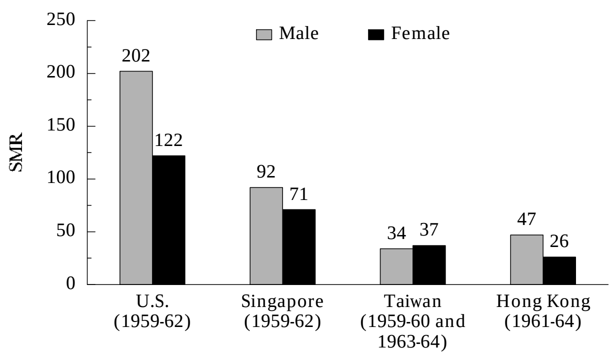
Sloan[12] showed the age-adjusted diabetes prevalence

Figure 33.9
Percent of All Deaths Attributed to Diabetes Among Caucasians and Japanese in Hawaii, 1952-79



Source: Reference 28

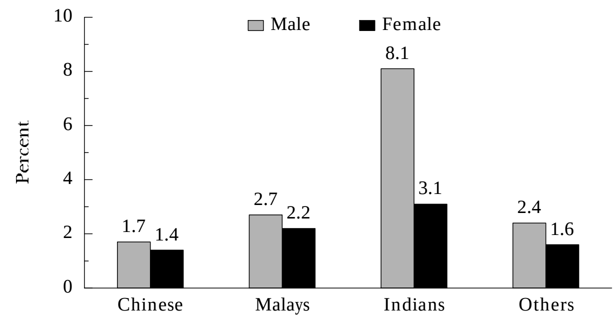
Figure 33.10
Standardized Mortality Ratios (SMR) for Death Due to Diabetes in Chinese Populations



Reference is mortality in white males and females in the U.S. (SMR = 100).

Source: Reference 29

Figure 33.12
Prevalence of Diabetes in Chinese, Malays, Asian Indians, and Other Ethnic Groups in Singapore, 1975



Subjects found positive for postprandial glucosuria had a 50-g OGTT, with diagnosis of diabetes based on a 2-hour blood glucose ≥140 mg/dl.

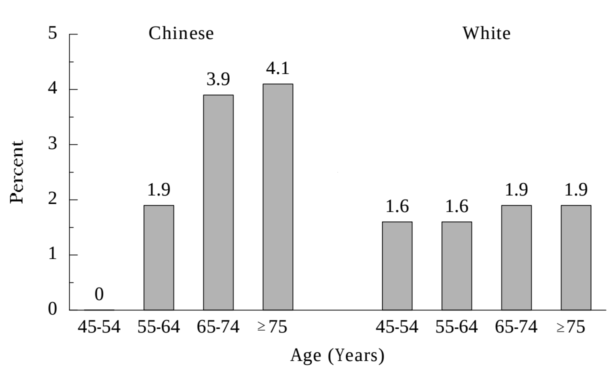
Source: Reference 33

to be 10.3% for new cases and 14.6% for total cases among Chinese in Hawaii (Figure 33.6). Diabetes as cause of death has been reported to be increased among Chinese Americans, not only when compared with Caucasians in the United States, but also when compared with Chinese in Taiwan, Hong Kong, and Singapore (Figure 33.10)[29]. Diabetes has been shown to be a more frequent underlying cause of death in Chinese men than in Caucasian men in New York City (Figure 33.11)[30]. The prevalence of diagnosed diabetes was high among elderly Chinese Americans age ≥60 years in Boston, MA, ascertained in 1981-83 to be 12.5% among men (mean age 69 years) and 13.3% among women (mean age 70 years)[31].

Korean

Sloan[12] reported the age-adjusted prevalence of total cases of diabetes in Koreans in Hawaii to be 19.7% and for new cases of diabetes to be 11.7% (Figure 33.6).

Figure 33.11
Percent of Deaths Attributed to Diabetes Among Chinese and White Men in New York City, 1968-72



Source: Reference 30

Filipino

The age-adjusted prevalence of total cases of diabetes in Filipinos in Hawaii was 21.8% and for new cases of diabetes 15.5%, as reported by Sloan (Figure 33.6)[12]. Filipinos had the highest prevalence of both total cases and new cases of diabetes among the four largest ethnic Asian groups in Hawaii (Chinese, Filipino, Japanese, and Korean).

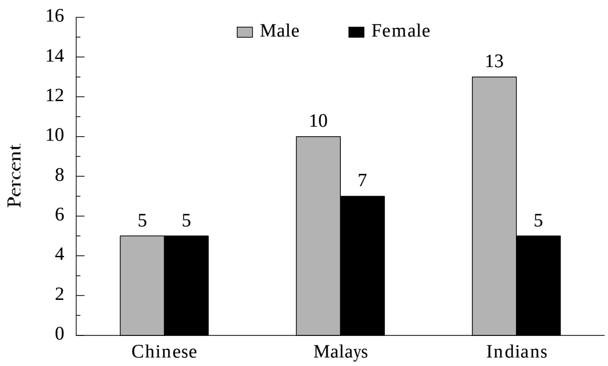
Migrant Asian Populations in Other Countries

The island city-state of Singapore is multiethnic. In 1985 Chinese comprised the majority (76.5%), with Malays (14.8%) and Asian Indians (6.4%) being the next two major ethnic groups[32]. In 1975, subjects screened and found positive for postprandial (post-meal) glucosuria had a 50-g OGTT, with diagnosis of diabetes based on a 2-hour blood glucose ≥140 mg/dl[33]. Diabetes was strikingly higher in Asian-Indian males than in any other group (Figure 33.12).

In a second survey done in 1985, subjects with fasting plasma glucose ≥108 mg/dl and no known history of diabetes had a 75-g OGTT and diabetes diagnosed by fasting plasma glucose ≥140 mg/dl and/or 2-hour plasma glucose ≥200 mg/dl[32]. Age-standardized prevalence rates indicated that the ethnic differences had been maintained since 1975 (Figure 33.13).

Prevalence of NIDDM also has been determined for the multiethnic island nation of Mauritius, in the southwestern Indian Ocean[34]. In 1986, the population of Mauritius comprised Indians (70%); Creoles (peo-

Figure 33.13
Prevalence of Diabetes in Chinese, Malays, and Asian Indians in Singapore, 1985



Subjects with fasting plasma glucose ≥108 mg/dl and no known history of diabetes had a 75-g OGTT. Diagnosis of diabetes was based on a fasting plasma glucose ≥140 mg/dl or 2-hour plasma glucose ≥200 mg/dl.

Source: Reference 32

Table 33.11
Numbers of Deaths from Diabetes and Standardized Mortality Rates for First-Generation Japanese Age >50 Years, Sao Paulo, Brazil, 1979-81

	No.	SMR-J	p-value*	SMR-S	p-value*
Men	26	176	<0.01	43	<0.01
Women	52	389	<0.01	71	<0.05

SMR-J was based on age-specific mortality rates for Japan in 1980, and SMR-S on age-specific mortality rates for Sao Paulo in 1980. *SMR significantly different from 100.

Source: Reference 35

ple with mixed African, Malagasy, and European ancestry, 28%); and Chinese (2%). The survey, conducted with a 75-g OGTT among those age 25-74 years on the main island of Mauritius, where 96% of the total population resides, based diagnosis of diabetes on a 2-hour plasma glucose ≥200 mg/dl or current treatment with insulin or oral hypoglycemic medication, and IGT upon a 2-hour plasma glucose ≥140 mg/dl but <200 mg/dl combined with a fasting plasma glucose <140 mg/dl. Prevalence of diabetes was greatly increased in all three ethnic groups but especially in Asian-Indian men (Table 33.10).

Japanese

About 1,168,000 individuals of Japanese descent lived in Brazil in 1987, and of these about 290,000 lived in Sao Paulo. Thus, after Japan, Brazil has the second-largest number of resident Japanese.

Death certificates (1979-81) for first-generation Japanese-Brazilian men and women age >50 years were examined in Sao Paulo and numbers of deaths from diabetes were compiled[35]. Japanese Brazilians in Sao Paulo had significantly higher standardized mortality rates attributable to diabetes than Japanese in Japan, although standardized mortality rates due to diabetes were lower than in the general population of Sao Paulo (Table 33.11).

A survey of self-reported diabetes was carried out in 1987 in a sample derived from Japanese-Brazilian sociocultural organizations in Sao Paulo[36]. This survey found that among 747 first-generation and 1,017 second-generation Japanese Brazilians age 45-74 years, prevalence of diabetes was 10.5% for men and 13.0% for women in the first generation (mean age 63 years) and 11.1% for men and 7.9% for women in the second generation (mean age 44 years). The prevalence of self-reported diabetes among Japanese Brazilians in Sao Paulo was similar to prevalence of self-reported diabetes found for Japanese Americans in Seattle, WA (Figure 33.14).

Two other surveys have been conducted on Japanese Brazilians[36]. The first of these, carried out during a

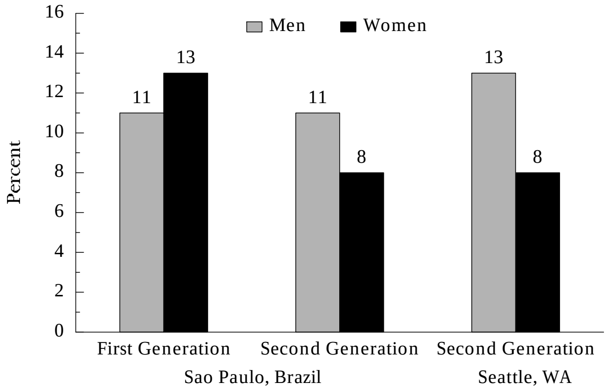
Table 33.10
Age-Adjusted Prevalence (95% CI) of Diabetes and Impaired Glucose Tolerance (IGT) in Mauritius

	Diabetes				IGT			
	Men		Women		Men		Women	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Chinese	16.0	10.5-21.5	10.3	5.3-15.3	16.5	11.0-22.1	21.7	15.2-28.1
Creole	9.3	6.4-12.1	15.8	12.7-18.9	17.1	13.5-20.7	21.9	18.4-25.4
Indian								
Hindu	17.8	15.1-20.4	13.2	10.9-15.4	14.5	12.2-16.9	22.4	19.6-25.1
Muslim	18.0	12.6-23.3	16.6	12.0-21.2	9.6	5.8-13.3	19.7	14.8-24.5

Subjects had a 75-g OGTT and diagnosis of IGT was based on a 2-hour plasma glucose ≥140 mg/dl and <200 mg/dl, and diabetes on treatment for diabetes or 2-hour plasma glucose ≥200 mg/dl.

Source: Reference 34

Figure 33.14
Prevalence of Self-Reported Diabetes in Japanese Brazilians in Sao Paulo, Brazil, and Japanese Americans in Seattle, WA



Source: References 19, 20, and 36

socioeconomic census of the Japanese-Brazilian population in 1987-88, asked questions about the presence of diabetes and treatment used. In Sao Paulo prevalence of self-reported diabetes in the sample was 7.4% for the first generation and 5.2% for the second generation. After age adjustment, rates were 5.3% for the first generation and 5.8% for the second generation.

In the second survey, carried out in 1990 among employees (70% of whom were of Japanese ancestry) of branches of a bank in metropolitan Sao Paulo, prevalence of self-reported diabetes in those age >40 years was 7.1% in the first generation and 4.2% in the second generation. The age-adjusted prevalence rates were 7.3% for the first generation and 8.2% for the second generation.

Chinese

Rates for diabetes-related deaths among Chinese in Singapore were greater than in Taiwan or Hong Kong (Figure 33.10). Prevalence of diabetes among Chinese in the multiethnic populations of Singapore and Mauritius were high, as shown in Figures 33.12 and 33.13 and Table 33.10.

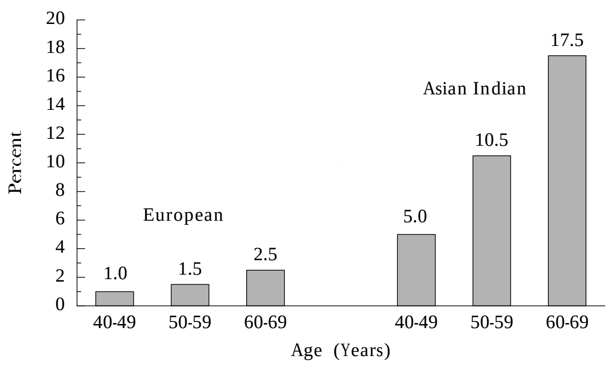
Indian

An increasing number of studies have shown diabetes prevalence to be high among migrant Asian Indians. Diabetes prevalence was higher in Indians than in either Chinese or Malays in Singapore in 1975 and in 1985 (Figures 33.12 and 33.13). Indians in the Cape Town area of South Africa, 65% of whom were Muslim and 20% Hindu, also had an increased prevalence of diabetes, as reported in 1969[37]. Subjects were screened for postprandial glucosuria or capillary blood glucose >140 mg/dl after a carbohydrate-rich meal or >160 mg/dl after ingestion of 50 g glucose. Subjects who screened positive had a 50-g OGTT and diabetes was diagnosed if two of three of the following blood glucose levels were exceeded: fasting 120 mg/dl, 1-hour 200 mg/dl, and 2-hour 140 mg/dl. Known diabetes was confirmed from medical records or by blood glucose. Prevalence of new cases of diabetes for the age groups 35-54 years and ≥55 years were 11.0% and 20.0%, much higher than found in Bantu living in the same area.

Similarly, diabetes prevalence among Asian Indians who had settled in the Fiji Islands of the southwest Pacific Ocean were reported in 1967 to be much higher than in indigenous Fijians of Melanesian origin[38]. In this survey, individuals with postprandial glucosuria were evaluated further with blood tests. Fasting blood glucose ≥120 mg/dl was accepted as diabetic, while those with fasting blood glucose between 100 mg/dl and 120 mg/dl had a 50-g OGTT. Diabetes was diagnosed from fasting or 2-hour blood glucose ≥120 mg/dl. Known diabetes was present in 3.8% of Indians age >21 years and proven diabetes in 5.7%.

In a population survey in 1961-62 carried out on the island of Trinidad in the western Atlantic Ocean, all persons with postprandial glucosuria and all known diabetic individuals were referred for further diagnostic testing[39]. Diabetes was diagnosed if there was postprandial glucosuria or a history of diabetes and a venous blood glucose ≥170 mg/dl at 2 hours after 100 g oral glucose in the nonfasting state, or an abnormal 100-g OGTT with fasting blood glucose ≥110 mg/dl, 1-hour blood glucose ≥170 mg/dl, and 2-hour blood glucose ≥120 mg/dl. Diabetes prevalence rates for the adult population age >20 years were 4.5% for Indians

Figure 33.15
Prevalence of Self-Reported Diabetes in Whites and Asian Indians in Southall, England, 1984



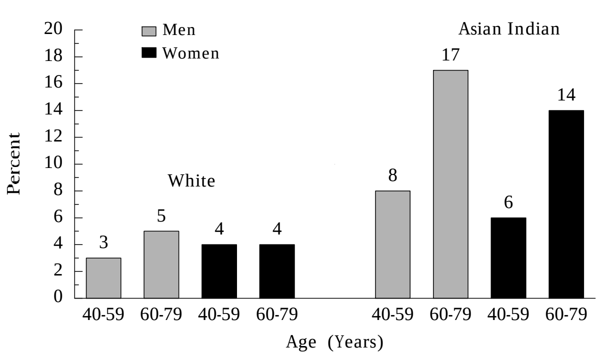
Source: Reference 40

and 2.5% for Africans. Diabetes prevalence was remarkably high among Indians in the 55-59 years age group, 14.7% of men and 19.4% of women.

A number of surveys of diabetes have been performed in the Asian-Indian population of England. In the Southall area of London, where there is a large influx of people from India, house-to-house ascertainment was done in 1984 to determine the prevalence of known diabetes among Asians and Europeans[40]. In the age range 40-74 years, prevalence rates were much higher for Asians than Europeans (Figure 33.15).

A study in 1987 in a predominantly Asian-Indian community in Coventry, England, also showed diabetes prevalence to be higher in the Indian than in the white population (Figure 33.16)[41,42]. Subjects were screened with measurement of casual capillary blood glucose and if this was ≥108 mg/dl within 2 hours of eating or >80 mg/dl at ≥2 hours after eating, a 75-g OGTT was done, with diagnosis of diabetes based on a 2-hour capillary blood glucose ≥200 mg/dl. Previously diagnosed diabetes was confirmed by a casual blood glucose >144 mg/dl, the patient receiving treatment, or verification from the physician. For Asians in the age group 40-59 years and 60-79 years, known diabetes was present in 8.2% and 17.3% of men, respectively, and 5.9% and 14.3% of women. In the same age groups, new cases of diabetes were found in 4.4% and 8.1% of Asian men and 3.4% and 5.6% of Asian women. Among Asians, age-specific diabetes prevalence for people age 20-79 years were 11.2% for men and 8.9% for women, while among whites, rates were 2.8% for men and 4.3% for women. Other studies[43,44] have shown diabetes prevalence in Asian Indians living in London to be related to central obesity, measured as waist-to-hip circumference ratio, and insulin resistance (hyperinsulinemia). The increased prevalence of central obesity and insulin resistance among Asian Indians in England has also been shown in Bradford, in the Yorkshire region[45].

Figure 33.16
Prevalence of Self-Reported Diabetes in Whites and Asian Indians in Coventry, England, 1987



Source: References 41 and 42

Table 33.12
Prevalence of Diabetes in Japan, 1972-73

	Age (years)	Prevalence (%) Men	Women
Rural Honshu	40-49	0.8	1.6
	50-59	3.4	3.4
	60-69	4.5	4.7
	≥70	7.5	7.0
Tokyo	40-49	2.3	
	50-59	5.1	
	60-69	6.9	

Diagnosis of diabetes was based on 1-hour blood glucose >160 mg/dl and 2-hour blood glucose >130 mg/dl after 50 g oral glucose. (Prevalence was not determined for women in the Tokyo survey.)

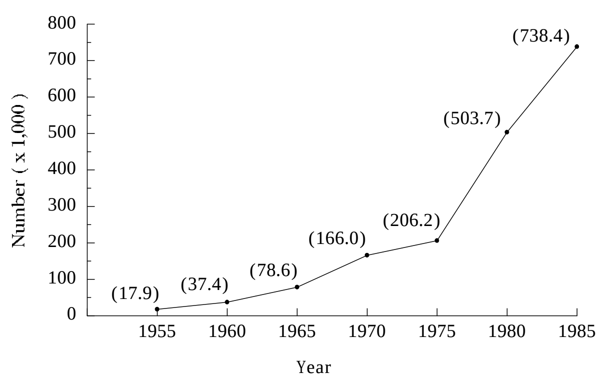
Source: Reference 46

Native Non-Migrant Asians

Japanese

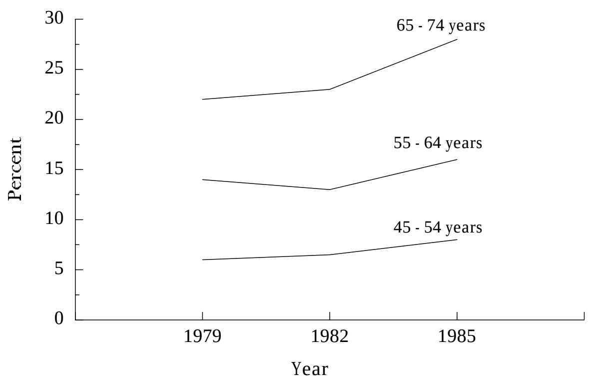
Prevalence of NIDDM has been uniformly reported as much lower in Japan than in the United States. In a survey conducted in 1972-73 in a small rural town in northern Honshu Island, diabetes prevalence in persons age ≥40 years ranged from 0.8%-7.5% for men and 1.6%-7.0% for women (Table 33.12)[46]. Diagnosis of diabetes was based on a 50-g OGTT, and 1-hour blood glucose >160 mg/dl and 2-hour blood glucose >130 mg/dl. Using similar criteria, diabetes prevalence in Tokyo men in 1973 was slightly higher (Table 33.12)[46]. Prevalence was not determined for women in the latter survey.

Figure 33.17
Growth in the Number of Diabetic Patients in Japan, 1955-85



Source: Reference 48

Figure 33.18
Prevalence of Diabetes in Japan by Age, 1979-85



Source: Reference 49

In a survey done in 1981-82 in rural Japan, diabetes prevalence was 4.4% for men and 3.8% for women age 40-69 years, based on a 75-g OGTT and fasting plasma glucose ≥140 mg/dl or both a 2-hour plasma glucose and a mid-test plasma glucose ≥200 mg/dl[47]. In a survey done in Tokyo in 1980-82, 4.1% of men and 2.5% of women age >40 years had diabetes, based on fasting plasma glucose ≥140 mg/dl or a 2-hour plasma glucose ≥200 mg/dl after 75 g oral glucose[22].

Although the above surveys suggest that diabetes prevalence is much lower in native Japanese than in Japanese Americans, data from Japan show diabetes prevalence in Japan to be increasing. Data compiled by the Ministry of Health and Welfare of Japan have shown a >2.5-fold increase in the number of diabetic patients in Japan from 1975 to 1985 (Figure 33.17)[48]. The greatest increase was found in Japanese age 65-74 years (Figure 33.18)[49]. Data compiled in 1990 from Japan show the prevalence of diabetes to be at least double the rates reported earlier (Table 33.13)[49].

Chinese

As discussed previously, standardized mortality ratios for diabetes as the cause of death for several Chinese populations showed these to be lowest in Taiwan and Hong Kong (Figure 33.10).

Table 33.13
Prevalence of Diabetes in Japan, 1988-90

Year	Location	Age (years)	Prevalence (%) Men	Women
1988	Hisayama	>40	13.1	9.1
1989-90	Osaka	30-79	10.4	6.0
1990	Yamagata	≥40	9.9	11.5

Diagnosis of diabetes was based on treatment for diabetes, fasting serum glucose ≥140 mg/dl, or 2-hour serum glucose ≥200 mg/dl after 75 g oral glucose.

Source: Reference 49

Table 33.14
Prevalence of Diabetes in China

	Age (years)	Prevalence (%)
Beijing (1979-81)	40-49	2.3
	50-59	5.6
	60-69	6.4
	70-79	9.7
Shanghai (1978)	40-49	1.4
	50-59	2.4
	60-69	3.6
	70-79	4.1

Diagnosis of diabetes in Beijing was based on fasting serum glucose ≥140 mg/dl or 2-hour serum glucose ≥200 mg/dl after 100 g oral glucose. In Shanghai, all subjects were first screened for glucosuria; those age >40 years also had a measurement of post-meal (2-3 hours) glucose. In those with glucosuria or post-meal plasma glucose >140 mg/dl and <160 mg/dl, a 100 g OGTT was done and diagnosis of diabetes was made if, at any three sampling times, levels exceeded fasting plasma glucose ≥130 mg/dl, 0.5-hour and/or 1-hour plasma glucose ≥180 mg/dl, 2-hour plasma ≥140 mg/dl, and 3-hour plasma glucose ≥130 mg/dl. Diabetes was also diagnosed in Shanghai if 2-hour post-meal plasma glucose was ≥160 mg/dl.

Source: References 50 and 51

In 1979-81, 39,896 people were screened in Beijing with a 100-g OGTT, and diabetes was diagnosed if fasting serum glucose was ≥140 mg/dl or 2-hour serum glucose was >200 mg/dl (Table 33.14)[50]. A survey on diabetes was started in Shanghai in 1978, and prevalence was lower than in Beijing (Table 33.14)[51]. A different diagnostic procedure was followed, however, since all subjects were first screened for glucosuria while those age >40 years also had a measurement of plasma glucose 2-3 hours after a meal. In those with glucosuria or postprandial plasma glucose >140 mg/dl but <160 mg/dl, a 100-g OGTT was done. Diagnosis of diabetes was established if at any three sampling times levels exceeded fasting plasma glucose ≥130 mg/dl, 0.5-hour and/or 1-hour plasma glucose ≥180 mg/dl, 2-hour plasma glucose ≥140 mg/dl, and 3-hour plasma glucose ≥130 mg/dl. Diabetes was also diagnosed if there was glucosuria or fasting plasma glucose ≥130 mg/dl or 2-hour postprandial plasma glucose ≥160 mg/dl. The prevalence rate standardized to the age distribution of Shanghai was 0.9%. Subsequently, a national survey was carried out using essentially the same procedure as in Shanghai. An overall standardized prevalence rate of 0.7% was found, ranging from 0.16% in Guizhou to 1.1% in Beijing[52].

In 1985 and 1986, a diabetes survey was carried out in rural Taiwan and in Taipei City[53,54]. Each subject was tested for capillary blood glucose and those with fasting glucose ≥120 mg/dl or 2-hour postprandial glu-

Table 33.15
Prevalence of Diabetes in Taiwan and Hong Kong, 1985-88

	Age (years)	Prevalence (%)
Taiwan (1985-86)		
Taipei City	40-49	4.2
	50-59	7.4
	60-69	10.9
	≥70	12.6
Rural	40-49	1.9
	50-59	4.9
	60-69	6.5
	≥70	9.0
Taiwan (1987-88)		
Pu-Li	30-39	10.2
	40-49	10.5
	50-59	11.4
	≥60	17.5
Hong Kong	60-64	8.3
	65-69	5.7
	70-74	12.6
	≥75	17.1

In Taipei City and rural Taiwan, subjects were tested for capillary blood glucose and those with fasting blood glucose ≥120 mg/dl or 2-hour postprandial blood glucose ≥200 mg/dl were defined as diabetic, and fasting blood glucose <100 mg/dl or 2-hour blood glucose <150 mg/dl as normal. Those with equivocal results had a 75-g OGTT and both 1- and 2-hour plasma glucose levels ≥200 mg/dl defined diabetes. In Pu-Li, diagnosis of diabetes was based on either a medical history of diabetes or, in those with fasting plasma glucose 100-140 mg/dl, a 75-g OGTT showing either fasting plasma glucose >140 mg/dl or 2-hour plasma glucose >200 mg/dl. In Hong Kong, those with a random plasma glucose >225 mg/dl were considered diabetic. A 75-g OGTT was done on subjects with glucosuria, random plasma glucose 140-225 mg/dl, glycosylated hemoglobin >8.5%, or fructosamine >2.2mM, and diabetes was diagnosed by fasting plasma glucose >140 mg/dl or 2-hour and mid-OGTT plasma glucose >200 mg/dl.

Source: References 53, 54, 56, and 57

cose ≥200 mg/dl were defined as diabetic, and fasting glucose <100 mg/dl or 2-hour postprandial glucose <150 mg/dl as normal. Those with equivocal results underwent a 75-g OGTT, and both 1- and 2-hour plasma glucose levels ≥200 mg/dl defined diabetes. Those with a history of diabetes and being treated with insulin or sulfonylurea were classified as diabetic regardless of their glucose levels. The age-adjusted prevalence of diabetes was 7.6% in Taipei City and 4.7% in rural areas. Age-specific prevalence rates are shown in Table 33.15. Subsequent cross-sectional and longitudinal studies carried out in the adult population of Taiwan showed a positive association between diabetes and body mass index, even though this population is relatively lean[55].

A community-based survey in 1987-88 determined diabetes prevalence using a stratified cluster sampling of residents age ≥30 years in the town of Pu-Li in central Taiwan. Diagnosis of diabetes was based on either a medical history of diabetes or, in those without this history, a fasting plasma glucose >140 mg/dl or in those with fasting plasma glucose 100-140 mg/dl, a 75-g OGTT showing either fasting plasma glucose >140 mg/dl or 2-hour plasma glucose >200 mg/dl[56]. Age-specific prevalence rates of total cases of diabetes are given in Table 33.15. The prevalence of total cases of diabetes was 12.4%, and the age-adjusted prevalences were 6.9% for previously diagnosed cases of diabetes and 4.4% for newly diagnosed cases. These prevalence rates were higher than those reported for Taiwan in 1985-86 (Table 33.15).

The prevalence of diabetes has also been ascertained in elderly Chinese age ≥60 years in Hong Kong[57]. Those with a random plasma glucose >225 mg/dl were considered diabetic. A 75-g OGTT was done on subjects with glucosuria, random plasma glucose 140-225 mg/dl, glycosylated hemoglobin >8.5%, and fructosamine >2.2mM, and diabetes diagnosed by fasting plasma glucose >140 mg/dl or 2-hour and mid-OGTT plasma glucose >200 mg/dl. Overall prevalence of diabetes was 9.8%. Age-specific rates are shown in Table 33.15.

Indian

In a survey begun in 1970, prevalence of diabetes diagnosed by venous blood glucose >130 mg/dl at 2 hours after 50 g oral glucose was found to be 8.8% among South Indian railway doctors and 2.7% in North Indian railway doctors[58]. Among South Indian carpenters and fitters, those on a rice diet typical of the South had a diabetes prevalence of 4.7%, while those on a wheat diet typical of the North had a rate of 1.4%. Railway doctors with an intermediate diet had a diabetes prevalence of 5.5%.

Prevalence of diabetes in six widely separated geographical regions of India was determined by the In-

Table 33.16
Prevalence of Diabetes in India, 1975

		Prevalence (%)	
	Age (years)	Men	Women
Rural	41-50	1.3	0.7
	51-60	1.3	1.3
	>60	5.7	4.8
Urban	41-50	4.7	4.6
	51-60	13.6	6.5
	>60	16.6	15.3

Diagnosis of diabetes was based on a two-stage testing scheme. Those with blood glucose >100 mg/dl at 2-hour after 75-g oral glucose were given oral glucose at a standard dose of 40 g/m^2, and diabetes diagnosed if the summed value of the fasting, 1-, 2-, and 3-hour venous blood glucose exceeded 500 mg/dl or if at least two of the following occurred: fasting blood glucose >100 mg/dl, 1-hour blood glucose >170 mg/dl, 2-hour blood glucose >120 mg/dl, 3-hour blood glucose >110 mg/dl.

Source: Reference 59

Table 33.17
Prevalence of Self-Reported Diabetes in a Suburb of New Delhi, India

	Prevalence (%)	
Age (years)	Men	Women
45-49	10.7	3.8
50-54	9.8	7.1
55-59	10.8	7.2
60-64	20.7	12.4
65-69	11.9	11.4
70-74	14.1	10.5

Source: Reference 60

Table 33.18
Prevalence of Diabetes in Korea

		Prevalence (%)	
	Age (years)	Men	Women
Seoul	40-49	15.9	
	50-59	13.4	
Kwang-Ju	40-49	3.0	
	50-59	2.6	
Rural area	40-49	2.0	1.2
	50-59	3.6	1.9
	60-69	4.4	3.0

Subjects with glucosuria had 50-g OGTT, diagnosis of diabetes being established by 1-hour blood glucose >170 mg/dl and 2-hour blood glucose >120 mg/dl.

Source: Reference 62

dian Council of Medical Research in 1975[59]. Diagnosis of diabetes was based on a two-stage testing scheme. The first stage was a 75-g OGTT, with those individuals having a blood glucose >100 mg/dl at 2 hours undergoing a second stage of testing in which subjects were given oral glucose at a standard dose of 40 g/m^2; criteria for diabetes was a summed value of the fasting, 1-, 2-, and 3-hour venous blood glucose >500 mg/dl or at least two of the following being met: fasting >100 mg/dl, 1-hour >170 mg/dl, 2-hour >120 mg/dl, and 3-hour >110 mg/dl. Age-specific prevalence rates are shown in Table 33.16. Diabetes prevalence was higher in urban than rural areas and slightly higher for men than women.

A report[60] provided age-specific prevalence rates for self-reported diabetes in a relatively affluent suburb of New Delhi. Diabetes prevalence was quite high for the age range 45-74 years, as shown in Table 33.17. This higher prevalence of diabetes in urban India has been confirmed in a separate study[61]. A 75-g OGTT was administered and diabetes diagnosed if the post-glucose plasma glucose was ≥200 mg/dl, and a diagnosis of IGT was made if the post-glucose value was ≥140 mg/dl but <200 mg/dl. The age-adjusted prevalence of diabetes was 8.2% (8.4% in men and 7.9% in women) in the urban population of Madras and 2.4% (2.6% in men and 1.6% in women) in a rural population near Madras. The age-adjusted prevalence of IGT was 8.7% (8.8% in men and 8.3% in women) and 7.8% (8.7% in men and 6.4% in women) in the urban and rural areas, respectively.

Korean

The prevalence of diabetes has been determined in Korea from surveys among bank employees in Seoul, workers in the small town of Kwang-Ju, and inhabitants of a rural area[62]. Subjects were screened in two stages: a test for glucosuria, with a 50-g OGTT for all those with glucosuria, diagnosis of diabetes being established by 1-hour blood glucose >170 mg/dl and 2-hour blood glucose >120 mg/dl. Diabetes prevalence rates were higher in Seoul than in either Kwang-Ju or the rural area (Table 33.18). In both Seoul and Kwang-Ju, very few females age ≥40 years were examined. In the rural area, prevalence was higher in men than women.

Filipino

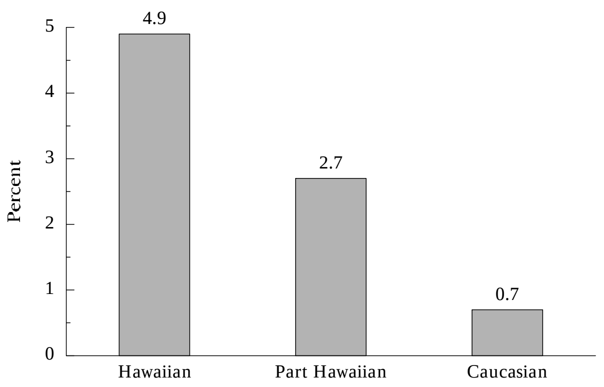
Limited information is available concerning diabetes prevalence in the Philippines. Diabetes prevalence has been reported to be 8%-10% among Filipino adults, with an almost equal distribution between genders and a peak prevalence at age 50-60 years[63].

PACIFIC ISLANDERS

As shown in Table 33.1, in 1990 the two largest Pacific Islander groups in the United States were Hawaiians and Samoans, both of Polynesian origin. Diabetes prevalence in isolated Polynesian populations is low. In Funafuti, Tuvalu, prevalence of diabetes was 1.1% in males and 7.2% in females in 1976[64]. The large gender difference was attributed to differing levels of physical activity, men being engaged in manual labor while women were almost completely sedentary. Furthermore, caloric intake by women was inappropriately high in relation to their level of physical activity.

In Western Samoa, home to the world's largest Polynesian population, age- and sex-adjusted diabetes prevalence in the rural population was less than half that in the urban (3.4% versus 8.7%)[65]. This difference was still present after adjusting for body weight. In contrast to the urban areas, daily activities in the rural areas involved heavy labor and gave access to basic traditional foods. In rural subjects, prevalence of diabetes was about threefold greater in women than in men, a finding similar to that in Tuvalu. Since diet was similar between rural men and women, greater physi-

Figure 33.19
Age-Adjusted Prevalence of Diabetes in Full- and Part-Hawaiians and Caucasians in Hawaii, 1958-59



Capillary blood samples were obtained at 2-2.5 hours after a meal containing at least 50 g carbohydrate, and persons with blood glucose >130 mg/dl were referred to their physicians, who were asked to determine whether the person was diabetic and whether the diagnosis had been previously known.

Source: Reference 12

cal activity in men may have had a protective effect.

American Samoa, a traditionally agricultural island, experienced rapid modernization in the late 1950s. Correlated with this has been an increase in adiposity. In 1976, official death records of American Samoa for the years 1962-74 were examined[66]. The Samoan diabetes-related mortality rate was 13.9 per 100,000 compared with a U.S. rate of 15.9 in 1959. After age adjustment, the Samoan rate was more than double that of the United States (32.2 versus 13.4). It is likely that a significant contributing factor was the adiposity of the Samoan people.

Hawaiians

Diabetes prevalence has been reported to be high in full- and part-Hawaiians on the Island of Oahu[12]. The age-adjusted diabetes prevalence was 4.9% in Hawaiians and 2.7% in part-Hawaiians in the survey for years 1958 and 1959, compared with 0.7% in Caucasians (Figure 33.19). Data on self-reported diabetes prevalence were also obtained for 1974-76 through questionnaires administered by the Health Surveillance Unit of the Hawaii State Department of Health[67]. Hawaiians and part-Hawaiians had intermediate diabetes prevalence rates (men 2.0% and women 2.2%, compared with 4.5% in Chinese men and 2.8% in Chinese women, and 1.3% in Caucasian men and 1.5% in Caucasian women). There were, however, possible errors in these data related to the method of sampling and respondent errors that could not be corrected by verification. One study[68] reported age-adjusted diabetes prevalence rates during 1980-86 of 3.0% for native Hawaiian men and 3.1% for native Hawaiian women in Hawaii (compared with 1.4% for Caucasian men and 1.5% for Caucasian women). Diagnostic criteria were not described, however. In another study[69], diabetes prevalence (physician-diagnosed or glucosuria ≥2+) was greatly increased in Hawaiians age 20-59 years on the Island of Molokai, particularly in the age groups 40-49 years (>15%) and 50-59 years (>20%). Approximately 65% of those participating were ≥20% above the average body mass index for Caucasians, and 45% were ≥40% overweight by these standards.

Samoans

Obesity is highly prevalent in migrant Samoan populations. In an urbanized Samoan community living in the San Francisco Bay area, ~50% of the sample exceeded the 95th percentile for weight, although aver-

Table 33.19
Macronutrient Intake of Japanese-American Men in Seattle, WA by Glucose Tolerance Status (Mean ± SEM)

				Self-reported nondiabetic		
	Normal	NIDDM	p-value	Normal	NIDDM	p-value
Energy (kcal)	2,191±65	2,197±66	NS	2,177±65	2,273±121	NS
Protein (%)	15.8±0.3	18.0±0.4	<0.001	15.7±0.3	16.4±0.7	NS
Fat (%)	31.3±0.7	34.0±0.8	0.013	31.3±0.7	33.7±1.2	NS
Carbohydrate (%)	50.1±0.8	46.3±0.8	0.001	50.2±0.8	46.8±1.4	0.073
Protein (g)	85.4±2.6	96.9±3.0	0.005	84.3±2.5	92.8±5.4	NS
Animal (g)	47.5±2.0	58.3±2.2	<0.001	46.8±1.9	57.5±4.3	0.017
Animal cal (%)	8.8±0.3	10.9±0.4	0.001	8.8±0.3	10.1±0.6	0.070
Fat (g)	76.7±3.1	83.4±3.5	NS	76.1±2.9	84.2±4.6	NS
Animal (g)	34.0±1.6	41.3±2.1	0.006	33.8±1.6	42.3±3.2	0.026
Animal cal (%)	14.1±0.6	17.1±0.8	0.002	14.1±0.6	16.9±1.1	0.047

Source: Reference 75

age height was between the 25th and 50th percentile of the U.S. population[70,71]. Weight of Samoans in California exceeded that of their counterparts in Hawaii and Samoa. Obesity was accompanied by elevated blood pressure, and in women, by elevated fasting plasma glucose. Although the number of fasting plasma glucose samples was too small for detailed analysis, 18% of the male fasting sample and 9% of the female had plasma glucose levels that exceeded the 95th percentile for fasting plasma glucose in the U.S. population.

POTENTIAL CAUSAL RISK FACTORS

Lifestyle

Studies in Asian and Pacific Islander populations have suggested that dietary changes and reduction in physical activity are lifestyle changes that may be important in the etiology of NIDDM. A possible explanation of this is the "thrifty" genotype hypothesis, which proposes that in populations that were subject to periods of famine, a survival advantage was given to those with a metabolism that stored energy with maximum efficiency[72]. In periods of abundance, however, this leads to obesity. It has been further proposed that such populations may be prone to developing the insulin resistance syndrome, or "Syndrome X"[73], under lifestyle changes of westernization[74].

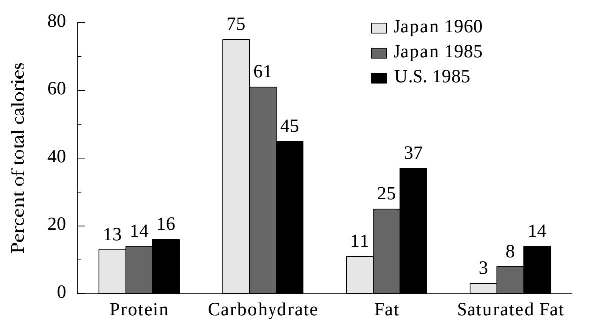
Research in the Seattle Japanese-American Community Diabetes Study has shown that diabetic men were consuming a significantly greater amount of animal fat and protein than men with normal glucose tolerance, even when total kilocalories were similar (Table 33.19)[75]. Self-reported nondiabetic men who were diagnosed diabetic from a 75-g OGTT also consumed significantly more animal fat and protein than self-reported and confirmed nondiabetic men. A comparison of macronutrient intakes of similarly-aged Japanese-American men in Seattle and Japanese men in Japan, summarized in Table 33.20, showing much lower intake of fat in Japan, is of interest in view of the lower prevalence of diabetes in Japan. Furthermore, the increase in prevalence of diabetes in Japan is associated with a change between 1960 and 1985 in the dietary pattern of the Japanese towards the consumption of proportionally greater amounts of fat and saturated fat and lesser amounts of carbohydrate (Figure 33.20)[76].

Table 33.20
Mean Daily Macronutrient Intake of Similarly Aged Japanese-American Men in Seattle,WA and Japanese Men in Japan

	Japanese-American	Japanese
Energy (kcal)	2,137	2,016
Protein (%)	16.5	14.8
Fat (%)	32.4	16.7
Carbohydrates (%)	48.5	61.1

Source: Reference 75

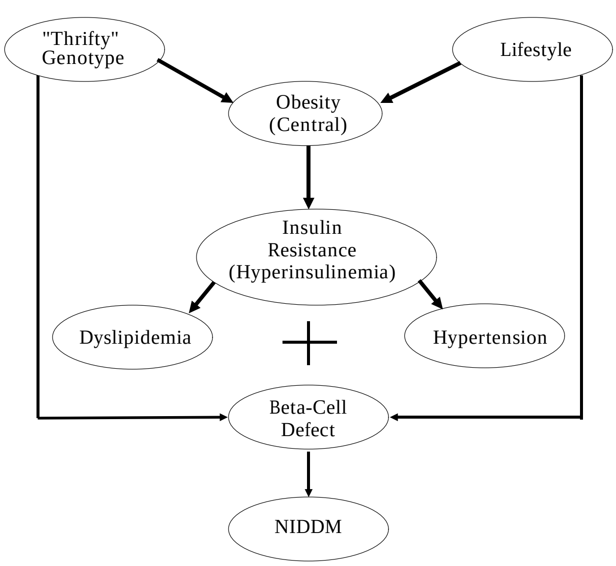
Figure 33.20
Dietary Patterns in Japan, 1960 and 1985, and U.S., 1985



Source: Reference 76

As regards physical activity, there is evidence that urbanization and movement away from heavy manual labor has been associated with increased diabetes prevalence in Asian and Pacific Islander populations.

Figure 33.21
Relationship of Genotype and Lifestyle to Central Obesity and Insulin Resistance in the Development of the Insulin Resistance Syndrome and NIDDM



Weight gain

In westernizing migrants, weight gain, a powerful risk factor for NIDDM, probably plays an important role[77-79]. It has been postulated that westernizing migrants with the "thrifty" genotype are susceptible to develop central obesity as a consequence of both reduced physical activity and consumption of a diet high in saturated fat. In some Asian populations, the amount of weight gain may not be large. Central obesity is in turn associated with insulin resistance and hyperinsulinemia and other adverse metabolic consequences, such as dyslipidemia. NIDDM, however, occurs only when a significant islet beta-cell secretory defect develops. This paradigm is shown in Figure 33.21.

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Appendix 33.1

Values for Metabolic Variables in Diabetic Subjects in the Seattle Japanese-American Community Diabetes Study, Age 40-64 Years

	Japanese-American men	Japanese-American women
Previously diagnosed diabetes		
Mean fasting plasma glucose (mg/dl)	196.0	162.1
Mean 2-hour plasma glucose (mg/dl)	360.5	335.9
Mean fasting insulin (μu/ml)	15.0	22.6
Mean 2-hour insulin (μu/ml)	49.2	103.8
Mean number of years since diagnosis of diabetes	7.1	6.6
Newly discovered diabetes		
Mean fasting plasma glucose (mg/dl)	122.3	128.8
Mean 2-hour plasma glucose (mg/dl)	234.7	271.9
Mean fasting insulin (μu/ml)	19.5	20.6
Mean 2-hour insulin (μu/ml)	153.3	140.4
All diabetes combined		
Percent with self-reported history of diabetes in mother and/or father	57.1	81.8
Mean BMI	25.9	24.8
Percent with BMI ≥25	55.1	63.6
Percent with BMI ≥30	6.1	18.2
Percent with BMI ≥35	0	18.2
Mean subscapular/triceps skinfold ratio	2.6	1.3
Mean waist/hip ratio		0.87
Mean CT thoracic fat (cm^2)	100.8	180.2
Mean CT subcutaneous abdominal fat (cm^2)	132.9	206.6
Mean CT intra-abdominal fat (cm^2)	130.0	125.0
Mean systolic blood pressure (mmHg)	141.7	137.9
Mean diastolic blood pressure (mmHg)	81.7	79.6
Percent with hypertension	57.1	36.4
Mean total cholesterol (mg/dl)	226.7	229.3
Mean LDL cholesterol (mg/dl)	135.9	143.6
Mean HDL cholesterol (mg/dl)	44.5	60.6
Mean fasting triglycerides (mg/dl)	221.8	125.1
Percent with total cholesterol ≥240 mg/dl	36.7	40.9
Percent with LDL cholesterol ≥160 mg/dl	24.5	36.4
Percent with HDL cholesterol <35mg/dl	26.5	0
Percent with triglycerides ≥250 mg/dl	24.5	4.5

BMI, body mass index; CT, computed tomography; LDL, low-density lipoprotein; HDL, high-density lipoprotein. Hypertension defined as systolic blood pressure ≥160 mmHg or diastolic blood pressure ≥95 mmHg or using antihypertensive medication; values for blood pressure include values for subjects using antihypertensive medications; waist/hip ratio was not available for men.

Source: Wilfred Fujimoto, University of Washington