CHAPTER 1

DIABETES MELLITUS: A PANDEMIC IN THE MAKING

It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts.

Sir Arthur Conan Doyle, British mystery author & physician (1859–1930)

On December 20, 2006, the General Assembly of the United Nations passed resolution 61/225, the United Nations World Diabetes Day Resolution, designating November 14 as World Diabetes Day. On October 29, 2010, the President of the United States, Barack Obama, declared November 2010 as National Diabetes Month in the United States.[1]

Diabetes mellitus[2] is an array of diseases that have a common symptom—abnormally high blood glucose levels. Diabetes mellitus is a noncommunicable disease. It is not transmitted from person to person by viruses or bacteria as is HIV or cholera. Diabetes mellitus is a chronic, costly, and often debilitating disease. This will be our working definition of diabetes mellitus until later in the book where we shall learn more specifics about the disease. The President, in his Proclamation, uses the terms type 1 and type 2 diabetes. By the end of Chapter 6,

[1]See Appendix A for texts of the UN Resolution and President Obama's Proclamation, respectively.
[2]Diabetes mellitus should not be confused with diabetes insipidus, which is caused by vasopressin deficiency. When the term *diabetes* alone is used in this book it will always refer to diabetes mellitus.

Understanding Diabetes: A Biochemical Perspective, First Edition. Richard F. Dods.

you will fully understand both these terms.[3] In this chapter we will learn about the extent of the diabetes problem both in the United States and globally. Later in this chapter we will learn of a related pandemic in the making—obesity and overweight. Finally, we will describe the connections between the diabetes and obesity/overweight pandemics.

DIABETES PREVALENCE[4] AND COST IN THE UNITED STATES

A Dire Prediction Based on Alarming Data

The Centers for Disease Control and Prevention (CDC) estimated that as of 2008 there were as many as 18.1 million Americans who had been diagnosed with diabetes (8 in 100 Americans). This number is presumed low because it is estimated that 6.0 million cases remain undetected. Thus, 10 in 100 adult Americans actually had the disease in 2008 (1). Between 1980 and 2008, the number of diagnosed diabetic Americans has nearly tripled.

An analysis of this data according to age, gender, and race is revealing. All of the following data derived from the CDC is for civilian, noninstitutionalized individuals with diagnosed diabetes.

Figure 1.1 shows the age-adjusted percentage of diagnosed cases of diabetes by sex. You may notice that percentages were similar for males and females until 1999, at which time the percentage for males with diabetes began to increase at a greater rate than for females.

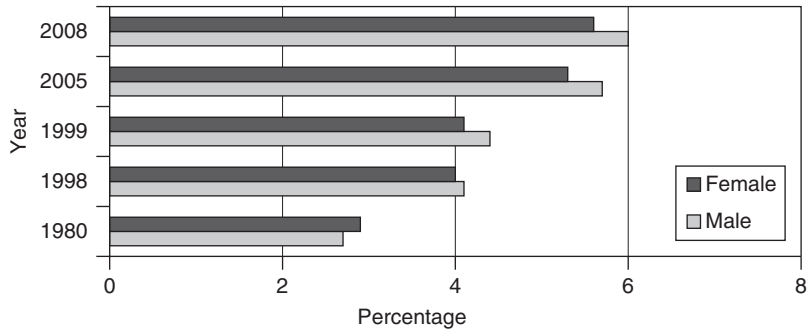

Figure 1.1 Age-adjusted percentage of civilian, noninstitutionalized persons with diagnosed diabetes by sex for selected years. (*See insert for color representation of the figure*.)

[3]Type 1 diabetes refers to hyperglycemia (high blood glucose levels) due to insufficient insulin secretion caused by destruction of pancreatic β-islet cells by an autoimmune response and type 2 refers to hyperglycemia due to insulin resistance (relative insulin deficiency). Type 1 diabetics exhibit blood insulin levels that are low or nonexistent and type 2 diabetics have levels that are high.

[4]Prevalence relates to the number of individuals who have diabetes at the time of the study. Incidence refers to the frequency of occurrence and is associated with a defined period of time.

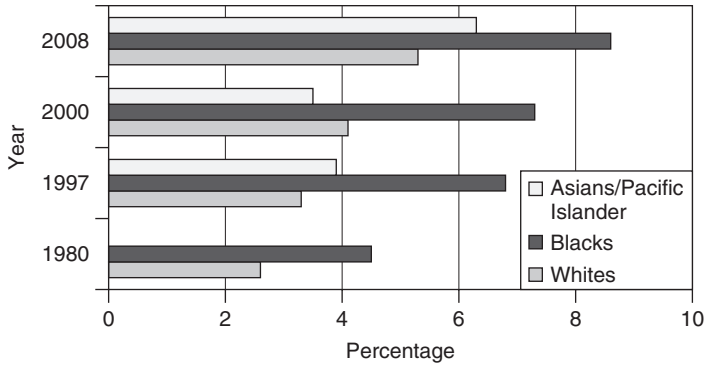

Figure 1.2 Age-adjusted percentage of civilian, noninstitutionalized persons with diagnosed diabetes by race: whites, blacks, and Asians/Pacific Islanders for selected years. (*See insert for color representation of the figure*.)

As you can see from Figure 1.2, the number of white diabetics increased 104% in the period 1980–2008; that of blacks increased 91% and of Asians/Pacific Islanders 62%. Blacks were diagnosed with diabetes at consistently higher percentages than whites and Asians. All races increased in percentage from 1980 to 2008. For Hispanics (Fig. 1.3), the largest increase in percentage was for Mexican/Mexican-Americans, 42.2%. All Hispanic groups, Puerto Ricans, Mexican/Mexican-Americans, and Cubans had percentages that significantly increased from 1997 to 2008.

Most alarming are the statistics presented in Figure 1.4. The CDC estimates that by the middle of this century the total number of diagnosed cases of diabetes will increase to between 1 in 3 and 1 in 5 Americans. These ratios correspond to 61–102 million Americans in 2050 assuming a total US population of 306.3 million adult persons (2). This estimate is based on an aging population—with increased age, there is a greater likelihood of developing diabetes; increases in

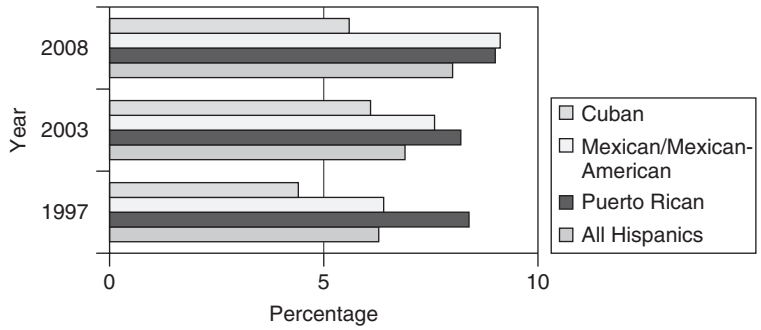

Figure 1.3 Age-adjusted percentage of civilian, noninstitutionalized persons with diagnosed diabetes among Hispanics: Puerto Ricans, Mexicans/Mexican-Americans, and Cubans for selected years. (*See insert for color representation of the figure*.)

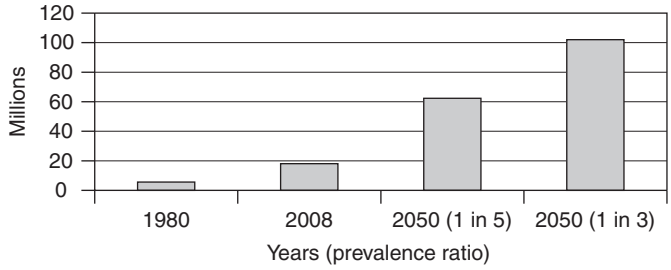

Figure 1.4 Number (in millions) of projected cases of diabetes for 2050 assuming prevalence of one in five and one in three compared to those reported in 1980 and 2008. (*See insert for color representation of the figure.*)

minority groups—minority groups have a higher prevalence of diabetes; longer life spans of people diagnosed with diabetes mellitus; and the exclusion in most studies of people younger than 18 years—an age bracket in which there have been significant increases in diabetes cases. This study also assumes 4.5–5.2% of the total population of Americans as having undiagnosed diabetes, which itself maybe an underestimated statistic. A poorer diet, overeating, and a sedentary lifestyle add credence to the prediction that by 2050 the number of cases of diabetes will at least triple.

Additional support for this prediction derives from the estimate (3) that in 2010 there were 67 million Americans (90% undiagnosed) who had prediabetes. Prediabetes (defined in Chapter 6) is the precursor to full blown diabetes.

Summary Box 1.1

- Diabetes mellitus is a noncommunicable disease that causes abnormally high blood glucose levels.
- Diabetes has a high prevalence in the United States across all racial groups.
- Projections of the increase in diabetes by 2050 are alarming.

The Increase of Diabetes in Youths

The statistics shown in Figure 1.5 with respect to children and adolescents are quite scary. The increase in diabetes cases is occurring in greater prevalence in younger persons. In 1980, the percentage of diagnosed diabetics under the age of 45 years was 0.6%. The increase began in 1986, and gradually has increased since 1986 to 1.4% in 2008. Also shown in this figure is that the greatest increases over time have occurred in the 65–74 age bracket.

Data shows (4, 5) that hospitalizations for diabetes increased 102% for young adults, 30–39 years between the 14-year period, 1993–2006.

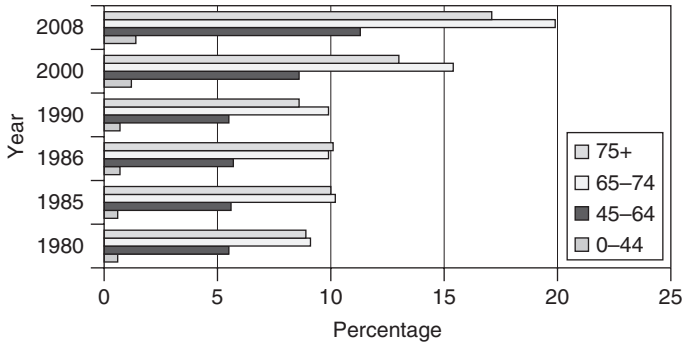

Figure 1.5 Percentage of civilian, noninstitutionalized persons with diagnosed diabetes by age (0–44, 45–64, 65–74, 75+) for selected years. (*See insert for color representation of the figure*.)

This alarming data suggests that diabetes is occurring at a younger age. Over the same period, charges for hospitalizations for diabetes increased 220%.

Additional data from Search for Diabetes in Youth (6) shows the same trends among American youth. The study, the first extensive one focused on diabetes, is specifically aimed at persons younger than 20 years. Funded by the CDC and the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), it is located in six centers—Kaiser Permanente, Southern California; the University of Colorado Health Sciences Center, Denver, Colorado; the Pacific Health Research Institute, Honolulu, Hawaii; Children's Hospital Medical Center, Cincinnati, Ohio; University of South Carolina School of Public Health, Columbia, South Carolina; and Children's Hospital and Regional Medical Center, Seattle, Washington. The study's goals (7) are to determine diabetes prevalence in youths under 20 years, to classify the types of diabetes and their individual prevalence, to identify the types of complications, to determine the current care and treatment given to children and adolescents with diabetes, and to determine the quality of life for youths diagnosed with diabetes.

Figure 1.6 shows the prevalence of diabetes in non-Hispanic whites, African Americans, Hispanics, and Asian/Pacific Islanders younger than 20 years (8–11). This data combines males and females, age, and types of diabetes. In Chapter 6, we analyze this data according to gender, age, and type. As may be seen from the figure, non-Hispanic white youth had the highest prevalence, second were Hispanics, third African Americans, and fourth were Asian and Pacific Islanders. On the basis of this data compiled in 2002–2003, a total of 18,700 children and adolescents were diagnosed with diabetes. In total, approximately 150,000 children and adolescents have diabetes—1 in 400–500 American youths (12, 13). Combined with the data for individuals with diabetes who are older than 20 years, these statistics are ominous.

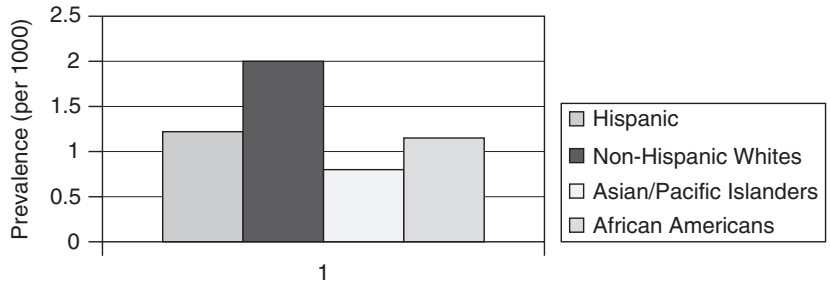

Figure 1.6 Diabetes prevalence in African Americans, Asian and Pacific Islanders, non-Hispanic whites, and Hispanics under the age of 20 years. The data for gender, age intervals, and type of diabetes were combined. This data will be expanded upon in Chapter 5. (*See insert for color representation of the figure*.)

The Cost

Using 2007 figures, diabetes was the seventh leading cause of death among Americans[5] and the total medical costs were estimated at $174 billion annually. Direct medical costs were estimated at $116 billion and indirect costs, which include disability compensation, work loss, and premature mortality, were estimated at $58 billion. By 2020, the cost is estimated (3) to grow to $500 billion. The disease is quite costly. A Consumer Reports Health survey (14) reported in 2009 that the cost of routine care for a diabetic (pharmaceuticals, testing, supplies, and doctor's visits) is in the vicinity of $6000 per year. The cost escalates for those who have any of the serious complications (see Chapter 8) associated with diabetes. This is part of the reason why only one-quarter of diabetics in the United States are obtaining optimal care.

Summary Box 1.2

- Since 1986 there has been a steady increase in diabetes in American children and adolescents.
- For young adults the number of hospitalizations for diabetes increased significantly between 1993 and 2006.
- A study on American youth called SEARCH demonstrates that diabetes is becoming more prevalent in youths under 20 years irrespective of race.
- The cost of diabetes care currently estimated at $174 billion annually is expected to increase to $500 billion annually by 2020.

[5]Heart disease, cancer, stroke, chronic lower respiratory disease, accidents, and Alzheimer's disease have greater numbers as the cause of death in the United States, according to the CDC.

DIABETES PREVALENCE AND COST WORLDWIDE

A Worldwide Epidemic

These increases in incidence, mortality, and cost are not only forecast for the United States but also are predicted worldwide. The International Diabetes Federation (IDF)[6] estimated that 285 million people worldwide were afflicted by diabetes in 2010 and by 2030 this figure will have increased to 438 million (15). Seventy percent of individuals diagnosed with diabetes live in low income to middle income areas of the world. These are alarming numbers, and if you add to this the fact that half of these go undiagnosed until complications have developed, you further understand why diabetes is considered a very serious public health problem worldwide.

Numbers of Cases of Diabetes

Until 2010, India was considered to have the largest diabetic population (50.8 million) with China second (43.2 million). However, a new study in China (16), which uses better methods to detect diabetes, indicates that there are 92.4 million Chinese adults with the disease. Those younger than 20 years of age were not included in this study.

Figure 1.7 shows the worldwide distribution of the number of cases of diabetes estimated in 2009 contrasted with the predicted number in 2030 (17). The number of diabetes cases is 1.54-fold greater in 2030 than in 2009. For 2009, the number of cases of males and females was approximately equal. The greatest number of cases was in the 40- to 59-year-old bracket. For the 2030 estimate, there are slightly more females than males (1.4% difference) and the age bracket for the number of cases of diabetes has advanced to 60–79 years. Looking purely at the number of cases of diabetes since 2009, China had the most in 2010, followed by India, the United States, the Russian Federation, and Brazil. In 2030, the alignment is expected to be China first, followed by India, the United States, Pakistan, and Brazil.

The IDF reported that the highest diabetes prevalence in adults in 2010 was in Saudi Arabia, Bahrain, and the United Arab Emirates in the Middle East; the North African region; Mauritius in the South-East Asian region; and Nauru in the Western Pacific region. Some of these figures may be underestimated in countries where healthcare is more limited and diagnosis more unreliable.

Cost

The costs of medical care in the poorest countries is borne almost entirely by the family, making it less likely that medical help will be sought until the condition of the family member becomes serious. Thus, in low income and middle income

[6]The IDF represents over 200 diabetes associations located in more than 160 countries. The IDF is associated with the World Health Organization and the United Nations Department of Public Information.

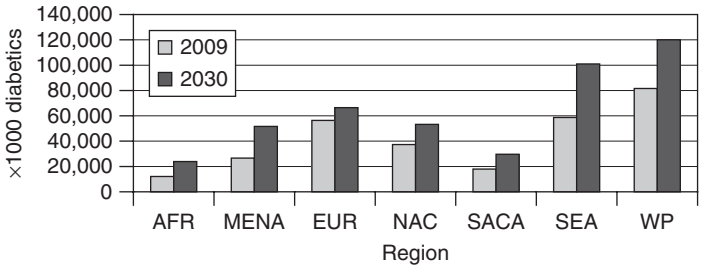

Figure 1.7 Estimated numbers of diabetics for 2030 contrasted with 2009 data for seven regions of the world; AFR, African Region; MENA, Middle East and North African Region; EUR, European Region; NAC, North America and Caribbean Region; SACA, South and Central American Region; SEA, South-East Asian Region; WP, Western Pacific Region. Data is compiled from the "IDF Diabetes Atlas," 4th ed., November 2009. The WP Region was recalculated to represent the data from the more recent estimates from Reference 14. (*See insert for color representation of the figure*.)

countries, the complications of diabetes result in a greater degree of disability and loss of life than in wealthier countries. In turn, diabetes exacts huge losses in productivity and economic growth for the countries that can least afford it. For example, in most countries of Latin America the family bears 40–60% of the cost of medical care. In fact, a recent study of seven countries—Colombia, England, the Islamic Republic of Iran, Mexico, Scotland, Thailand, and the United States—found that financial access to care was a strong predictor of diagnosis and treatment (18).

Using international dollars (ID),[7] the predicted net loss in income from diabetes and cardiovascular disease[8] during 2005–2015 is estimated for Brazil as 49.2 billion ID; China, 557.7 billion ID; the Russian Federation, 303.2 billion ID; India, 336.6 billion ID; and Tanzania, 2.5 billion ID (19).

Summary Box 1.3

- The number of diabetes cases worldwide was 285 million in 2010; it is projected to increase to 438 million by 2030.
- China has surpassed India in greatest number of diabetic cases.
- The greatest number of cases of diabetes is in China, India, the United States, Russian Federation, and Brazil.
- Diabetes is most prevalent in Saudi Arabia, Bahrain, the United Arab Emirates, Mauritius, and Nauru.
- In many nations the cost of diabetes is borne mostly by the family.

[7]ID is a unit of currency that has the same purchasing power as the United States dollar at a specific period in time.

[8]In these statistics from the World Diabetes Foundation (WDF), both diabetes and cardiovascular disease were combined.

OBESITY AND OVERWEIGHT; ANOTHER EPIDEMIC IN THE UNITED STATES

A Parallel Pandemic

In the previous section, we considered the global prevalence of diabetes. Next, we will investigate another seemingly unconnected pandemic, overweight and obesity. Later, we will investigate a strong connection between the diabetes pandemic and the overweight–obesity pandemic and describe the pathophysiology that links the two.

Definitions of Overweight and Obesity

Overweight and obesity are defined as more than the normal body fat accumulation (adiposity) relative to height. It is measured by the body mass index (BMI). BMI does not measure body fat accumulation directly. There is a significant difference in the correlations of BMI with adiposity between black and white persons. Nonetheless it is an easily calculated yardstick to identify overweight and obese individuals. A person's BMI is equal to w/h^2, where w equals the weight of the individual expressed in kilograms and h^2 the height squared expressed in meters squared. In the United States, where the metric system is not used except in scientific circles, the conversion from pounds (lb) to kilograms (kg) is obtained by multiplying the weight in pounds (lb) by 0.454 and the height by multiplying the height in inches ($''$) by 0.0254. For example, a person weighing 176 lb with a height of $68''$ would have a BMI $= 79.9/1.73^2 = 79.9/2.98 = 26.8$.

The World Health Organization (WHO) (20) defines overweight as a BMI $\geq$25 and obesity $\geq$30. Although the WHO has developed BMI charts for infants and children younger than age 5, no corresponding charts have been developed for children in the 5–14 age bracket.

Overweight and Obesity among Adults in the United States

An increasing sedentary lifestyle coupled with poor eating habits and overeating has led to an increasingly overweight and obese American population. The prevalence of obesity according to ethnicity, gender, and region of the United States was surveyed by the Behavioral Risk Factor Surveillance System (BRFSS) in 2006–2008. BRFSS is a self-reported, random-dialed telephone survey of noninstitutionalized Americans aged $\geq$18 years residing in the 50 states, Washington, DC, and the three territories. The CDC analyzed this data and published the results in the CDC Morbidity and Mortality Weekly Report (MMWR) (21, 22) in 2009.

As shown in Figure 1.8, there were nine states in 2009 that had prevalence of obesity $\geq$30% of their adult populations. The nine states were mostly in the South and were Mississippi (34.4%), Louisiana (33.0%), Tennessee (32.3%), Kentucky

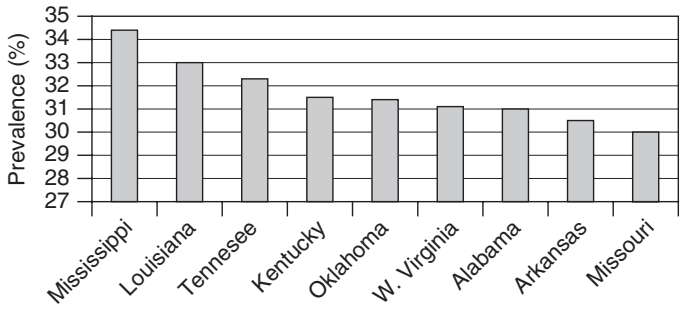

Figure 1.8 States with ≥30% obesity prevalence in 2009. (*See insert for color representation of the figure*.)

(31.5%), Oklahoma (31.4%), West Virginia (31.1%), Alabama (31.0%), Arkansas (30.5%), and Missouri (30.0%). The remainder of the states shown in Table 1.1 ranged in prevalence from 18.6% to 29.6%.

Table 1.2 shows the trends for the United States from 1994 to 2009. As you can see from this table, the number of states in the 10–14% prevalence range decreased from 33 in 1994 to nil in 2002, while those in the ≥30% range increased from 0 in 2004 to 9 in 2009. The state with the lowest prevalence was Colorado, although this figure increased significantly to 15–19% in the ensuing years. Colorado and Washington, DC had the lowest prevalence in 2009.

Figure 1.9 represents the racial/ethnic breakdown of this data. As you can see from the figure, non-Hispanic blacks had age-adjusted overall prevalence of obesity (35.7%) greater than Hispanics (28.7%) and non-Hispanic whites (23.7%). Non-Hispanic black females had a greater prevalence of obesity than their male counterparts. Hispanic females had a slightly greater percentage of obesity, while among non-Hispanic whites the opposite was true; the prevalence of obesity was slightly greater in males than in females.

For non-Hispanic blacks, the prevalence of obesity was greater in the South (36.9%) followed by the Midwest (33.1%), West (33.1%), and Northeast (31.7%). Among Hispanics, prevalence was highest in the Midwest (29.6%), South (29.2%) and West (29.0%), and lowest in the Northeast (26.6%). For non-Hispanic whites, the highest prevalence was found in the Midwest (25.4%), closely followed by the South (24.4%). Lowest prevalence was in the West (21.0%) and Northeast (22.6%).

Because of the uncertainty introduced into the survey by the manner in which the data was collected, that is, self-report by telephone, the number of persons successfully contacted, and the number of persons who gave complete interviews, the only principle conclusions from the study are the following:

TABLE 1.1 States with Prevalence of Obesity <30% in 2009

State	Prevalence, %	State	Prevalence, %
Colorado	18.6	Maine	25.8
Massachusetts	21.4	Nevada	25.8
Hawaii	22.3	Maryland	26.2
Vermont	22.8	Washington	26.4
Oregon	23	Illinois	26.5
Montana	23.2	Delaware	27
New Jersey	23.3	Georgia	27.2
Utah	23.5	Nebraska	27.2
New York	24.2	Pennsylvania	27.4
Idaho	24.5	Iowa	27.9
Minnesota	24.6	North Dakota	27.9
Rhode Island	24.6	Kansas	28.1
Wyoming	24.6	Texas	28.7
Alaska	24.8	Wisconsin	28.7
California	24.8	Ohio	28.8
Virginia	25	North Carolina	29.3
New Mexico	25.1	South Carolina	29.4
Florida	25.2	Indiana	29.5
Arizona	25.5	Michigan	29.6
New Hampshire	25.7	South Dakota	29.6

TABLE 1.2 Prevalence of Obesity (in Percentage) for the Years 1994–2009

	10–14%	15–19%	20–24%	25–29%	≥30%
1994*	33	16	0	0	0
1995	23	27	0	0	0
1996	20	30	0	0	0
1997	15	32	3	0	0
1998	10	33	7	0	0
1999	6	26	18	0	0
2000	1	27	22	0	0
2001	1	20	28	1	0
2002	0	18	29	3	0
2003	0	15	31	4	0
2004	0	7	34	9	0
2005	0	4	29	14	3
2006**	0	4	25	20	2
2007	0	1	20	27	3
2008	0	1	18	26	6
2009	0	2	16	28	9

*No data from Rhode Island.
**First year that data includes Washington, DC.
Source: Behavorial Risk Factor Surveillance System, CDC.

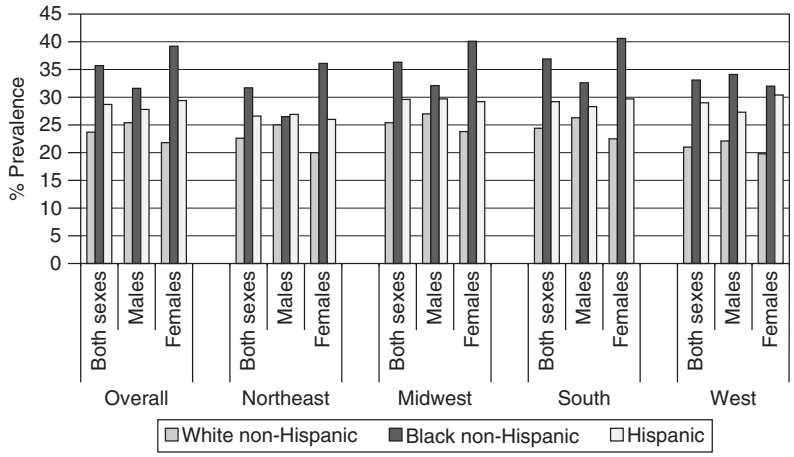

Figure 1.9 Obesity prevalence according to ethnicity, gender, and region. Data analyzed by the CDC from the Behavioral Risk Factor Surveillance System. Data collected by a random-dialed telephone survey of the US civilian noninstitutionalized ≥18 years. Surveys conducted in states, Washington, DC, and three territories. Pregnant women and those ≥500 lb or a height ≥7 ft were excluded. Surveys were conducted in 2006–2009. The data was age-adjusted to the US 2000 standard population. The prevalence relative standard error was less than 30%. (*See insert for color representation of the figure*.)

- The order of prevalence of obesity from greatest to least is non-Hispanic blacks, Hispanics, and non-Hispanic whites.
- While there are probably no differences in prevalence of obesity between genders for Hispanics and non-Hispanic whites, non-Hispanic black women have a slightly higher prevalence of obesity than non-Hispanic black men.
- Non-Hispanic blacks have the highest prevalence of obesity in the South.
- Non-Hispanic whites have the highest prevalence of obesity in the Midwest and South, with lowest prevalence in the West and Northeast.
- Hispanics had prevalence of obesity equally distributed throughout all regions.

Obesity and Overweight among Children and Adolescents in the United States

The BMI used earlier for adults is also used for children and adolescents. The definitions of overweight and obese are based on the 2000 CDC BMI age-adjusted growth charts. Children and adolescents aged 2–19 ≥ the 95th percentile for age are considered obese, and those who fall between the 85th and 95th percentiles are considered overweight (23). The CDC has published (24) a convenient BMI

calculator for children and adolescents on their web site. All one has to do to calculate the BMI for age percentile is enter the birth date, date of measurement, sex, height, and weight.

The present generation of American adults who are overweight and obese will soon be joined by the next generation of Americans. Analysis of data from the National Health and Nutrition Examination Survey (NHANES), conducted by the National Center for Health Statistics (NCHS) of the CDC, estimates that in 2007–2008 about 16.9% of children and adolescents 2–19 years old were obese and 31.7% were overweight. In addition, the same report states that 9.5% of infants and toddlers are obese (25). This is an alarming statistic as obese children and adolescents are likely to remain obese into adulthood (26), thus augmenting the prevalence of obesity in adulthood.

Figure 1.10 was produced from the data presented in Reference 25. As you may see from the figure,

- Obesity is more prevalent among Mexican-Americans and Hispanics.
- Among non-Hispanic black males, obesity increases as age increases for all age brackets.
- Among non-Hispanic whites, obesity in Mexican-Americans and Hispanics is more prevalent in the 6–11 age bracket (elementary school age) than in the 2–5 age bracket (preschool age). Prevalence then decreases significantly in the 12–19 age bracket.
- For females, obesity is more prevalent as age increases from 2–5 to 6–11 and decreases in the 12- to 19-year range with one exception, non-Hispanic blacks.
- Mexican-American and Hispanic males had a greater prevalence for obesity in all age brackets than for females of the same race.

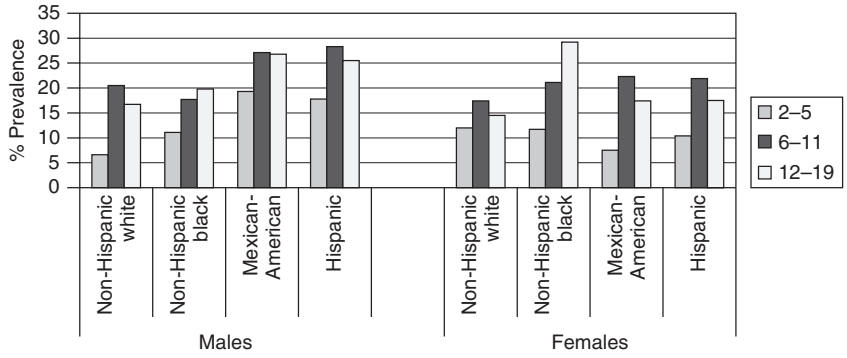

Figure 1.10 Obesity prevalence in US youths aged 2–19 by gender, age, and ethnicity in 2007–2008. Obesity defined as BMI at the 95th percentile or higher. Data are from Reference 22. (*See insert for color representation of the figure.*)

Summary Box 1.4

- An increasing sedentary life style with poor eating habits and overeating is creating a population of Americans who are overweight and obese.
- Obesity is most prevalent in the South. Southern states such as Mississippi, Louisiana, Alabama, and Arkansas have an obesity prevalence of ≥30%.
- Since 1994 obesity has been on the increase.
- During 2004–2009, BRFSS surveyed obesity in the United States, the District of Columbia, and three territories and found that among Americans ≥18 years non-Hispanic Blacks had the greatest prevalence of obesity followed by Hispanics and non-Hispanic Whites.

OVERWEIGHT AND OBESITY WORLDWIDE

Overweight and Obesity Globally in Adults

That obesity is not just an American problem is suggested by statistics from the WHO (27). The worldwide data on obesity in the WHO report is derived from multiple sources and for many countries the data is fraught with a great deal of uncertainty. In many instances, there is missing data. There is a great deal of variation in the manner that the data was collected, the definitions used, coverage, and statistical methods and modeling used. There is fewer data available for overweight and obese children. However, there are some valid conclusions that can be drawn from the statistics that were compiled.

The author took the liberty of including in Table 1.3 those countries that had ≥10% prevalence of persons (male or female or both) ≥15 years old who were overweight in 2000–2009, and ≥20% prevalence of persons (male or female or both) ≥15 years old who were obese in 2000–2009. In contrast, countries that had less than 5% prevalence were also listed in the table. With respect to obesity, the prevalence was greater in females than in males. Of the 193 countries that participated in the survey, 30 countries placed in the overweight category, 38 in the ≥20 obese category, and 20 in the less than 5% obese category. Those of you who know your geography may recognize from the table the lowest prevalence of obesity countries were for the most part in Asia and Africa (an average BMI of 22) and the highest were in North America, Europe, Latin America, North Africa, and the Pacific Island (BMI of 26).

In summary, obesity has tripled since 1980 in many countries throughout most regions of the world. The increase has been occurring in developing countries as well as industrialized countries. The WHO reported (28) that there were over 1 billion overweight adults (>15 years), with 300 million of them obese.

TABLE 1.3 Countries with Overweight Prevalence ≥10% and Obesity Prevalence <5% and ≥20%

Overweight (≥10%)	Obesity	
	≥20%	<5%
Albania	Australia	Burkina Faso
Algeria	Bosnia and Herzegovina	Cambodia
Armenia	Brazil	Cameroon
Azerbaijan	Canada	Chad
Belize	Chile	Democratic Republic of the Congo
Benin	Cook Islands	Eritrea
Bosnia and Herzegovina	Croatia	Ethiopia
Botswana	Czech Republic	Guinea
Bulgaria	El Salvador	India
Central African Republic	Fiji	Indonesia
Comoros	Germany	Japan
Egypt	Greece	Lao People's Democratic Republic
Georgia	Guyana	Mozambique
Indonesia	Iraq	Nepal
Iraq	Isreal	Niger
Kazakhstan	Jordan	Rwanda
Kyrgyzstan	Kiribati	Uganda
Lebanon	Kuwait	United Republic of Tanzania
Libyan Arab Jamahiriya	Lithuania	Viet Nam
Malawi	Malta	
Mongolia	Mexico	
Montenegro	Nauru	
Morocco	New Zealand	
Nigeria	Nicaragua	
Serbia	Oman	
Sierra Leone	Panama	
Swaziland	Samoa	
The former Yugoslav Republic of Macedonia	Seychelles	
Ukraine	South Africa	
Uzbekistan	Syrian Arab Republic	
	Tonga	
	Turkey	
	Tuvalu	
	United Arab Emirates	
	United Kingdom	
	United States of America	
	Uruguay	
	Vanuatu	

Overweight and Obesity in Children

The seriousness of the overweight and obesity problem worldwide is emphasized by the data compiled on children. Although published reports on childhood weight worldwide are fewer for children than adults, the most reliable published data (29) indicates that in 2010, the number of overweight and obese children was 43 million. Approximately 35 million (81%) children were from developing nations. Indeed, the prevalence of overweight and obesity in children increased from 4.2% in 1990 to 6.7% in 2010. If this trend were to continue unabated, the prevalence would be 9.1% in 2020. This would correspond to 60 million children.

The data provided in this chapter[9] supports the conclusions by epidemiologists that diabetes mellitus and obesity are pandemics in the making. Next, we will describe the connections between these two pandemics.

Summary Box 1.5

- Overweight and obesity is a worldwide problem.
- A total of 38 of 193 member countries of WHO have populations with $\geq$20% that are classified as obese.
- There more than 1 billion adults who are overweight and 300 million obese.
- If the trend of overweight and obesity continues there will be by 2020 60 million overweight and obese children.

THE RELATIONSHIP BETWEEN OBESITY AND DIABETES

Now we shall connect the dots. The link between obesity and diabetes was remarked upon since the late 1800s, as shown in Figure 1.11. The Books Ngram Viewer developed by Googlelabs© (30, 31) has a database of 500 billion words compiled from 5.2 million books published since 1500. By putting in the phrase "obesity and diabetes," it returns the graph shown in Figure 1.11.

An earlier observation of the link between obesity and diabetes was reported by Lyman (32), stating in a chapter of a textbook published in 1895 that "The coexistence of obesity and diabetes is a matter of frequent observation." In 1906, Ebstein (33) reported "... fact must be expressly pointed out that gout, obesity and diabetes mellitus are intimately related, which is evident from the circumstance that two of these diseases, or not infrequently all three, simultaneous occur in the same person." Horsford reported in an article (34) published in 1920 that "Obesity and diabetes, as signified by overfatness and glycosuria, are frequently associated conditions."

However, most of these early reports were anecdotal—the observations of medical practitioners. An early report that utilized measurements to substantiate

[9]The statistics cited in this chapter may be dated by the time this text is published. Those who want more current data may go to the URL web sites cited in this book for updates.

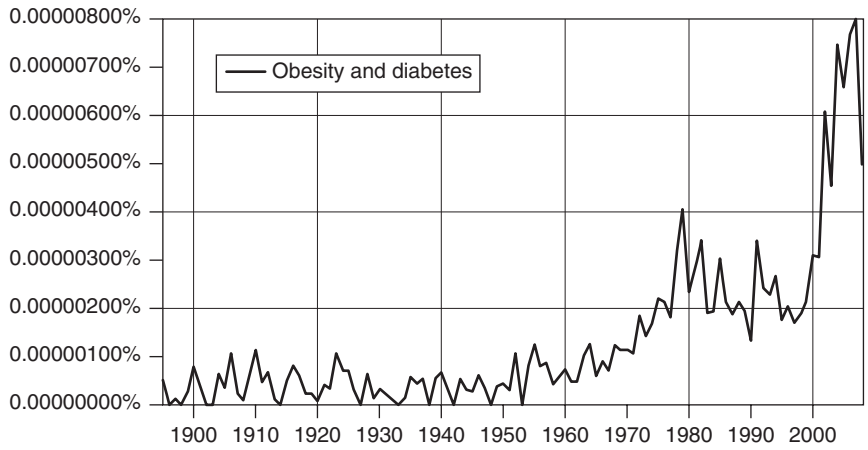

Figure 1.11 This figure shows the Googlelabs Books Ngram Viewer return for the phrase "obesity and diabetes" from the year 1895 to 2008. (*See insert for color representation of the figure*.)

conclusions measured the distribution of subcutaneous fat tissue in males and females. Using calipers to measure the degree of fatness in certain regions of the body, Vague (35) reported that a person with an abundance of upper body fat was more apt to suffer from atherosclerosis and diabetes. He stated "... it is also the usual cause of diabetes in 80 to 90 per cent of the cases."

More modern studies (since 1985) demonstrate the association of obesity and diabetes. Data collected from the NHANES indicated (36) that the relative risk of developing diabetes was 2.9 times greater for obese persons 20–75 years of age than for normal weight persons. A later publication (1996) reported (37) that the prevalence of morbidity and mortality from diabetes decreases with weight loss. In this report, it was recommended that a BMI of 20–25 should be maintained during a person's lifetime. A 12-year study (38) of 6917 men with no previous history of diabetes found an increased occurrence of diabetes in those who had a substantial weight gain as compared to those who had a stable weight. Furthermore, those who had a substantial weight loss were associated with a decreased prevalence of diabetes.

Convinced? As indicated by Figure 1.11, starting in about 1997, there has been a multitude of citations referring to the association between obesity and diabetes.

Summary Box 1.6

- The earliest reports that associated obesity with diabetes was anecdotal stories by medical practitioners.
- Individuals with excess upper body fat were found to be more likely to develop diabetes than those who had less fat.

This chapter is followed by a historical view of diabetes from caveman to modern times. In Chapter 3, we will look at the basics of normal glucose metabolism. In Chapter 5, we will look at glucose metabolism in the diabetic.

PROJECTS AND QUESTIONS

1.1 Describe the various approaches that are used for determining the prevalence of diagnosed diabetes using the original articles listed for this chapter.

1.2 Obtain data from an epidemiological diabetes study and determine if there are a significant number of persons with diabetes who are over the age of 40 years and of normal weight.

1.3 Choose a person (relative or friend) who has been diagnosed with diabetes. Learn what you can in regard to the following:
   (a) When was the disease diagnosed?
   (b) How was it diagnosed?
   (c) What were the symptoms (if any)?
   (d) The age, weight, and sex of the person.
   (e) The classification of the diabetes (to be explained in later sections).

1.4 In order to have a BMI of 28, a person 75″ tall would weigh _____ kg.

1.5 Place in the Googlelabs Books Ngram Viewer the phrase "obesity causes diabetes" and analyze the returned graph. Try other words, and phrases involving overweight, obesity, and diabetes.

GLOSSARY

Adiposity Body fat. Measured indirectly by BMI.

BMI Body mass index. BMI equals weight in kilograms divided by height in meters squared.

BRFSS Behavioral Risk Factor Surveillance System is a self-reported, random-dialed telephone survey of noninstitutionalized Americans aged $\geq$18 reporting the prevalence of obesity in 50 states, Washington, DC, and three territories during 2006–2008.

CDC Centers for Disease Control and Prevention is a US federal agency under the Department of Health and Human Services directed to protect public health and safety by providing information to enhance health decisions.

Diabetes insipidus A disease caused by vasopressin deficiency. This disease should not be confused for diabetes mellitus.

Diabetes mellitus An array of noncommunicable diseases that have abnormally high blood glucose levels.

Epidemic A disease or condition that spreads rapidly among many people in a community. Word used in this textbook for a disease or a condition occurring in a region or nation.

ID International dollar equates foreign dollars to the same purchasing power as the US dollar at the same specific period of time.

IDF International Diabetes Federation represents over 200 diabetes associations located in more than 160 countries.

Incidence The frequency of occurrence of the disease during a defined period of time.

Morbidity Number of cases of a specific disease per unit of time, per unit of population.

Mortality Number of cases of death from a specific disease per unit of time, per unit of population.

MMWR The Morbidity and Mortality Weekly Report published by the CDC analyzes and publishes the morbidity and mortality due to diseases and conditions in the United States.

NHANES National Health and Nutrition Examination Survey conducted by the National Center for Health Statistics of the CDC. NHANES combines interviews and physical examinations designed to assess the health and nutritional status of adults and children in the United States.

Obesity More than the normal fat accumulation relative to height according to WHO, a BMI $\geq$30.

Overweight More than the normal fat accumulation relative to height according to WHO, a BMI $\geq$25.

Pandemic Epidemic over a large region of the world. Used in this textbook to represent a disease or condition spreading across a large international region.

Pathophysiology Deals with the biochemical structural and functional changes caused by disease.

Prevalence The number of individuals who have the disease at the time of the study.

SEARCH SEARCH for Diabetes in Youth provides the first extensive diabetes study focused on persons younger than 20 years in the United States.

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