



# BESITY

## AND ITS HEALTH EFFECTS

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with preface by Daniel T. Stein, M.D.

American Council on Science and Health



# OBESITY AND ITS HEALTH EFFECTS

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# P R E F A C E

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Obesity is increasing at alarming rates in our society. While excessive attention to “thinness” carries its own physical and mental health problems, increasing overweight is a much “larger” problem in our society and currently affects over two thirds of the population. This handbook sponsored by the American Council on Science and Health (ACSH) has been written with the layman in mind and is meant to be a comprehensive and concise source of reliable information for the educated consumer. In contrast to smoking, which has decreased due to improved public health awareness, overweight and obesity have steadily increased — particularly over the last twenty-five years.

On average, obesity shortens life by six to seven years. Excess weight increases the risk of deadly diseases such as heart disease, stroke and cancer. One of the great ironies of advances in medical technology is that deaths due to heart attacks, stroke, and cancer, which have rapidly declined in the past, are now leveling off and in some cases increasing due to obesity-related conditions. For example, diabetes, which is directly related to being overweight, is increasing rapidly, and deaths due to heart disease in diabetics are also increasing. Similarly, cancers linked to obesity, such as colon, prostate, and breast, are also increasing. Right now the American Cancer Society considers obesity to be the second largest cause of preventable cancer, after cigarette smoking. Within ten years, obesity might exceed smoking as an avoidable cause of cancer.

Of even greater concern is the increase in overweight and obesity among children, adolescents, and young adults. Shockingly, we are now seeing Type 2 diabetes in young people whereas this used to be a disease of middle age. While the implications for the future wellbeing of our society are grave, the good news is that interventions to reduce overweight among young people have long-lasting effects on future weight. Increased awareness of the complications of obesity can be a strong motivation to adopt healthier lifestyles.

Overweight and obesity affect many aspects of health and quality of life in addition to the more dramatic effects described above. Obesity increases the risks of undergoing surgery and anesthesia. It increases the risk of asthma and sleep apnea (interrupted breathing during sleep). Common gastrointestinal-associated problems include gallstones, acid reflux, fatty liver disease, and pancreatitis. Not surprisingly, obesity increases stress on bones and joints causing degenerative joint disease.

Obesity is associated with menstrual irregularities, polycystic ovarian syndrome (a hormonal condition), and increases the difficulty of getting pregnant. Obesity increases the risk of urinary incontinence and, for men, prostate enlargement, infertility, and erectile dysfunction. Several skin conditions are more common in obesity, including fungal and bacterial infections, pressure sores, and psoriasis. Lastly, obesity carries with it a significant degree of social stigmatization and depression. Many medications to treat depression and other neurological conditions can also lead to weight gain.

In summary, obesity is not just a “cosmetic” problem; it negatively affects almost all aspects of human health. We can thank the experts at the ACSH for making this information more easily available to the public.

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# CHAPTER



Reviewed by Gilbert L. Ross, MD; Ruth Kava, Ph.D., R.D., ACSH

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## Obesity: An Increasingly Common Health Problem

**Two-thirds of all American adults weigh more than is consistent with good health.**

Many of them think of the excess weight as mostly a cosmetic issue. They don't like the way they look. They're embarrassed about their appearance. Living in a society that values thinness and fitness, they feel out of place and unattractive.

What they may not realize is that their weight problem is not just an appearance issue; it's also a health issue. Overweight and obesity (the term used to refer to the more severe degrees of overweight) are linked to increased risks of serious health problems. In fact, the health risks associated with obesity are so extensive that if the spare tires around Americans' middles were consumer products, they would need to carry a warning label.

But no warning label could be large enough to tell the whole story about the health impact of obesity. For that you would need about a hundred pages — the hundred pages of this book. The American Council

on Science and Health has prepared this book to bring the scattered information about the health effects of obesity together in a single publication, written in terms accessible to the general public. We want you to know what being too heavy can do to your health so that you will understand why preventing and treating obesity are so important.

In some respects, the health effects of obesity are similar to those of cigarette smoking. Both cigarette smoking and obesity affect the cardiovascular, respiratory, digestive, neurologic, and reproductive systems, among others. Both contribute to or exacerbate multiple diseases, including several of the major killer diseases, such as heart disease and cancer. Cigarette smoking is the greater killer; in fact, it is the leading cause of preventable deaths both in the United States and in the world as a whole.<sup>1</sup> Obesity is also a major contributor to preventable deaths. As will be discussed

<sup>1</sup> For a full discussion of the health impact of cigarette smoking, see the book *Cigarettes: What the Warning Label Doesn't Tell You*, 2<sup>nd</sup> edition, published by ACSH in 2003.

in Chapter 2, there is good evidence that obesity now ranks second only to cigarette smoking as a preventable cause of death and disease in the United States.

In one important way, though, obesity differs from cigarette smoking. Unlike cigarette smoking, which has become less common in the United States in recent decades, obesity is becoming more common.

Figure A shows trends in the proportion of American adults who smoked cigarettes from the 1960s through the first years of the 21st Century. As the graph shows, there has been a continuing downward trend in the proportion of people who smoke. In the mid-1960s, one half of all men and one third of all women smoked cigarettes. By 2004, only about one fifth of adults of either sex were cigarette smokers.

Figure B shows trends in the number of American adults who were overweight or obese during approximately the same time period. The proportion of the

population that was overweight (that is, those who were heavier than they should have been, but only to a relatively modest extent) remained at about one third throughout the period shown on the graph. However, the proportion of the population that was obese (greatly in excess of normal weight) increased steadily, starting in about 1980. In 1976-1980, only about 15 percent of American adults were obese; by 2003-2004, 34 percent were obese. Thus, the proportion of the adult population that is obese has doubled in only two decades. And, as will be discussed in detail in Chapter 16, a similar trend has been taking place among children and adolescents as well, in whom obesity rates have more than doubled since the 1970s — a very serious issue, since obesity in childhood often persists into adulthood, leading to long-term health problems. A recent editorial in the prestigious *New England Journal of Medicine* described the current trends in obesity in both adults and children as “a time bomb for the future risk of

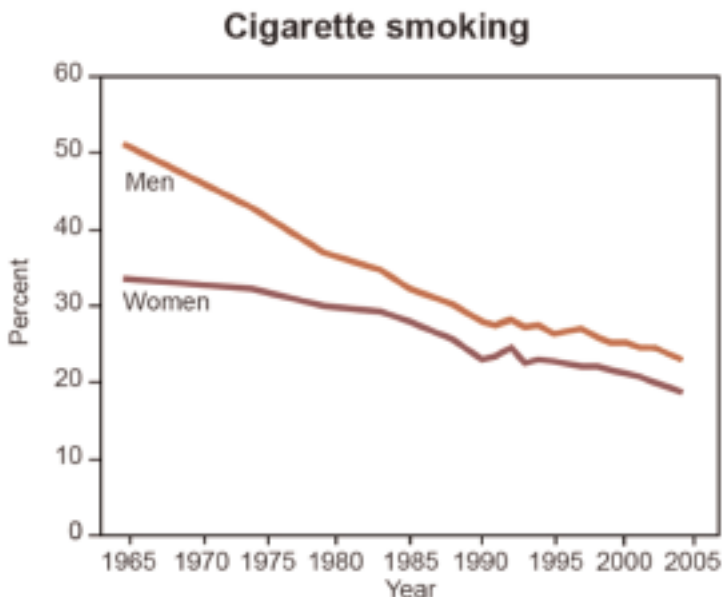


Figure A Percentages of U.S. men and women who smoked cigarettes, 1965 to 2005.

From *Health, United States, 2006*. Original data from the National Health Interview Survey, National Vital Statistics System.



diabetes and other illnesses and the attendant costs” (Bray, 2007).

The individual chapters of this book will examine the effect of obesity on various health indicators, such as mortality (death) rates and disability rates, and on specific body organs and systems, classified by medical specialities. But before beginning the discussion of these topics, it is necessary to define some terms that are commonly used in discussions of overweight and obesity.

**ASSESSING OVERWEIGHT  
AND OBESITY**

In terms of health effects, it is the amount of adipose tissue (body fat) that a person has that matters, rather than the individual's body weight. There are techniques for measuring body fat, such as underwater weighing and dual energy x-ray absorptiometry, but most of them are expensive and difficult; they are suitable for use only in

research settings, not in the home or the doctor's office.

Instead, for routine purposes, preliminary determinations of whether an individual's weight is normal or excessive are usually made using a measure called the body mass index (abbreviated BMI). BMI is the individual's weight in kilograms divided by the square of the height in meters. Or, in conventional (English) measures, it is the weight in pounds divided by the square of height in inches, multiplied by 703. BMI is not a perfect index; it can overestimate the amount of body fat in people who are very muscular, and it can underestimate body fat in people who have lost muscle mass, such as many elderly people (Department of Health and Human Services, 2001). However, it is extensively used because of its ease and minimal cost.



Figure B Percentages of American adults who were overweight or obese, 1960 to 2004.

*Health, United States, 2006.* Original data from the National Health and Nutrition Examination Survey.

For adults, BMI values are classified as follows:  
Less than 18.5 = underweight  
18.5 to 24.9 = normal weight  
25.0 to 29.9 = overweight  
30.0 or greater = obese

If you want to determine your own BMI, here are two easy ways to do it:

You can go online and use the BMI calculator provided by the U.S. government's Centers for Disease Control and Prevention at [http://www.cdc.gov/nccd-php/dnpa/bmi/adult\\_BMI/english\\_bmi\\_calculator/bmi\\_calculator.htm](http://www.cdc.gov/nccd-php/dnpa/bmi/adult_BMI/english_bmi_calculator/bmi_calculator.htm). All you have to do is enter your height (in feet and inches) and your weight (in pounds), and the calculator determines your BMI.

Or, if you prefer, you can use Table 1, which is a BMI chart similar to those used in many doctors' offices. To use the chart, you find your height in inches on the left-hand side and read across until you find your approximate weight. The number at the top of the column where your weight appears is your BMI. For example, if you are 66 inches tall (5 feet, 6 inches), and you weigh 167 pounds, your BMI is 27, which is in the "overweight" range.

For an individual, BMI is best regarded as a screening tool, much like other screening tests for health risk factors — such as blood cholesterol levels. To determine whether an individual's weight poses a health risk, a physician would need to perform further assessments (CDC, 2007), such as skinfold thickness measurements; evaluations of diet, physical activity, and family history; and screenings for other risk factors that are related to and promoted by excess weight, such as high blood pressure and dyslipidemia (abnormal levels of cholesterol and other blood lipids).

When researchers are investigating overweight and obesity in entire population groups, however, BMI is one of the best available measures because it is inexpensive and easy to use (CDC, 2007). The kind of detailed assessment that a physician would perform on an individual patient is not practical in large studies.

## THE IMPORTANCE OF BODY SHAPE

One of the reasons why BMI is not, by itself, an adequate indicator of the health risks associated with an individual's body weight is that it does not reflect differences in body shape. People who accumulate fat in the abdominal area and develop an "apple-shaped" body have higher risks of obesity-related disease than do "pear-shaped" people, who accumulate fat around their hips and buttocks (NIDDK, 2006). Excess abdominal fat, as indicated by a large waist measurement or large waist-to-hip ratio, indicates an undesirable body fat distribution. In general, a waist circumference of 40 inches or more in men or 35 inches or more in women is considered too high (NIDDK, 2006).

## SUMMARY

Obesity is not just a cosmetic issue; it is a health issue. Much like cigarette smoking, it increases the risk of a variety of health problems, including several major killer diseases. Table 2 lists these health problems, which are discussed in greater detail in the remaining chapters of this book. Obesity does not account for as many deaths as smoking does, but it is nevertheless a serious concern, especially because the proportion of American adults who are obese has doubled in the past two decades.

Body Mass Index Table																																														
Normal										Overweight					Obese					Extreme Obesity																										
BMI	19	20	21	22	23	24	25	26	27	28	29											30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Height (inches)													Body Weight (pounds)																																	
58	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258										
59	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267										
60	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276										
61	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222	227	232	238	243	248	254	259	264	269	275	280	285										
62	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295										
63	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304										
64	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314										
65	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324										
66	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334										
67	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344										
68	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354										
69	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365										
70	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376										
71	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301	308	315	322	329	338	343	351	358	365	372	379	386										
72	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397										
73	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408										
74	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420										
75	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431										
76	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443										

From [http://www.ars.usda.gov/SP2UserFiles/Place/123535000/pdf/bmi\\_table/.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/123535000/pdf/bmi_table/.pdf)

Table 1. Body Mass Index Table.

In research on large populations, obesity and overweight are usually determined using the body mass index (BMI), which is derived from the individual's height and weight. BMI is also used as a preliminary screening tool in determining whether a particular individual's weight poses a health risk. The accumulation of weight in the abdominal area poses a greater risk to health than does the accumulation of weight in the hips and buttocks; thus, waist circumference is also a useful indicator of obesity-related health risks.

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NIDDK (National Institute of Diabetes and Digestive and Kidney Diseases). Understanding adult obesity. Washington, DC: U.S. Department of Health and Human Services, 2006.

## CHAPTER



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# The Overall Impact of Obesity

**In Chapter 1, we introduced the idea that obesity is not just a cosmetic issue – it's a major health problem. In later chapters, we will be looking at the impact of obesity on a variety of specific health conditions.**

But before we narrow our focus to individual medical specialties and body systems, we will take a look at the overall impact of obesity on health in the United States — as indicated by mortality (death rates), health care expenditures, and disability rates. Whenever possible, we will compare the impact of obesity on these health indicators with the impact of cigarette smoking — which has long been the number one threat to health in America. The bottom line: smoking is still the leading health threat, but obesity is not very far behind.

### MORTALITY

Being obese can kill you.

That's the basic conclusion of a variety of scientific studies that have examined the relationship between body mass index and mortality (death rate). The exact extent of the effect of obesity on mortality is not completely clear; this is a difficult topic to

investigate, and different studies have produced different estimates. However, the scientific evidence as a whole indicates that obesity does increase death rates and that the effect is substantial. In fact, one group of scientists has projected that if the current trend toward an increase in the prevalence of obesity continues, it may lead to a leveling off of, or even a decline in, life expectancy in the United States in coming decades (Olshansky et al., 2005).

In one important study, researchers from the American Cancer Society kept track of more than one million U.S. adults, most of them older people, for 14 years (Calle et al., 1999). They found that in healthy non-smokers, mortality was lowest among men with a body mass index (BMI) of 23.5 to 24.9 and among women with a body mass index of 22.0 to 23.4.<sup>1</sup> For those with BMIs in the overweight or obese ranges, mortality increased steadily as BMI increased, with those in the highest BMI category

<sup>1</sup> These are values in the “normal” weight range. Remember that “overweight” means a BMI of 25 or more but less than 30, and “obese” means a BMI of 30 or more.

having twice the risk of death of those at optimum weight.

How many years of life are lost due to obesity? In one study, which followed a group of people in Framingham, Massachusetts for decades, both smokers and nonsmokers who were obese in midlife (their BMIs were determined at age 40) had shortened life expectancies, as shown in Table 2 (Peeters et al., 2003). A particularly alarming relationship was seen when the researchers looked at the combined effects of obesity and smoking by comparing the life expectancies of obese smokers with those of normal-weight nonsmokers. The lives of the obese smokers were about 13 years shorter than those of the normal-weight nonsmokers.

**Table 2. Years of Life Expectancy Lost Due to Obesity in the Framingham Heart Study\***

	Men	Women
Obese nonsmokers compared to normal-weight nonsmokers	5.8 years	7.1 years
Obese smokers compared to normal-weight smokers	6.7 years	7.2 years
Obese smokers compared to normal-weight nonsmokers	13.7 years	13.3 years

*\*All comparisons are based on long-term follow-up of people whose body mass index was determined at age 40. Source: Peeters A, et al. et al. Ann Intern Med. 2003;138:24-32.*

Another study, which analyzed data from successive U.S. national health surveys, compared the impact of different degrees of obesity on life expectancy (Fontaine et al., 2003). The researchers found that

years of life lost increased steadily with increasing obesity, with the greatest decrease among people with a BMI of 45 or more. The study also showed some other interesting patterns: moderate obesity had a much more detrimental effect on life expectancy in white Americans than in African Americans, and severe obesity was associated with more years of life lost among men than among women. The effect of obesity on mortality may also vary with age. An analysis of American Cancer Society mortality data indicates that obesity has a greater effect on mortality in younger adults than in older ones (Stevens et al., 1998).

How many deaths in the U.S. each year can be attributed to obesity? Estimates vary, depending on the assumptions made in different analyses. One analysis of data from five studies linked approximately 280,000 deaths per year in the U.S. — and perhaps as many as 325,000 — to obesity (Allison et al., 1999). This analysis is the principal basis for the ballpark figure of approximately 300,000 deaths per year frequently cited by government authorities such as the U.S. Surgeon General (U.S. Department of Health and Human Services, 2001) and professional organizations such as the American College of Physicians (Snow et al., 2005). Other studies, however, have produced different estimates, some as low as about 100,000 (Flegal et al., 2005). These lower estimates are widely believed to have greater credibility because they are based on surveys in which people were actually weighed and measured rather than on self-reported heights and weights.

Regardless of whether the death toll due to obesity turns out to be closer to 100,000 deaths per year or 300,000, obesity is second only to tobacco (responsible for about 438,000 deaths per year [Centers for Disease Control and Prevention, 2007]) as an underlying cause of death in the United States. All other so-called lifestyle factors, including alcohol abuse,<sup>2</sup>

<sup>2</sup> Alcohol abuse is estimated to be responsible for about 80,000 deaths per year.

motor vehicle crashes, sexual behavior, illicit drug use, and incidents involving firearms, each account for fewer deaths per year than even the lowest estimate of obesity's impact on the annual death toll (Mokdad et al., 2004).

Among deaths linked to obesity, more result from cardiovascular disease than from any other cause (Schulte et al., 1999; McTigue et al., 2006). There is evidence that the risk of death due to obesity may have declined somewhat in recent decades due to the use of more effective treatment for cardiovascular risk factors (high blood pressure and abnormal levels of blood cholesterol and related lipids) (Gregg et al., 2005; Flegal et al., 2005, 2007). Nevertheless, obese people still have substantially higher total mortality and cardiovascular disease mortality than people of normal weight do. Obese people also have increased rates of death from several other causes, including some types of cancer (Flegal et al., 2007), diabetes mellitus (which is also a contributing factor to many cardiovascular disease deaths), and accidents (Tsai et al., 2006).

Although the scientific evidence clearly indicates that being obese is associated with increased mortality, the impact of being overweight but not obese (that is, having a BMI between 25 and 30) is less certain. Some studies have indicated that people whose weight is in the overweight range have a slightly higher risk of death than those in the normal weight range do (Peeters et al., 2003; Ajani et al., 2004; Katzmarzyk et al., 2001; Meyer et al., 2002), but other studies have shown no excess mortality or even lower mortality among those in the overweight range, as compared to those of normal weight (Farrell et al., 2002; Haapanen-Niemi et al., 2000; Strawbridge et al., 2000; Heiat et al., 2001; McGee et al., 2005; Flegal et al., 2005, 2007). Differences in the populations studied, in the length of follow-up, and in the degree to which the researchers have been able to account for the effects of smoking and preexisting illness (both of which tend to lower people's

weight and increase their likelihood of dying) may account for the variation in the research findings.

Since the jury is still out on the question of how overweight influences mortality, losing weight may not be a top health priority for people with BMIs between 25 and 30 if lowering mortality risk is the only goal. However, for some individuals in this BMI range, such as those who have been diagnosed with osteoarthritis of the knee or diabetes, losing weight may have important health benefits by enabling better management of these health problems.

## HEALTH CARE EXPENDITURES

People who are obese have higher health care costs than those of normal weight do, and health care expenditures increase as the severity of obesity increases. This trend is clearly illustrated, for example, in an analysis of data from a study of Americans in their fifties, which showed that the health care expenditures of people with a BMI of 30 to 35 were 25 percent higher than those of normal-weight individuals, while those of people with a BMI of 35 to 40 were 50 percent higher and those of people with a BMI of over 40 were 100 percent higher than those of individuals of normal weight (Andreyeva et al., 2004). Most types of health care expenditures are affected by obesity, but the highest relative increases involve outpatient services, such as prescription medications and office visits (Andreyeva et al., 2004; Raebel et al., 2004; Wee et al., 2005).

It has been suggested that obesity may have a greater effect on illness (morbidity) than death (mortality) (Flegal, 2005). Obesity is associated with increased rates of a variety of diseases that can cause ongoing health impairment and require long-term treatment, such as diabetes, asthma, and osteoarthritis. The costs of treating these diseases are substantial. Obesity is also associated with increases in cardiovascular risk factors, including hypertension and abnormal levels of blood lipids. An individual's likelihood of dying of

cardiovascular disease can be reduced if these risk factors are identified and treated, but diagnosis and treatment involve substantial costs for physician visits, diagnostic tests, and medicines.

Because of the nature of the health conditions associated with obesity, the health care costs of obesity may be in the same range as those of cigarette smoking, even though obesity is responsible for fewer deaths (Thompson et al., 1999). Based on data compiled from individual states, it has been estimated that annual medical expenditures attributable to obesity in the United States are about \$75 billion (Finkelstein et al., 2004). The direct health care expenditures attributable to smoking are estimated at \$75.5 billion per year (Centers for Disease Control and Prevention, 2007).

The direct health care costs attributable to overweight and obesity have been estimated to account for about 9 percent of total health care costs in the United States (Finkelstein et al., 2003). About half of these costs are paid by Medicare and Medicaid (Finkelstein et al., 2003).

Direct health care costs are not the only costs attributable to obesity, however. Additional, indirect costs result from lost wages and productivity due to illness or premature death. The total economic impact of obesity, including both direct and indirect costs, has been estimated at \$117 billion per year (U.S. Department of Health and Human Services, 2001). The estimated total annual economic impact of smoking is higher, at \$167 billion (Centers for Disease Control and Prevention, 2007).

## DISABILITY

Another way to assess the impact of obesity is to look at disability rates. Are obese people more likely than normal-weight people to have difficulty staying employed or leading independent lives? A variety of studies indicate that the answer to this question is yes.

A study of Americans over the age of 70 indicated that those who were obese were more likely than those of normal weight to experience disabilities affecting activities of daily living (Reynolds et al., 2005). In a study of working-age people, those who were obese in 1986 were more likely than those of normal weight to be out of the workforce 13 years later; the obese women in this study, though not the men, also reported more health limitations that affected their ability to work (Tunceli et al., 2006). Long-term follow-up of the group of people from Framingham, Massachusetts who were mentioned earlier in this chapter showed that among nonsmokers, those who were of normal weight during their thirties and forties enjoyed about five more years of disability-free life as they grew older than obese nonsmokers did (Peeters et al., 2004). A study from Finland showed that obese people had more years of work-related disability and more years in which they needed to take medication than their normal-weight counterparts did (Visscher et al., 2004). There are even data from a large U.S. prepaid health plan indicating that obesity in midlife (though not overweight) is associated with an increased likelihood of nursing home admission as much as 25 years later (Elkins et al., 2006).

Unlike obesity-related death rates and rates of cardiovascular disease, which have decreased in recent years, the burden of disability among obese people appears to be getting worse. A recent comparison of U.S. national survey data collected in 1988-1994 with similar data collected in 1999-2004 showed that obese people over the age of 60 in the newer survey reported more functional limitations (such as difficulty in walking, stooping, and getting up from a chair) than those in the earlier survey did (Alley and Chang, 2007). This contrasts with findings in the general population of older adults, among whom decreases in disability have been reported in recent years (Freedman et al., 2002).



## SUMMARY

Obesity (defined as a BMI of 30 or more) is a major cause of impaired health and increased mortality in the United States. Although numerical estimates of the impact of obesity on death rates in the United States vary, even the lowest such estimates establish obesity as Public Health Enemy Number Two — second only to cigarette smoking. The impact of overweight (BMI between 25 and 30) on mortality has not been clearly established. In terms of direct health care expenditures, obesity is tied with smoking for first place. Obesity also accounts for substantial indirect health care expenditures and increases in disability in the United States. There is evidence that mortality due to obesity has declined somewhat in recent decades, probably due to better treatment of cardiovascular risk factors; however, disability due to obesity among older people has increased recently.

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## CHAPTER



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### Endocrine and Metabolic Conditions Related to Obesity

**Obesity can have profound effects on the endocrine system (the system of glands that release hormones – substances that exert effects on distant parts of the body) and on metabolism (the chemical reactions that occur in the body).**

This chapter will focus on two of the most important obesity-related conditions involving hormones and metabolism: diabetes and the metabolic syndrome.

#### OBESITY AND DIABETES

Diabetes is one of the most prevalent and serious diseases related to obesity.

Approximately 21 million people in the United States — about 7 percent of the population — have diabetes; 14.5 million of these people have been diagnosed with the disease, and more than 6 million have it but do not know it (NDIC, 2006). Diabetes is also common in other technologically advanced countries. The prevalence of diabetes in Western Europe (British Heart Foundation, 2005) and Australia (Australian Government, 2006) is similar to that in the United States. Diabetes is also emerging as a major health problem in developing countries, particularly middle-income countries in Latin America, Asia, and Eastern Europe (Hossain et al., 2007).

Diabetes is a disorder that affects the way the body uses the food it digests. The carbohydrates that we eat are mostly broken down into glucose, a sugar that travels through the bloodstream and provides the main source of fuel for the body. To act as fuel, glucose must pass out of the bloodstream and into body cells, a process that requires a hormone called insulin. Insulin is produced by the pancreas, a large gland located behind the stomach. In diabetes, insulin does not transport glucose into body cells properly, and glucose builds up in the blood and is excreted into the urine (NDIC, 2006).

There are two principal types of diabetes. In type 1 diabetes, an autoimmune disease that usually starts in childhood or young adulthood, the insulin-producing cells of the pancreas are destroyed, and as a result, the pancreas produces little or no insulin. This type of diabetes, which accounts for 5 to 10 percent of all diabetes cases in the United States, and which must always be treated with injections of insulin (in combination with other forms of

therapy), is not related to obesity (NDIC, 2006).

The other principal type of diabetes is type 2 diabetes, in which, for reasons that are poorly understood, the body does not effectively use the insulin that the pancreas produces — a condition called insulin resistance, which can also cause excess glucose to accumulate in the blood. Eventually, in type 2 diabetes, insulin production decreases. Type 2 diabetes is managed with healthy eating, physical activity, blood glucose testing, and weight loss, often with the addition of oral medication, injected insulin, or both. The goal is to control blood levels of glucose (NDIC, 2006). In addition, managing diabetes should include efforts to keep other cardiovascular risk factors, such as high blood pressure and abnormal blood lipid levels, under control.

Type 2 diabetes, which accounts for 90 to 95 percent of all cases of diabetes in the United States, is strongly associated with obesity (NDIC, 2006). In addition to obesity, other risk factors for type 2 diabetes include older age, family history of diabetes, prior history of diabetes during pregnancy, physical inactivity, and belonging to certain ethnicities (NDIC, 2006). Obesity is one of the most important risk factors. A U.S. national health survey showed that 85.2 percent of adults with diagnosed diabetes were overweight or obese, with 54.8 percent having body mass indexes (BMIs) that fell into the obese range (CDC, 2004). The risk of diabetes increases with the severity and duration of obesity and with a more central distribution of body fat (Bray, 2004).

Between 60 and 90 percent of all cases of type 2 diabetes are believed to be related to obesity or weight gain; as one group of scientists put it, “Obesity and diabetes have become so inseparable that they are like ‘conjoined twins’” (Anderson et al., 2003).

The extent to which obesity increases the risk of type 2 diabetes is dramatic. For

example, in one large study of U.S. women, those with a body mass index (BMI) of 31 or greater (30 or greater is considered obese) had at least a 40 times greater likelihood of developing diabetes than the thinnest women did (Colditz et al., 1995).

The extent to which weight gain increases diabetes risk is also substantial. A 20-kilogram (44-lb.) weight gain increases the risk of diabetes 15-fold (Bray, 2004). Weight loss or moderation in weight gain, however, can reduce the risk of diabetes. In one large study of U.S. men, the relative risk of developing diabetes decreased by nearly half in men who lost 5 to 11 kilograms (11 to 24 lb.) (Chan et al., 1994).

Type 2 diabetes is a major health concern because it can harm a wide variety of body organs and functions, as follows (CDC, 2006):organs and functions, as follows (CDC, 2006):

- Diabetes is harmful to the cardiovascular system. People with diabetes are two to four times more likely than those without diabetes to develop heart disease or to have a stroke.
- Diabetes can lead to a type of kidney disease called diabetic nephropathy, in which the cells and blood vessels in the kidneys become damaged, causing waste products to build up in the blood rather than being excreted in the urine. In some instances, diabetic nephropathy can progress to kidney failure, which must be treated through dialysis or a kidney transplant.

Diabetes can lead to an eye disease

- called diabetic retinopathy, in which excess amounts of glucose in the bloodstream, combined with high blood pressure, cause small blood vessels to leak liquid into the retina of the eye. This causes blurring of vision and can lead to blindness. In fact, diabetes is one of the most common causes of blindness in the United States. Two other serious eye

diseases — cataracts and glaucoma — are also more common among people with diabetes than among those without the disease.

- Diabetes, especially if present for long periods of time, can damage the nerves, particularly those in the arms and legs. This condition, called diabetic neuropathy, can cause numbness, pain, and weakness in the hands, arms, feet, and legs. Neuropathy is most common among people who have had diabetes for 25 years or more.
- Circulatory problems, neuropathy, and infections can all lead to serious foot problems for people with diabetes. This combination of conditions can lead to injuries that do not heal properly, requiring amputation in some instances.
- People with diabetes are more prone than other people to oral health problems, especially gingivitis and periodontitis — a gum infection that can lead to a loss of teeth.
- Because of nerve problems and circulatory problems, people with diabetes are more likely than others to have sexual dysfunction. Both men and women can be affected. People with diabetes are also prone to developing urinary tract infections.
- People with diabetes are at higher risk of complications from infectious diseases, such as influenza. They are more likely than those without diabetes to die from influenza or pneumonia.

As might be expected, considering its multiple and profound effects on the human body, diabetes is a leading cause of death and disability. In 2002, it was the sixth-leading cause of death in the United States. However, its impact may be even greater than this statistic would indicate. About 65

percent of deaths among those with diabetes are due to heart disease or stroke, and diabetes increases the risk of dying from these causes. However, diabetes may not be listed as a cause of death on death certificates of people with diabetes who die of a heart attack or stroke (NDIC, 2006).

Rates of diabetes are currently increasing, in conjunction with increases in rates of obesity. At a scientific conference held while this book was being edited (Healthday, 2007), it was reported that by the year 2050, an estimated 48 million Americans will have type 2 diabetes — more than twice the number who have it today. Diabetes rates have been increasing since the 1960s, and there is no slowdown in sight. Thus, diabetes will continue to be a major public health problem in the U.S. in coming decades. Similarly, diabetes is expected to continue to grow worldwide. The number of people worldwide with diabetes is expected to increase from 171 million in 2000 to 366 million by 2030, with the greatest increase in developing countries, where the number is expected to increase from 84 million to 228 million (Hossain et al., 2007).

## THE METABOLIC SYNDROME

The metabolic syndrome is a cluster of risk factors for heart disease and diabetes occurring in the same person. All of these risk factors are linked to obesity. Each of them by itself poses some threat to the individual's health, but in combination they have a far greater impact than each would alone. An individual is considered to have metabolic syndrome if he or she has any three or more of the following five risk fac-

- Abdominal obesity, as indicated by having a large waistline or an “apple-shaped” body. Excess fat in the abdominal area is a greater risk factor for heart disease than excess fat in the hips or other areas. (In fact, fat in the legs may even be protective against cardiovascular disease [Williams et al., 1997].

- A lower-than-normal level of high-density lipoprotein (HDL) cholesterol (the so-called good cholesterol), or being on medicine to treat a low HDL cholesterol level.
- A higher-than-normal level of triglyceride in the blood, or being on medicine to treat a high triglyceride level.
- Higher-than-normal blood pressure, or being on medicine to treat high blood pressure.
- Higher-than-normal fasting blood glucose (sugar) or being on medicine to treat this problem.

tors (Grundy, 2004; NHLBI, 2007):

A person with metabolic syndrome is five times as likely to develop diabetes as someone without this condition (NHLBI, 2007). Having metabolic syndrome also substantially increases the risk of heart disease and of death from all causes. For example, in one European study, having metabolic syndrome more than doubled cardiovascular mortality in both men and women; it also increased mortality from all causes by 44% in men and 38% in women (Hu et al., 2004).

Metabolic syndrome is very common in the United States. In a 1988-1994 survey of a representative sample of the U.S. population, it was found that 21.8% of adults had metabolic syndrome, with similar rates in men and women. The prevalence of metabolic syndrome increased with age, from 7% among those in their twenties to more than 40% among those aged 60 and over (Ford et al., 2002). More recent data indicate that the prevalence of metabolic syndrome today is even higher than it was at the time of this survey, with especially notable increases among women (Ford et al., 2004). The increase in the proportion of people with metabolic syndrome in recent years is believed to be due largely to the increase in obesity during the same time period (Ford et al., 2004). An estimated 47 million Americans have the metabolic

syndrome (AHA, 2004).

The underlying cause of the metabolic syndrome has not been clearly established, although many scientists believe that insulin resistance (a situation in which body cells do not respond adequately to the actions of the hormone insulin) plays a role (NHLBI, 2007). Regardless of the underlying cause, the metabolic syndrome is a condition that should be treated because it substantially increases the risk of heart disease and diabetes. Often, patients receive treatment for individual risk factors (e.g., medications to reduce high triglyceride levels or control blood pressure), but experts believe that the most effective approach is to treat the syndrome as a whole through weight management and increased physical activity (Ford et al., 2002).

Obesity is the leading risk factor for type 2 diabetes — the most common type of diabetes. Diabetes is a major risk factor for cardiovascular disease and can also have a wide variety of other complications affecting the kidneys, eyes, nerves, and other body organs and systems. Diabetes is the sixth-leading cause of death in the United States and is also linked to many deaths attributed to heart disease or stroke.

Obesity, especially abdominal obesity, is a central feature of a cluster of often-coexisting risk factors known as metabolic syndrome. Individuals with metabolic syndrome are twice as likely to develop heart disease and five times as likely to develop diabetes than those without this syndrome. The recent increase in the prevalence of metabolic syndrome is believed to be due largely to the simultaneous increase in obesity.



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## CHAPTER

# 4

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## Obesity and Diseases of the Circulatory System

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### This is the big one.

More obesity-related deaths are due to circulatory diseases — primarily cardiovascular disease — than to any other type of disease. This chapter discusses the relationship between obesity and cardiovascular disease, as well as several other circulatory problems including heart failure, peripheral vascular disease, leg ulcers, and blood clots. But first, the relationship of obesity to two conditions that are important risk factors for cardiovascular disease — hypertension and dyslipidemia — will be described.

#### **HYPERTENSION (HIGH BLOOD PRESSURE)**

Almost one-third of American adults have hypertension (high blood pressure) (NHBLI, 2006a). Hypertension is sometimes called the “silent killer” because it usually has no symptoms. Most people who have been diagnosed with this condition first learned about it through routine medical exams, not because they felt ill. Hypertension is a major risk factor for coronary heart disease and other

diseases caused by atherosclerosis (narrowing and damage to the arteries), such as stroke. Hypertension also increases the risk of kidney failure.

When people think about risk factors for hypertension, the first thing they often mention is eating too much salt. And in fact, it is true that for some people, too much salt (sodium) in the diet can increase blood pressure. However, there are other risk factors as well, and obesity is among the most important. It has been estimated that approximately 65 to 75% of the risk for hypertension can be directly attributed to excess weight (Hall et al., 2003).

In a survey of a representative sample of U.S. adults (Must et al., 1999), high blood pressure was the most common overweight- and obesity-related health condition in both men and women, with higher prevalences of hypertension in people with severe obesity than in those who were less severely obese or overweight, as shown in Table 3

**Table 3. Frequency of Hypertension by Body Mass Index (BMI) and Sex**

BMI Category*	Percentage of Men with Hypertension	Percentage of Women with Hypertension
Less than 18.5	23	20
18.5-24.9	23	23
25.0-29.9	34	39
30.0-34.9	49	48
35.0-39.9	65	55
40.0 or more	65	63

\*A BMI of less than 18.5 is considered underweight; 18.5 to 24.9 is considered normal; 25.0 to 29.9 is considered overweight; and 30.0 or over is considered obese. The researchers in this study grouped their obese study participants into three groups representing different degrees of obesity.

Source: Must et al,et al., JAMA. 1999;282:1523-1529.

Gaining weight promotes the development of hypertension. For example, in one large study of U.S. women, for each 10-pound weight gain, the risk of hypertension increased by 20 percent (Field et al., 1999).

#### ABNORMAL LEVELS OF CHOLESTEROL AND RELATED LIPIDS

Practically everyone has heard that having too much cholesterol in your bloodstream is unhealthy, but the actual situation with cholesterol and related lipids (fat-like substances) is more complex than many people realize.

Cholesterol is carried through the bloodstream on proteins called lipoproteins. Having elevated levels of one of these lipoproteins, low-density lipoprotein (LDL), is strongly associated with an increased risk of heart disease. However, having high

levels of another lipoprotein, high-density lipoprotein (HDL), is actually desirable; low levels of HDL, rather than high levels, are associated with increased heart disease risk. Another lipid that may play a role in heart disease risk is triglyceride. Elevated triglyceride levels are associated with increased risk of heart disease, but the relative importance of triglyceride and HDL have not been established.

The term for undesirable levels of blood lipids (high LDL cholesterol and/or low HDL cholesterol and/or high triglyceride) is dyslipidemia ("dys" means abnormal or impaired, as in the word "dysfunction"). Obesity is associated with an increased likelihood of having dyslipidemia. It has long been known that obesity is associated with elevated triglyceride levels, and obesity has also been linked to decreased HDL levels. The effect of obesity on HDL may be more important than the effect on triglyceride because a low HDL level carries a greater heart disease risk than high triglyceride levels do (Bray, 2004).

#### CORONARY HEART DISEASE AND OTHER CARDIOVASCULAR DISEASES

Cardiovascular disease is the leading cause of death for both men and women in the United States. In 2002, 29 percent of all deaths were attributable to heart disease (CDC, 2007). Seventy-one percent of heart disease deaths are due to coronary heart disease, the principal type of cardiovascular disease (CDC, 2007).

Obesity is a risk factor for cardiovascular disease. People who are overweight or obese are more likely than normal-weight people to develop cardiovascular disease, and they are also more likely to die of it (Stein and Colditz, 2004). Because overweight and obesity have become more prevalent in recent years, they have become increasingly prominent cardiovascular risk factors (Nanchahal et al., 2004; Smith, 2007). In one study in the U.K., for example, 32 percent of the men examined

were found to be at high risk for heart disease; 47 percent of these instances of elevated heart disease risk were attributable to excess body weight — more than any other single risk factor (Nanchahal et al., 2005).

Obesity increases heart disease risk because it promotes several well-established heart disease risk factors — hypertension, dyslipidemia, and diabetes. Recent scientific evidence indicates that obesity may also be an independent risk factor for heart disease — that is, it may have effects of its own that are not mediated by its impact on other risk factors. An analysis of a long-term follow-up study of a representative sample of the U.S. population showed that even after all of the other known risk factors were taken into account, obese people were significantly more likely than those of normal weight to die of heart disease (Mann et al., 2006). Several other epidemiologic studies have also supported the concept that obesity is an independent risk factor for heart disease (Manson et al., 1995; Wilson et al., 2002; Schnohr et al., 2002), but others have not shown such an effect (Schulte et al., 1999; Reaven, 2003). Very recently, a combined statistical analysis (meta-analysis) of the results of 21 epidemiologic studies that included a total of more than 300,000 people indicated that effects on blood pressure and cholesterol accounted for only 45 percent of the increase in heart disease risk associated with obesity; some of the remaining increase in risk may have been due to diabetes, which was not taken into account in the analysis, and some may have been due to obesity per se, rather than being mediated through other risk factors (Bogers et al., 2007).

The mechanism by which obesity may exert an independent effect on cardiovascular disease risk has not been established. Nevertheless, the probable existence of such an independent effect has important public health implications. If obesity increases the risk of death from cardiovascular disease even in the

absence of other risk factors, as recent evidence indicates, it is important to prevent or treat obesity even if these other risk factors are not present.

## HEART FAILURE

Heart failure is a condition, common among elderly people, that develops when the heart has lost some of its ability to pump blood (AAFP, 2005). Symptoms include fatigue; shortness of breath when lying down; inability to perform ordinary physical activities such as climbing stairs; irregular heartbeats; and fluid buildup, which can cause swelling in the legs. Heart failure is not the same thing as a heart attack, although people with a history of heart attack or high blood pressure are at increased risk of developing heart failure. Having a heart attack can predispose a person to heart failure because the ability of the undamaged portion of the heart muscle to contract forcefully may be diminished.

Obesity has been associated with a doubling of the risk of developing heart failure (Kenchiah et al., 2002); the increase in risk is greater in more severely obese people than in those with milder obesity. It has been estimated that obesity alone causes about 11 percent of cases of heart failure in men and 14 percent in women (Kenchiah et al., 2002). One reason for the increase in heart failure risk may be that the heart has to work harder to circulate blood to a larger body. The increased cardiac work associated with overweight may promote heart failure even in the absence of hypertension or other established risk factors for this condition (Bray, 2004). People with a significant degree of heart failure have a much reduced life expectancy.

Ironically, some evidence suggests that among patients with established heart failure, those who are obese are less likely than leaner patients to die from this condition (Curtis et al., 2005). The reason for this is not known.

## PERIPHERAL VASCULAR DISEASE

Just as coronary heart disease results from damage to the arteries that carry blood from the heart, peripheral vascular disease is caused by damage to the arteries that carry blood to the extremities. The same risk factors that promote coronary heart disease — including obesity and diabetes — also promote the development of peripheral vascular disease. Peripheral vascular disease can cause pain, numbness, and susceptibility to infection in the legs and feet. In some instances, the decrease in blood flow to the legs can be severe enough to cause tissue death, sometimes leading to the need for amputation (NHBLI, 2006b).

Leg ulcers are wounds that heal slowly, if at all. They occur in up to one percent of the population (Chaby et al., 2006), mostly in elderly people. They are associated with peripheral vascular disease and are common among people with diabetes. Leg ulcers are more common in obese people than in those of normal weight (Scheinfeld, 2004). This reflects the increased likelihood of both peripheral vascular disease and diabetes associated with obesity. Increased fluid retention (lymphedema) in obese people is also a contributing factor because it puts stress on the skin and underlying tissues.

## DEEP VEIN THROMBOSIS AND

A deep vein thrombosis is a blood clot that forms in a vein deep in the body, usually in the leg. Unlike clots in superficial veins, clots in deep veins are dangerous because they can break off and travel to the lungs, causing a potentially fatal condition called pulmonary embolism (NHBLI, 2007). As discussed in Chapter 7, surgery, injury, or other conditions causing immobilization increase the risk of deep vein thrombosis. Other risk factors include sitting for a long period of time, such as on a car or airplane trip; being over age 60; having recently

given birth; and having certain other medical conditions, such as varicose veins or cancer. Being overweight or obese is also a risk factor. The risk for deep vein thrombosis increases if an individual has multiple risk factors, so those who are overweight or obese are at particularly high risk during any of the situations mentioned above that promote blood clot development. One recent study indicated that having the metabolic syndrome, which includes insulin resistance, abdominal obesity, and several other risk factors (see Chapter 3), is associated with a two-fold increased risk of developing deep vein thrombosis or pulmonary embolism (Ay et al., 2007).

Obesity is a risk factor for cardiovascular disease, the leading cause of death in the United States. The effect of obesity on cardiovascular risk is at least partly accounted for by its promotion of hypertension, dyslipidemia, and diabetes, but recent evidence indicates that obesity may be an independent risk factor for cardiovascular disease as well.

Obesity is responsible for a large proportion of all cases of hypertension, and there is a strong positive relationship between body mass index and blood pressure. Obesity is associated with a reduction in the level of desirable HDL cholesterol, as well as an undesirable increase in blood triglyceride levels.

Obesity is also associated with an increased risk of other circulatory conditions, including stroke (see Chapter 12), heart failure, peripheral vascular disease, leg ulcers, and deep vein thrombosis.

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# CHAPTER



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## Effects on the Respiratory System

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**Obesity can affect the functioning of the respiratory system and the likelihood of developing certain diseases that affect breathing.**

In this chapter, we will discuss the effects of obesity, especially extreme obesity, on respiratory function and respiratory symptoms such as shortness of breath. We will also examine the scientific evidence linking obesity to two disorders that affect the respiratory system — asthma and sleep apnea.

### OBESITY AND RESPIRATORY FUNCTION

Imagine that you're lying on your back and that someone has just placed a large weight on your chest. That's what it can feel like to breathe lying down for people with severe obesity.

Obesity impairs the ability to breathe because of the accumulation of fat tissue around the ribs, the diaphragm, and the abdomen (Parameswaran et al., 2006). In most obese people, this effect is mild, but in those with severe obesity, it can be a significant health problem (Poulain et al., 2006). Severely obese people are

especially likely to have trouble breathing while lying down; this is believed to be due to a reduction in the amount of air that can enter the lungs because of pressure from the abdomen, which is very enlarged in severe obesity (Ferretti et al., 2001). Obesity increases the work of breathing especially while lying down; this results in shallower breaths.

Obese people have a lower capacity for exercise than normal-weight people do. Impaired respiratory function plays a role here, along with a variety of non-respiratory-related factors such as loss of muscle, increased friction at skinfolds where areas of skin and fatty tissue overlap, and increased joint pain (Parameswaran et al., 2006). The impairment of respiratory function in obese people may contribute to a vicious cycle; shallower breaths caused by obesity may lead to shortness of breath, which prompts a person to exercise less, which in turn may contribute to a further increase in obesity.

Research has shown a clear link between obesity and shortness of breath. For example, in one study of elderly people — an age group in whom shortness of breath is common and has an important adverse effect on the quality of life — two-thirds of those who were obese suffered from shortness of breath, compared to only about one-third of those who were not obese (Ho et al., 2001). Shortness of breath linked to obesity is not limited to the elderly, however. In a study of generally healthy middle-aged obese men, the majority experienced shortness of breath despite the absence of any evidence of lung disease, and shortness of breath was more common in those with higher BMIs (near 40) than in those with lower BMIs (low 30s) (Sahebajami, 1998).

## **OBESITY AND ASTHMA**

Obesity and asthma often coexist. Epidemiological studies conducted in a wide variety of populations from around the world have consistently shown an increased prevalence of asthma among obese and overweight individuals, as compared to those of normal weight (Ford, 2005; Shore and Johnston, 2006). However, it has been difficult for researchers to determine whether obesity actually plays a role in causing asthma.

One factor that has made investigation of the relationship between obesity and asthma difficult is that obesity is known to cause respiratory symptoms such as shortness of breath. Obese people who have these symptoms sometimes believe that they have asthma, but their conditions may not fit the technical definition of asthma (Beuther et al., 2006). For this reason, studies that rely on obese people's self-reports of whether they have asthma may reach incorrect conclusions.

Another factor that has made investigation of the relationship between obesity and asthma difficult is that a causal relationship between these two conditions could operate in either direction. While obesity may contribute to the causation of asthma,

it is also plausible that asthma may contribute to the causation of obesity. Asthma symptoms can limit physical activity, and a lack of physical activity can promote weight gain (Weiss and Shore, 2004).

Despite these complicating factors, however, recent research has supported the concept that obesity does indeed contribute to the causation of asthma. A combined analysis of seven large studies indicated that the likelihood of developing asthma for the first time in adulthood is greater for overweight and obese people than for normal-weight people, with higher risks of asthma for people with higher body mass indexes (BMIs) (Beuther and Sutherland, 2007). Since the participants in these studies were overweight or obese before they developed asthma, their obesity could not be the result of having asthma. Several studies in children have also shown that obesity often occurs first, with asthma developing later (Weiss and Shore, 2004). For example, in one study in which children who were asthma-free during their first two years of life were weighed at age two years and then followed for 14 years, a higher proportion of boys with BMIs above the 85th percentile developed asthma, as compared to boys with lower BMIs; no significant relationship was detected in girls in this study, however (Mannino et al., 2006).

Obesity is believed to play a role in asthma severity and may influence the response to asthma medicines (Shore, 2007). Weight reduction in obese people with asthma has been shown to improve lung function and to decrease the need for asthma medication (Stenius-Aarniala et al., 2000).

The biological basis for the relationship between obesity and asthma has not been established, but several mechanisms have been proposed (Shore, 2007). First, obesity and asthma may share a common genetic basis or may both be promoted by common events occurring during fetal life. Second, obesity may increase the risk of asthma through its effects on other disease processes, such as sleep apnea or

gastroesophageal reflux disease, both of which are promoted by obesity and are linked to increased asthma risk. Third, obese people tend to breathe in a rapid shallow pattern, probably as a result of reduced lung volume; this breathing pattern may promote narrowing of the airways. Finally, substances called adipokines, which are produced by body fat, may promote the development of asthma. There is some scientific evidence in favor of each of these possible mechanisms, but further research is needed to clarify the matter.

## SLEEP APNEA

How do you think you would feel in the daytime if your sleep was disturbed 100 times or more every night?

That's the way people with sleep apnea feel, although they may not know why.

Sleep apnea is a condition in which people stop breathing repeatedly, usually for periods of 10 to 30 seconds, while they are asleep. Each time this happens, the brain responds to the resulting drop in oxygen level by rousing the person briefly so that breathing will resume. In some people with sleep apnea, this cycle occurs hundreds of times during the night, leading to very fragmented sleep. However, because people with sleep apnea may not wake up completely, they may be unaware that their sleep was interrupted. What they are aware of is daytime sleepiness — which may be so severe in some cases that they fall asleep while working, talking, or driving. If they share a bedroom with another person, they may also be aware — because their partner has told them so — that they snore heavily and perhaps also that they make unusual choking or gasping noises while sleeping.

There are two different types of sleep apnea. In the more common type, called obstructive sleep apnea, either the tongue or redundant or thickened tissue at the back of the throat blocks the airway during sleep. In the less common type, called central sleep apnea, the problem is not in

the airway but in the brain, which fails to signal the need to breathe. The obstructive type of sleep apnea is the type that is linked to obesity.

The exact mechanism by which obesity promotes obstructive sleep apnea has not been established, but one possible explanation is that the upper airway is narrowed in obese people as a result of increased fat deposition in the neck, surrounding the airway (Arias et al., 2005; Deegan and McNicholas, 1995). In addition, obese people often have smaller lung volumes than normal-weight people do, which can indirectly influence upper airway size and contribute to narrowing of the airway (Deegan and McNicholas, 1995). Obesity may also cause changes in muscle tone in the airway that promote sleep apnea (Arias et al., 2005).

Estimates of the number of people who have sleep apnea vary, partly because many cases go undiagnosed and partly because there is disagreement on how to classify mild cases (those where interruptions in breathing occur only a few times nightly and where symptoms such as daytime sleepiness are absent). As many as 4 percent of middle-aged men and 2 percent of middle-aged women have sleep apnea that is severe enough to produce symptoms (Victor, 1999; Young et al., 1993). The number of people who show some breathing abnormalities during sleep when evaluated in a sleep laboratory is greater — about 24 percent of men and 9 percent of women (Young et al., 1993).

Obesity is an important risk factor for obstructive sleep apnea. It has been estimated that roughly 58 percent of all cases of moderate to severe sleep apnea are attributable to excess weight (Young et al., 2005). Studies in the United States, Europe, Asia, and Australia have consistently shown that the prevalence of sleep apnea increases as BMI, neck girth, and other measures of body size increase (Young et al., 2005). It has been suggested that differences in body shape and patterns of fat accumulation may contribute to the

higher risks of sleep apnea in men than in women and in postmenopausal women than in premenopausal women (Young et al., 2005). Weight gain is associated with an increase in the severity of sleep apnea (severity is assessed by the number of apnea events [pauses in breathing] per hour), and weight loss is associated with a reduction in severity (Charuzi et al., 1992; Young et al., 2005).

Sleep apnea can lead to significant problems in daytime functioning (Young et al., 2004). The daytime sleepiness that is characteristic of sleep apnea is associated with an increased risk of motor vehicle crashes resulting from falling asleep behind the wheel. Sleep apnea can also lead to psychosocial problems, impairment of the ability to concentrate and pay attention, and a reduced quality of life (Aloia et al., 2004; Young et al., 2004).

Sleep apnea is also associated with increased risks of diabetes, hypertension (high blood pressure), coronary artery disease, heart attack, congestive heart failure, and stroke (Victor, 1999; Young et al., 2004). All of these diseases, like sleep apnea, are linked to obesity, so their occurrence in the same individuals may reflect the fact that they have a risk factor in common with sleep apnea. However, in some instances, the connection with sleep apnea may be more direct. Sleep apnea causes changes in physiological pathways, such as activation of the sympathetic nervous system, that may carry over into the daytime hours (Caples et al., 2005). These changes may cause or exacerbate chronic diseases.

There is evidence that obstructive sleep apnea contributes to obesity-related hypertension (Wolk et al., 2003). In fact, one study showed that successful treatment of sleep apnea (using positive-pressure devices that help keep the airway open during sleep) in obese people who have hypertension that is resistant to drug therapy can sometimes make it possible for the hypertension to be treated success-

fully (Goodfriend and Calhoun, 2004).

The possibility that sleep apnea is an independent risk factor for heart disease (meaning a factor that influences risk by itself, not merely because of its association with other risk factors) is currently being investigated (McNicholas et al., 2007). One study has already shown that among people with severe obesity, those with severe sleep apnea were more likely to have heart rhythm abnormalities detectable on an electrocardiogram (Valencia-Flores et al., 2000), and another study has found a higher rate of heart attacks in people with untreated severe obstructive sleep apnea, as compared with untreated people with mild sleep apnea, patients treated for sleep apnea, or normal individuals (Marin et al., 2005).

Sleep apnea also appears to be an independent risk factor for insulin resistance, a precursor of diabetes mellitus; among people with the same BMI, those with sleep apnea have a higher risk of insulin resistance (Pack, 2006). When sleep apnea is treated successfully, insulin sensitivity may improve (Pack, 2006). Interactions have been reported between sleep apnea, insulin resistance, and various hormones, including hormones released from fat cells (Young et al., 2005); these findings suggest that sleep apnea may be related to the metabolic syndrome (see Chapter 3).

Considering how commonly sleep apnea occurs, it may be surprising that its existence was not recognized until 1965 (Pack, 2006). However, by the late 19th century, physicians had recognized an association between obesity and extreme excessive sleepiness. This phenomenon was sometimes described as "Pickwickian syndrome," a term that refers to a description of a sleepy fat boy in Charles Dickens' *The Pickwick Papers*. It is likely that the sleepy fat people whom 19th-century doctors diagnosed with Pickwickian syndrome were in fact suffering from sleep apnea.

The term “Pickwickian syndrome” is still used today, but in current usage, it has come to have a more specific meaning, referring to obese people who not only have daytime sleepiness but also experience inadequate breathing while awake (Pack, 2006). In this condition, more accurately known as “obesity hypoventilation syndrome,” extremely obese people take shallower breaths than normal and may actually not be getting enough oxygen in their blood, which over the long term can promote heart failure.

## SUMMARY

Obesity impairs the ability to breathe — an effect that is clinically significant in massively obese people. The common symptom of shortness of breath is more prevalent in obese people than in those of normal weight. Obesity and asthma often coexist, and increasing evidence indicates that obesity may cause or contribute to asthma. Obesity is a major risk factor for sleep apnea, which is associated with daytime sleepiness and an increased risk of motor vehicle crashes and may also be an independent risk factor for hypertension, heart disease, and insulin resistance.

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## CHAPTER



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### Cancer

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**When people think of serious health problems linked to obesity, they usually focus on cardiovascular disease and diabetes.**

But obesity is also linked to an increased likelihood of developing cancer — and this is not as well known (McMillan et al., 2006). A survey of the American public by the American Cancer Society found that less than 5 percent of respondents knew that overweight and obesity are associated with increased cancer risk (McMillan et al., 2006). Obesity is an important risk factor for several types of cancer, including colorectal cancer and breast cancer — two of the most common types of cancer in Western countries.

Obesity may contribute to the causation of cancer by several mechanisms. One of these involves insulin. There is evidence that links insulin resistance, which often accompanies obesity, with increased cancer risk (Bordeaux et al., 2006). Insulin influences cell growth and inflammation in several ways, some of which may promote cancer. One potential mechanism involves promoting the production of a substance called IGF-1 (for insulin-like growth factor 1), which has been shown to stimulate cell proliferation and inhibit cell death in labora-

tory studies (Bordeaux et al., 2006). Increased cell proliferation and decreased cell death can promote the development of cancer, which involves uncontrolled cell growth. Several studies have shown that obese people have higher-than-usual levels of the biologically active form of IGF-1 in their blood (Frystyk et al., 1995; Nam et al., 1997); this may contribute to their increased risk of cancer.

Increased inflammation may also be important. Adipose tissue (body fat) is a source of substances that promote inflammation, and chronic inflammation has been associated with increased cancer risk (Bordeaux et al., 2006; McMillan et al., 2006).

In women, obesity may promote cancer by increasing the amount of female sex hormones in the bloodstream. Cells in body fat produce estrogen; in fact, body fat is a major source of estrogen production in postmenopausal women. Like estrogens from medical sources, estrogens from body fat may increase the risk of several types of

cancer in women, including breast cancer and endometrial cancer (cancer of the lining of the uterus) (Bordeaux et al., 2006; Bray, 2004).

Another reason that obese people may be more likely to die from cancer is that they often get less frequent — or less effective — cancer screening (Bordeaux et al., 2006). Recent studies have indicated that severely obese people are less likely than other groups to be screened for colorectal cancer (Rosen and Schneider, 2004), and that obese women are less likely than others to have Pap smears to screen for cervical cancer and mammograms to screen for breast cancer (Wee et al., 2000). Doctors may not refer their obese patients for cancer screening tests as often as they do with other patients because they are busy treating the consequences of obesity, and patients who are referred may be too embarrassed to go for the tests because of problems such as difficulty fitting on examining tables (Bordeaux et al., 2006). Also, for technical reasons, obesity may make some kinds of cancer screening more difficult. For example, pelvic exams in women and digital rectal exams in men are more difficult and less informative in obese patients (Bordeaux et al., 2006).

Obese people also may not fare as well as others do during cancer treatment. Cancer may be harder to treat in obese people because surgical procedures are technically more challenging and because of difficulties in determining appropriate doses of chemotherapy and radiation (Bordeaux et al., 2006). For some types of cancer, obese people are at increased risk of recurrence and have lower survival rates (McTiernan, 2005). This may be due to increased levels of circulating sex hormones, increased levels of insulin, reduced immune functioning, effects of diet, effects of substances such as leptin that are produced by body fat cells, and other mechanisms, as well as difficulties with treatment (McTiernan, 2005).

Cancer is the second-leading cause of death in the United States. It has been

estimated that obesity may account for 14 percent of cancer deaths in men and 20 percent in women (Bordeaux et al., 2006). Overweight and obesity are believed to be responsible for approximately 90,000 deaths from cancer per year in the United States (Rubenstein, 2005). Among severely obese people (those with body mass indexes [BMIs] greater than 40), cancer death rates in one large study were 52 percent higher in men and 62 percent higher in women, in comparison with rates among people of normal weight (Calle et al., 2003). People with lesser degrees of obesity (BMI between 30 and 40) also had elevated cancer death rates, but the increase was not as drastic as in those with extremely high BMI values.

## TYPES OF CANCER MOST STRONGLY LINKED TO OBESITY

There is strong scientific evidence linking obesity with an increased risk of cancers of the endometrium (uterine lining), colon/rectum, esophagus, breast (in postmenopausal women and probably in men), kidney, and gallbladder, as described below.

### ***Endometrial Cancer***

One of the cancers most strongly associated with obesity is cancer of the endometrium (the lining of the uterus). In fact, this was the first type of cancer that was recognized as being related to obesity (Calle and Kaaks, 2004). In technologically developed countries, at least 40 percent of all cases are attributable to excess body weight (Kaaks et al., 2002). A recent meta-analysis (combined statistical analysis) of studies of endometrial cancer from several countries showed a strong relationship between greater BMI and greater likelihood of developing endometrial cancer (Renehan et al., 2008). In various studies, obesity has been associated with a twofold to fivefold increase in the risk of endometrial cancer in both premenopausal and postmenopausal women (Kaaks et al., 2002). Within the obese range, there is an almost linear increase in the risk of endometrial cancer with increasing BMI (Rubenstein, 2005; Kaaks et al., 2002).

Gaining weight during adulthood is also associated with an increased risk of endometrial cancer (Trentham-Dietz et al., 2006).

Most women who develop endometrial cancer are older and postmenopausal, but between 5 and 30 percent of endometrial cancers occur in younger, premenopausal women. Obesity seems to be especially important in these younger patients; in one group of young women with this disease, 58 percent had a BMI of 30 or greater, and the average BMI of the whole group was 34 (Soliman et al., 2005).

One explanation for the increased risk of endometrial cancer in obese women or those who gain weight is the increased production of estrogens by body fat cells (Bray, 2004).

Obese women with endometrial cancer may not survive as long as normal-weight women with the same disease do. For example, in one recent study, among a group of women diagnosed with endometrial cancer, those who were obese (BMI 30 or more) were twice as likely to die of their disease during a nine-year follow-up period than were those of normal weight (BMI less than 25) (Chia et al., 2007).

### **Colorectal Cancer**

Epidemiological studies have consistently associated obesity with an increased risk of colorectal cancer (Calle and Kaaks, 2004; Moghaddam et al., 2007). A recent meta-analysis of multiple studies found a strong relationship between higher BMI and higher risk of colon cancer in men, with weaker associations between higher BMI and higher risk of rectal cancer in men and between BMI and higher risk of colon cancer in women (Renehan et al., 2008). Another recent meta-analysis has estimated that people with a BMI of 30 or higher have a 19 percent higher risk than those with a BMI of less than 25 of developing colorectal cancer (Moghaddam et al., 2007). Previous analyses had produced higher estimates — in the range of 30 to 60

percent; the difference may reflect special efforts taken in the most recent analysis to correct for publication bias (the trend that studies with positive results are more likely than those with negative results to be published in the scientific literature).

Obesity is associated with a higher risk of colorectal cancer in men than in women (Calle and Kaaks, 2004; Moghaddam et al., 2007). The reasons for the sex difference are unclear, but researchers have speculated that the typical distribution of body fat in men is more harmful than that in women and that the increased levels of the female hormone estrogen present in obese women might offset some of the effect of obesity on colorectal cancer risk (Calle and Kaaks, 2004; Doria-Rose et al., 2006). Among women, obesity is a weaker risk factor for those who are postmenopausal than those who are premenopausal (Frezza et al., 2006). This observation is consistent with a possible protective effect of estrogen; in premenopausal women, the ovary is the main producer of estrogen, and body fat plays a lesser role, but in postmenopausal women, body fat is the major estrogen source. Thus, the quantity of body fat has more of an effect on total estrogen levels after menopause than before.

It is not always possible for researchers to distinguish between colon cancer and rectal cancer in their studies, but in instances where such a distinction has been made, obesity has been linked primarily to colon cancer rather than rectal cancer (Calle and Kaaks, 2004).

Obesity may influence colon cancer by multiple mechanisms, but the best established effect is that of insulin (Frezza et al., 2006). Insulin is associated with colon cancer risk, and obese people have higher insulin levels and are more likely than people of normal weight to have insulin resistance or diabetes. Leptin, a substance released by fat cells, may also play a role, and physical inactivity may also be important (Frezza et al., 2006).

As is also true for some other types of cancer, obesity has been associated with a poorer prognosis in colon cancer patients, especially women. Several studies in which data were collected on colon cancer patients for about 10 years after diagnosis have shown that women patients who were obese were more likely than those of normal weight to die during the follow-up period; findings have been less consistent for men, however (Meyerhardt et al., 2003; Dignam et al., 2006; Doria-Rose et al., 2006).

### ***Esophageal Cancer***

The International Agency for Research on Cancer estimates that 37 percent of all cancers of the esophagus are due to overweight and obesity (Stein and Colditz, 2004). Obesity, however, is only associated with one of the two main types of esophageal cancer, esophageal adenocarcinoma; it does not appear to be a factor in the other type, squamous cell carcinoma, which is linked to cigarette smoking and excess alcohol intake. A combined analysis of studies in several different population groups indicated that a BMI of greater than 30 is associated with a risk of esophageal adenocarcinoma almost triple that of normal-weight people (Hampel et al., 2005). A recent meta-analysis of studies of esophageal adenocarcinoma from several countries showed a strong relationship between greater BMI and greater likelihood of developing this type of cancer in both men and women (Renehan et al., 2008).

The link between obesity and esophageal adenocarcinoma might be mediated by gastroesophageal reflux disease (GERD) (see Chapter 8). GERD is more common among obese people than lean people, and GERD and its complications, such as Barrett's esophagus (a condition involving abnormal cell changes in the lower esophagus caused by repeated exposure to stomach acid), may promote the development of this type of cancer (Hampel et al., 2005).

In recent decades, rates of squamous cell carcinoma of the esophagus have been declining, while rates of adenocarcinoma of the esophagus have been increasing, both in the United States (Brown and Devesa, 2002; Crew and Neugut, 2004) and in other parts of the world (Fernandes et al., 2006; Bosetti et al., 2008). Decreases in cigarette smoking may be responsible for the former trend, and increases in obesity may be a contributing factor in the latter.

### ***Female Breast Cancer***

Breast cancer is the most common type of cancer among American women and the second-leading cause of cancer death in women (after lung cancer) (American Cancer Society, 2007). The risk of breast cancer increases with age, with most cases occurring in postmenopausal women.

Obesity has been consistently associated with a 30 to 50 percent increase in the risk of breast cancer in postmenopausal women (Calle and Kaaks, 2004). This effect is not seen in premenopausal women, however, in whom obesity may even be associated with decreased breast cancer risk (Dumitrescu and Cotarla, 2005). Weight gain in adulthood is associated with increased breast cancer risk in postmenopausal women and may actually be more important than BMI (Calle and Kaaks, 2004; Dumitrescu and Cotarla, 2005).

The relationship between obesity and postmenopausal breast cancer is believed to be mediated at least in part by estrogen, which is produced in greater quantity in obese postmenopausal women than in those of normal weight (Calle and Kaaks, 2004). Other factors, such as insulin, may also be involved.

Obesity is associated with a poorer prognosis in women with breast cancer (Carmichael, 2006). Obese women have a greater likelihood of recurrence of breast cancer and a reduced survival rate (Calle and Kaaks, 2004; McTiernan, 2005). The higher death rate from breast cancer in obese women may be due partly to delayed

diagnosis, since obese women are less likely than normal-weight women to have mammograms regularly (Calle and Kaaks, 2004). However, experts believe that there is a real biological effect on survival and recurrence as well. At least 26 scientific studies have found higher rates of breast cancer recurrence and/or shorter survival times among breast cancer patients who were overweight or obese, as compared to those of normal weight (McTiernan, 2005). Most recently, a study from the University of Texas M.D. Anderson Cancer Center found that among women with locally advanced breast cancer, those who were overweight or obese at the time of diagnosis had shorter survival times and higher recurrence rates, when compared with normal weight and underweight patients (Dawood et al., 2008).

### **Male Breast Cancer**

Breast cancer is a rare disease in men; less than 1 percent of all breast cancer patients are male. The limited evidence currently available indicates that obesity is an important risk factor for male breast cancer; it doubles a man's risk of this disease (Fentiman et al., 2006). The mechanism probably involves the female hormone estrogen; obese men produce more of this hormone, which promotes breast cancer, than normal-weight men do.

### **Kidney Cancer**

Epidemiological studies have shown that the risk of kidney cancer (renal cell cancer) is 1.5 to 3 times higher in overweight and obese people than in those of normal weight (Calle and Kaaks, 2004; Luo et al., 2007). It has been estimated that obesity may account for 25 to 30 percent of all kidney cancers (Stein and Colditz, 2004; Lipworth et al., 2006). High blood pressure, which is associated with obesity, is known to be a risk factor for this type of cancer, but obesity also seems to have an effect on kidney cancer risk that is unrelated to blood pressure (Calle and Kaaks, 2004). The mechanism of this effect has not been established.

A recent study of obesity and kidney cancer, which involved a large group of postmenopausal U.S. women, indicated that central obesity (the type characteristic of the metabolic syndrome) and weight cycling (repeated gain and loss of weight), as well as obesity in general, are associated with increased kidney cancer risk (Luo et al., 2007). A recent meta-analysis of studies of renal cancer from several countries showed a strong relationship between greater BMI and greater likelihood of developing kidney cancer in both men and women (Renehan et al., 2008).

### **Gallbladder Cancer**

Gallbladder cancer is relatively rare in the United States but is common in some areas of South America and India and some central European countries. The association of gallbladder cancer with obesity is one of the strongest seen for any cancer site. It is believed to be mediated at least in part by gallstones. Obese people have an increased risk of developing gallstones (see Chapter 8), and people with gallstones have an increased risk of gallbladder cancer (Randi et al., 2006).

A recent meta-analysis of studies of gallbladder cancer from several countries showed a strong relationship between greater BMI and greater likelihood of developing this cancer in women (Renehan et al., 2008). In men, however, the association was weaker. The number of sets of data included in the analysis for gallbladder cancer was small, and no North American data were included.

## **OTHER TYPES OF CANCER THAT MAY BE LINKED TO OBESITY**

In addition to the types of cancer discussed above, there are several other types where a smaller or less consistent body of scientific evidence indicates that obesity may play a role. In some of these instances, obesity may have more influence on the progression of the disease than on its occurrence, or obesity may only be relevant under specific circumstances. These include cancers of the prostate,

pancreas, ovary, and liver, as well as one type of stomach cancer.

### **Prostate Cancer**

Epidemiologic studies of obesity and prostate cancer have had inconsistent results, with some studies indicating that obese men have a small increase in risk of this cancer, while others have shown no relationship (Calle and Kaaks, 2004). However, although it is unclear whether obesity is related to prostate cancer in general, there is substantial evidence indicating that obesity is associated with more severe prostate cancers.

For example, in one study of men who had been diagnosed with prostate cancer, those who were obese were more than three times as likely to develop metastatic cancer and more than twice as likely to die of prostate cancer than those of normal weight (Gong et al., 2007). In another study, obesity was associated with an increased risk of dying of prostate cancer but not with an increased risk of developing the disease (Wright et al., 2007). In a study that analyzed data from a group of men who had undergone prostate biopsies, obese men were more likely than normal-weight men to be diagnosed with high-grade prostate cancer (a more advanced cancer that is more likely to be fatal) but less likely to be diagnosed with low-grade cancer (Gong et al., 2006). In a study of men who had undergone surgery for prostate cancer, those who were very obese were more likely to have a recurrence of their cancer (Bassett et al., 2005). In two large studies conducted by the American Cancer Society, which looked only at cancer deaths, not at the diagnosis of the disease, obese men (BMI 30 or more) were found to be more than 20 percent more likely than those of normal weight (BMI less than 25) to die of prostate cancer (Rodriguez et al., 2001). These findings and others like them indicate either that obesity is associated with an increased risk of developing the more aggressive types of prostate cancer or that obesity somehow worsens the prognosis of prostate cancer after it has developed.

Also, because digital rectal exams, one of the methods used for screening for prostate cancer, are more difficult to perform in obese men, prostate cancer may not be detected in these men until it has reached more advanced stages, when it is more difficult to treat successfully.

### **Pancreatic Cancer**

Several recent epidemiological studies have indicated that obesity is associated with a doubling of the risk of pancreatic cancer, but other, earlier studies did not show this association (Calle and Kaaks, 2004). The disagreement among the findings of different studies might reflect the difficulty in obtaining information in epidemiologic studies of pancreatic cancer. In most epidemiologic studies, information is obtained by interviewing patients, but pancreatic cancer is so rapidly fatal that it is often necessary to interview patients' family members, who may be less accurate sources of information than patients themselves would be.

If a relationship exists between obesity and pancreatic cancer, it might be mediated by diabetes mellitus, which is more common among obese people and is associated with increased pancreatic cancer risk. However, the relationship between diabetes and pancreatic cancer is controversial, with some scientists claiming that diabetes is a risk factor for pancreatic cancer while others contend that it is actually an early symptom of the disease; in its very early stages a developing pancreatic cancer could modify insulin secretion by the pancreas, causing diabetes to develop before cancer is diagnosed (Calle and Kaaks, 2004; Qiu et al., 2005).

In the most recent major study of obesity and pancreatic cancer, conducted by the National Cancer Institute, researchers investigated the relationship between obesity and pancreatic cancer risk in follow-up data from a group of almost 500,000 people who had completed a health questionnaire about five years earlier. The results showed that among nonsmokers, those who were severely obese (having a BMI of 35 or



more) had a 45 percent greater pancreatic cancer risk than those with BMI values in the normal range (between 18.5 and 25) (Stolzenberg-Solomon et al., 2008). No effect was seen in smokers, perhaps because smoking is a stronger risk factor for pancreatic cancer than obesity seems to be (smoking is associated with a 1.9-fold to 5.5-fold increase in pancreatic cancer risk [Fuchs et al., 1996]), and smoking is also associated with lower BMI. Thus, the effect of smoking on pancreatic cancer risk and weight might have obscured any smaller effect of obesity.

### **Ovarian Cancer**

Researchers conducting a large epidemiological study of female U.S. nurses found that a high BMI at age 18 was associated with an increased risk of developing ovarian cancer during the premenopausal years (Fairfield et al., 2002). However, recent weight and weight gain during adulthood were not associated with increased risk. The researchers speculated that the increased risk for those who were obese in late adolescence might be attributable to alterations in hormone levels, such as an increase in androgens (male sex hormones), in obese adolescent women.

Obesity in adulthood has not been consistently associated with ovarian cancer in epidemiologic studies.

### **Liver Cancer**

A limited amount of evidence indicates that obesity may be associated with an increased risk of liver cancer (hepatocellular carcinoma) (Qian and Fan, 2005). Nonalcoholic liver disease, which is common among obese people, especially severely obese people (see Chapter 8), may play a role here. This liver disease can lead to cirrhosis, and cirrhosis can progress to liver cancer.

### **Stomach Cancer**

One type of stomach cancer, adenocarcinoma of the gastric cardia (the upper part of the stomach, where the esophagus

enters the stomach), is very similar to esophageal adenocarcinoma, which has been clearly linked to obesity. Obesity appears to be associated with an increase in risk of this type of stomach cancer, but the magnitude of the increase and the strength of the evidence are not as strong as for esophageal adenocarcinoma (Calle and Kaaks, 2004). Obesity is not associated with other types of stomach cancer (Calle and Kaaks, 2004).

### **Multiple Myeloma**

Multiple myeloma is a cancer of the bone marrow involving plasma cells, a type of white blood cell that plays a role in the body's immune system. Multiple myeloma is an uncommon cancer, accounting for about 1 percent of all cancers in the United States, and it is more common among those of African-American or Hispanic heritage than among white Americans (Birmann et al., 2007). Multiple myeloma is more likely to occur in men than in women, and the risk of this cancer increases with advancing age. Not much is known about possible risk factors for multiple myeloma other than gender, age, and ethnicity.

A recent study of two very large groups of American men and women indicated that those with high BMI, especially BMI values in the obese range, have a higher risk of multiple myeloma than those with lower BMI values do (Birmann et al., 2007). The people included in this study were mostly white, however, so it is unclear whether the findings are applicable to other, higher-risk ethnic groups. Several previous studies, conducted mostly but not entirely in white populations, have also suggested a link between obesity and an increased risk of multiple myeloma (Blair et al., 2005; Calle et al., 2003; Oh et al., 2005), and plausible biological mechanisms for such an association have been proposed (Birmann et al., 2007).

### **Non-Hodgkin Lymphoma**

Several recent studies have suggested that people who are obese, especially those who are severely obese, may be at a slightly increased risk of non-Hodgkin

lymphoma (Chiu et al., 2007; Lim et al., 2007; Skibola et al., 2007), and a meta-analysis of multiple studies (Larsson and Wolk, 2007) has confirmed this association. However, the increase in risk associated with obesity is small, and scientists are uncertain whether the relationship is causal. Thus, the evidence should be regarded as suggestive rather than conclusive.

### ***Thyroid Cancer***

A recent meta-analysis of studies of thyroid cancer from several countries showed a strong relationship between greater BMI and greater likelihood of developing this type of cancer in men and a weaker relationship in women (Renahan et al., 2008). These conclusions, however, were based on only five sets of data, none of which was from North America. The possible relationship between obesity and the risk of thyroid cancer has received little research attention, but the findings of this meta-analysis indicate that it should be investigated further.

obese patients have a poorer prognosis than those of normal weight (i.e., their cancers are more likely to recur or the patients are more likely to die). Physical activity, which also helps with weight control, may reduce the risk of some types of cancer, such as colon cancer.

## **SUMMARY**

Obesity is an important risk factor for cancer and may account for 14 percent of cancer deaths in men and 20 percent in women. Strong scientific evidence indicates that endometrial cancer, colorectal cancer, esophageal adenocarcinoma, postmenopausal breast cancer, kidney cancer, and gallbladder cancer are all linked to obesity. Obesity is also associated with an increased risk of aggressive or fatal prostate cancers, though it may not be associated with prostate cancer in general. Obesity may also be linked to cancers of the pancreas and liver and to one type of stomach cancer, adenocarcinoma of the gastric cardia. Obesity in youth may be associated with a greater risk of later development of ovarian cancer. New data suggest possible links between obesity and increased risks of multiple myeloma, non-Hodgkin lymphoma, and thyroid cancer. For several types of cancer, including cancers of the breast, endometrium, and colon in women, there is evidence that



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## CHAPTER



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### Effects of Obesity on Patients Undergoing Surgery or Anesthesia

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**Obesity is associated with an increased risk of complications in patients who have surgery or who undergo anesthesia or sedation for other purposes, such as diagnostic tests or dental procedures.**

In some instances, these risks may be a result of obesity itself; it is more difficult for surgeons and anesthesiologists to perform certain types of procedures on an obese body than on a normal-weight one. In other instances, the link between obesity and various complications may reflect the association between obesity and other disorders that increase surgical risk, such as diabetes. This chapter reviews the scientific evidence linking obesity to increased risk of various types of difficulties and complications during and after surgery. As will be discussed in this chapter, although obesity is associated with surgical complications, the presence of obesity does not justify avoiding needed surgery. Indeed, for some patients who are extremely obese, surgery, in the form of bariatric surgery, such as gastric (stomach) bypass or banding, may be a desirable form of treatment for obesity itself. However, obesity can make surgery more difficult and increase the resources needed for successful surgery.

#### **SURGICAL EQUIPMENT AND PROCEDURES**

One very basic issue that must be addressed with regard to severely obese patients is the operating environment itself. Special equipment may be needed for larger patients to avoid safety risks for the patient and staff (Adams and Murphy, 2000). Extra personnel may be needed to lift the obese patient safely. Excessive fatty tissue may make inserting intravenous lines difficult. Even measuring blood pressure may be difficult — normal-sized blood pressure cuffs may give inaccurate readings, and special equipment designed for larger patients may be needed (Adams and Murphy, 2000).

Surgical procedures on obese patients are more difficult to perform and therefore take longer. One analysis showed that in obese patients as compared to those of normal weight, gallbladder surgeries typically took 5 minutes longer, mastectomies (breast removal) typically took 24 minutes longer, and surgeries on the colon (large intestine)

typically took 21 minutes longer (Hawn et al., 2005). In patients with extreme obesity, the extra time required to complete surgical procedures may be considerably longer than was observed in this study. Although the differences in time spent in the operating room may not mean much in terms of the experiences of individual patients, they are very important in terms of resource utilization, the workload of surgeons and other operating room personnel, and the overall cost of surgery.

## ANESTHESIA

The use of the breathing masks and tubes necessary for general anesthesia may be difficult in obese patients because of the shape of the face, cheeks, neck, tongue, and other relevant structures (Adams and Murphy, 2000). In addition, the use of general anesthetics can exacerbate the respiratory problems that are often present in severely obese people, leading to an increased risk of respiratory complications (Adams and Murphy, 2000; see Chapter 5 for a further discussion of respiratory problems in obese people).

Regional anesthesia (in which only one large part of the body is anesthetized, such as spinal or epidural anesthesia) is technically more challenging in obese patients than in those of normal weight because of difficulties in positioning patients correctly for the procedure, in finding the anatomic landmarks that indicate where the anesthetic should be injected, and in ensuring that the needle penetrates to the appropriate depth (Nielsen et al., 2005). In one large study of patients undergoing regional anesthesia in an outpatient surgery center, patients who were obese were more likely to experience failed anesthesia and had higher rates of some complications; however, the extent of the increase in risk was relatively small, and the researchers who conducted the study concluded that regional anesthesia is an appropriate technique for use in obese patients despite the potential for some difficulties (Nielsen et al., 2005).

Even sedation of patients for dental procedures can be more challenging if the patient is obese. In both adults and children, obesity is associated with an increased risk of obstructive sleep apnea (see Chapter 5), which can increase the likelihood of respiratory complications in sedated patients (Weaver, 2004; Baker and Yagiela, 2006).

## BLOOD CLOTS

Patients who have surgery, especially those who are unable to move around much after the operation, are at risk of developing harmful blood clots (deep-vein thrombosis). As was discussed in Chapter 4, obesity increases the risk of deep-vein thrombosis, and this is true after surgery as well as in other situations. The risk of deep-vein thrombosis in obese patients undergoing abdominal surgery is about twice that of lean patients, and the risk of pulmonary embolism (a blood clot that travels to the lung — a potentially very serious complication) is also doubled (Adams and Murphy, 2000). Obesity has also been reported to be a significant risk factor for deep-vein thrombosis in patients undergoing other types of surgery, including spinal surgery (Platzter et al., 2006), total hip or knee replacements (Mantilla et al., 2003), and other orthopedic surgeries (Bagaria et al., 2006; Guss and Bhattacharyya, 2006).

## INFECTIONS

Obese patients have an increased likelihood of experiencing infections following a variety of surgical procedures (Barber et al., 1995; Brown and Velmahos, 2006), including both surgical site infections (wound infections) and other types of infections, such as pneumonia or urinary tract infections (Brown and Velmahos, 2006). Factors contributing to the increased risk of surgical site infections include elevated blood glucose levels; poorer circulation of blood and oxygen; inadequate levels of antibiotics in the tissues; and lengthier surgical procedures, which may be necessary because of greater body size

or greater technical difficulties during surgery (Anaya and Dellinger, 2006). With certain specific types of surgery, additional factors may increase infection risk. For example, following total hip or knee replacement surgery, severely obese patients tend to have prolonged wound drainage; this not only increases the length of time they must spend in the hospital but also increases their risk of developing surgical site infections (Patel et al., 2007).

## MISCELLANEOUS AND OVERALL COMPLICATIONS

Many studies have found higher rates of total complications or of a variety of complications, not limited to those discussed above, in obese versus normal-weight patients undergoing many different types of surgery. For example, in an Australian study of patients undergoing heart surgery, those who were obese (BMI >30) had higher rates of kidney failure, and those who were extremely obese (BMI >40) also had higher rates of readmission to intensive care, a longer need for mechanical breathing assistance, and longer hospital stays (Yap et al., 2007). In a U.S. study of patients who underwent pancreas transplants, those who were obese had a higher rate of overall complications after surgery (Hanish et al., 2005). The rate of wound-healing complications in patients who underwent kidney transplants was higher in those with higher BMI (Dean et al., 2004). In a Swedish study of patients undergoing total hip replacements, a high BMI was associated with an increase of between 4 and 7 percent in length of hospital stay, and the risk of complications was increased by 58 percent (Azodi et al., 2006). In a study of patients undergoing abdominoplasty ("tummy tuck" plastic surgery), complication rates of 33 percent, 35 percent, and 76 percent were reported in those who were normal-weight, overweight, and obese, respectively (Rogliani et al., 2006).

Thus, in a variety of types of surgery, increased difficulties and rates of complications have been reported in obese patients. However, experts agree that the extent of these problems is not sufficient to warrant advising obese patients to avoid surgery (Choban and Flancbaum, 1997). The overall scientific evidence does not indicate that obese are more likely than others to have unacceptable results from surgery, and the mortality (death) rate from surgery in obese patients does not appear to be higher (Choban and Flancbaum, 1997). Surgical procedures can usually be carried out safely and effectively on obese patients. Thus, although obese patients should be aware of the increased likelihood of complications from surgery, and although their surgeons and anesthesiologists should be prepared to cope with potential complications, people who are obese should not avoid having needed operations.

## SUMMARY

It is more challenging for surgeons to perform operations on obese patients, especially those who are extremely obese, than on patients of normal weight. Severe obesity poses practical issues in the operating room, where it may be necessary to use equipment specifically designed for very large individuals. Obese patients have higher risks of complications related to anesthesia, as well as higher risks of blood clots and wound infections after surgery. Research studies of a variety of types of surgical procedures have indicated that overall complication rates are higher in obese patients than in those of normal weight. However, the scientific evidence does not indicate that obese people are more likely than others to die as a result of surgery or to have unacceptable results from surgery.

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## CHAPTER



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# Obesity and Gastroenterology

**Gastroenterology is the medical specialty that deals with diseases of the digestive organs, including both the gastrointestinal tract itself (mouth, esophagus, stomach, small intestine, and large intestine) and the organs involved in the production and release of enzymes and hormones that participate in the digestive process (liver, gallbladder, pancreas).**

Obesity can promote several diseases of the digestive organs and is also associated with increased rates of some common gastrointestinal symptoms.

### GALLSTONES

The gallbladder stores and releases a digestive juice called bile into the small intestine; bile is produced in the liver and helps to digest fat. In the most common type of gallbladder disease, gallstones form when bile hardens into stones inside the gallbladder. Most gallstones are made primarily of cholesterol. Gallstones sometimes cause no symptoms, but in other instances they may cause attacks of severe abdominal pain. Symptomatic gallstones are usually treated by surgery to remove the gallbladder. Gallbladder surgery contributes substantially to health care costs; more than 700,000 such surgeries are performed each year in the United States, at a cost of approximately 6.5 billion dollars (Shaffer, 2006).

Overweight and obesity increase the risk of gallstones and the likelihood of needing gallbladder surgery, with the risk increasing as body mass index (BMI) increases (Dittrick et al., 2005). Compared to women whose weight is in the normal range, overweight women have almost twice the risk of developing gallstones, and obese women have nearly three times the risk (Stein and Colditz, 2004). Similar trends have been seen in men; however, in general, men have a lower risk of gallstones than women do (Stein and Colditz, 2004).

The link between obesity and gallstones is believed to be due to the effect of body fat on the turnover of cholesterol. People with more body fat produce proportionally more cholesterol than leaner people do. The extra cholesterol becomes a component of the bile in the gallbladder. When the ratio of cholesterol to other bile components (bile acids and phospholipids) is high, as it is in obese people, the likelihood that the cholesterol will solidify and form gallstones is increased (Bray, 2004).

The efforts that many obese people make to lose weight may also contribute to gallstone formation. During periods of dieting and rapid weight loss, the amount of cholesterol crystals in the bile increases. This thickens the bile and increases the likelihood that the crystals will easily stick together and form gallstones.

One recent study of a large group of U.S. men indicated that so-called weight cyclers (those who repeatedly lost and gained weight) had as much as a 50 percent greater likelihood of gallstone disease, in comparison with men who maintained a constant weight (Tsai et al., 2006). An earlier study had shown a similar risk associated with weight cycling among women (Syngal et al., 1999). Another group of people who are at increased risk for gallstones is those who lose large amounts of weight after undergoing bariatric (weight loss) surgical procedures, such as gastric (stomach) bypass surgery (Abell and Minocha, 2006; Kiewiet et al., 2006).

## PANCREATITIS

Pancreatitis is an inflammation of the pancreas, a gland behind the stomach that releases digestive enzymes into the small intestine and that releases the hormones insulin and glucagon into the bloodstream. Normally, the digestive enzymes inside the pancreas do not become active until they reach the small intestine, where they help to digest food. But in pancreatitis, they can become active inside the pancreas, where they can damage the pancreas itself. Pancreatitis can be either acute, with severe symptoms that last only for a short period of time, or chronic, causing gradual damage to the pancreas over a long period of time. Either form can have serious complications (National Digestive Diseases Information Clearinghouse, 2004b). The main symptom of pancreatitis is pain in the upper abdomen, which can be severe. Other symptoms can include nausea, vomiting, and fever. In severe cases, there may be bleeding in the pancreas, which can cause shock and even be fatal

(National Digestive Diseases Information Clearinghouse, 2004b).

Epidemiological research has shown an increased risk of pancreatitis in obese people (Torgerson et al., 2003). Obesity is also associated with increased severity of pancreatitis and an increased likelihood of developing complications or dying of pancreatitis (Papachristou et al., 2006; Martinez et al., 2004 and 2006).

One mechanism by which obesity may be linked to pancreatitis is through dyslipidemia (abnormal levels of cholesterol and related fat-like substances in the bloodstream). As discussed in Chapter 4, obese people have an increased risk of dyslipidemia, especially of excessively high levels of blood triglyceride and low levels of desirable high-density lipoprotein (HDL) cholesterol. Elevated levels of triglyceride — especially if the elevation is extreme — increase the risk of pancreatitis (Oh and Lanier, 2007; Yuan et al., 2007).

Another possible mechanism by which obesity might be linked to pancreatitis in some instances is through its association with gallstones. The presence of gallstones is a risk factor for acute pancreatitis but not for chronic pancreatitis.

## GASTROESOPHAGEAL REFLUX DISEASE (GERD)

Gastroesophageal reflux disease (usually abbreviated GERD) occurs when the muscular opening between the esophagus and the stomach relaxes at inappropriate times, allowing the very acidic contents of the stomach to leak back into the esophagus. The main symptoms of GERD are frequent heartburn and acid indigestion. Sometimes, GERD can cause serious complications. Inflammation of the esophagus can lead to bleeding or ulcers; scars from tissue damage can narrow the esophagus and make swallowing difficult; and esophageal changes that can lead to cancer may develop in some individuals. In addition, certain other health problems including asthma, chronic cough, and pulmonary fibrosis may

be aggravated or even caused by GERD (National Digestive Diseases Information Clearinghouse, 2003).

Physicians have long suspected that excess weight promotes GERD, and there is now scientific evidence to back up this belief. Epidemiologic studies have shown that increasing degrees of overweight or obesity are associated with an increasing risk of GERD (Dent et al., 2005; Nilsson and Lagergren, 2004), although not all obese people experience this problem. For example, one study showed that obese people are almost three times as likely as normal-weight people to experience GERD symptoms (Murray et al., 2003). The relationship between obesity and GERD is stronger in women than in men (Nilsson and Lagergren, 2004). Weight reduction appears to reduce the risk of GERD symptoms (Nilsson and Lagergren, 2004).

The mechanisms by which obesity promotes GERD are not clearly established, but some evidence indicates that obesity may exert its effect by increasing the likelihood of hiatal hernia, a condition in which the upper part of the stomach is above the diaphragm, instead of being below it, as is usually the case (Nilsson and Lagergren, 2004). The diaphragm usually helps to keep acid from coming up into the esophagus, but in the presence of hiatal hernia, the diaphragm is not an effective barrier, and acid may move up more freely.

Obese patients have increased intraabdominal pressure due to the accumulation of intraabdominal fat. This phenomenon can result in failure of the antireflux mechanisms in the esophagus and stomach. In addition, it is well known that obese patients have a higher incidence of abnormal motility (contractions) of the esophagus (Koppmann et al., 2007; Suter et al., 2004), which may worsen reflux symptoms.

GERD and heartburn occur in children as well as adults. In late 2007, the company Medco Health Solutions, Inc., which tracks U.S. prescription data, reported that the

number of young children taking prescription drugs for heartburn or GERD increased by about 56 percent between 2002 and 2006. It has been speculated that this change may be linked to increased overweight in children, which may place them at greater risk for GERD and heartburn. However, the fact that some of the drugs used in the treatment of these problems were approved for use in children during the time period studied may also be a contributing factor in their increased use.

## NONALCOHOLIC LIVER DISEASE

When people think about liver disease, they usually think of it as a problem that results from long-term abuse of alcohol. However, there is another type of liver disease, called nonalcoholic liver disease or nonalcoholic steatohepatitis, that resembles alcoholic liver disease but occurs in people who drink alcohol moderately or not at all. The liver stores fat, and excess fat storage can cause inflammation of the liver, which in turn can develop into the severe form of liver damage called cirrhosis. Nonalcoholic liver disease is a relatively common problem; according to the National Institutes of Health, about 2 to 5 percent of Americans have this disease, and another 10 to 20 percent have fat in their livers without any evidence of inflammation or liver damage (National Digestive Diseases Information Clearinghouse, 2006). Other estimates are higher, with some scientists contending that either fatty liver or more serious manifestations of nonalcoholic liver damage affect as many as one third of all American adults (Angulo, 2007; Yan et al., 2007). The differences in the estimates may reflect differences in the techniques used to determine whether the condition is present (Angulo, 2007). Since nonalcoholic liver disease usually does not cause symptoms in its early stages, many people who have it are unaware of it or learn of it only when diagnostic tests have abnormal results. In its later stages, however, nonalcoholic liver disease can be severe, progressing to potentially fatal cirrhosis (Collantes et al., 2004). Nonalcoholic liver disease is one of the

leading causes of cirrhosis, along with hepatitis C infection and alcoholic liver disease (National Digestive Diseases Information Clearinghouse, 2006).

Nonalcoholic liver disease is associated with insulin resistance and the metabolic syndrome, both of which, in turn, are associated with obesity (Adams et al., 2005; Diehl, 2004). The frequency of nonalcoholic liver disease in people who have diabetes and are severely obese is especially high, at about 50 percent (Adams et al., 2005). Insulin resistance increases the levels of free fatty acids in the blood; these fatty acids are taken up by the liver, where they increase the synthesis of fat (Adams et al., 2005); this is believed to be one of the mechanisms by which obesity and insulin resistance promote the development of liver disease. Weight loss may be helpful in the treatment of nonalcoholic liver disease (Adams et al., 2005; Hickman et al., 2004).

## GASTROINTESTINAL SYMPTOMS

In the past, some physicians speculated that obese people might experience fewer gastrointestinal symptoms than other people do, and that this lack of symptoms might be one of the factors that encourages overeating; however, this does not seem to be the case (Delgado-Aros et al., 2004). Several studies have indicated that increased body weight is actually associated with an increased risk of some common gastrointestinal symptoms. Whether this association reflects a cause-and-effect relationship is uncertain.

In one study, increasing BMI was associated with an increased likelihood of upper abdominal pain, bloating, and diarrhea in adults (Delgado-Aros et al., 2004). In a study of young adults, higher BMI was associated with diarrhea and with abdominal pain accompanied by nausea or vomiting (Talley et al., 2004). And in a study in children, a higher-than-usual prevalence of obesity was seen among children being treated for constipation (Pashankar and

Loening-Baucke, 2005). This observation in children differs from the findings of studies in adults, in which obesity was not associated with constipation (Delgado-Aros et al., 2004; Talley et al., 2004). In all of these studies, increased BMI was simply linked to a higher frequency of a problem; whether it actually contributed to causing the symptoms remains to be determined.

## SUMMARY

Obesity is associated with an increased risk of several diseases of the digestive tract, including gallstones, pancreatitis, GERD, and nonalcoholic fatty liver disease and cirrhosis. Increased body weight is also associated with an increased likelihood of some common gastrointestinal symptoms, including abdominal pain, nausea/vomiting, bloating, and diarrhea in adults, and constipation in children, although causal relationships with these symptoms have not been established.

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## CHAPTER

# 9

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### Effects on Musculoskeletal Disorders

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**Diseases of the bones, joints, and muscles may not attract as much attention as heart disease and cancer do, but they can have important effects on the quality of life.**

As will be discussed in this chapter, obesity can increase the risk or worsen the severity of some musculoskeletal disorders, especially osteoarthritis of the knee, but it may reduce the risk of one important bone disease, osteoporosis.

#### OSTEOARTHRITIS

Osteoarthritis is the most common type of arthritis. It is especially common among older people, but it can also occur in young people who have an injured or malformed joint. Approximately 21 million Americans — 12 percent of the population age 25 and older — have osteoarthritis (NIAMS, 2006).

In osteoarthritis, cartilage — the hard, slippery material that covers the ends of the bones in a joint and helps to absorb the shock of movement — breaks down and wears away, allowing the bones to rub together (NIAMS, 2006). Osteoarthritis causes pain and swelling in affected joints, accompanied by a reduced ability to move the joint. Eventually, it can lead to permanent joint damage, and joint

replacement surgery is often required to restore painless function.

Osteoarthritis occurs most often in the knees, hips, and hands. Painful changes can also occur in the neck and lower back, but they are not really thought of as osteoarthritis. For osteoarthritis at some sites, overweight or obesity is an important risk factor.

The evidence linking obesity with increased risk or severity of osteoarthritis is strongest for osteoarthritis of the knee. In a large U.S. national health survey, it was found that the risk of osteoarthritis of the knee was increased almost fourfold in obese women and almost fivefold in obese men with BMIs between 30 and 35, as compared with those with BMI values in the normal range (Anderson and Felson, 1988). Obese people are especially at risk of developing osteoarthritis in both knees (Wolff et al., 2006), and obesity is a risk factor for the worsening of knee osteoarthritis as well as for its initial occurrence (Powell et al., 2005).

Obesity has been shown to occur prior to the development of knee osteoarthritis. Thus, it is not just a result of reduced physical activity due to knee pain (although this can also happen) (Woolf et al., 2006). People who are overweight in their thirties are at increased risk of developing knee osteoarthritis when they reach their seventies (Woolf et al., 2006). A gain in weight during young adulthood may increase the risk of later knee osteoarthritis to a greater extent than constant overweight does; in one study in Finland, people who moved from the normal weight range to the overweight or obese range between the ages of 20 and 50 were more likely than those who were overweight throughout those years to need knee replacement surgery as a result of osteoarthritis (Manninen et al., 2004).

Experts believe that the principal mechanism by which obesity promotes knee osteoarthritis is through overloading of the knee joint during weight-bearing activities (Woolf et al., 2006). The knee is especially prone to such overloading because for each pound of additional body weight, the compressive forces across a crucial portion of the knee joint increase by four pounds (Hooper, 2006). This may explain why knee osteoarthritis is strongly associated with obesity but osteoarthritis of some other weight-bearing joints, such as the ankle, is not.

Mechanical factors may not be the only way in which obesity contributes to osteoarthritis. Some scientific evidence suggests that leptin, a protein produced by cells in body fat, may influence metabolism in both bone and cartilage and may play a role in the causation of osteoarthritis (Pottie et al., 2004; Powell et al., 2005).

The scientific evidence linking obesity with osteoarthritis of the hip is not as strong as the evidence for an association with knee osteoarthritis. However, the results of some scientific studies have pointed to an approximate doubling in risk for obese individuals as compared to those of normal weight (Lieveense et al., 2002). Obese

people may experience more symptoms than normal-weight people do from the same degree of hip osteoarthritis because of greater weight-bearing forces on the hip joint (Lieveense et al., 2002).

There is limited scientific evidence suggesting that obesity may be weakly associated with an increase in the risk of osteoarthritis of the hands (Woolf et al., 2006).

## OSTEOPOROSIS

Osteoporosis is a condition in which bone density decreases, leading to an increased risk of fractures. It is common among older people, especially postmenopausal women of Caucasian or Asian heritage. In general, larger people — those with higher body weight and higher BMI — have higher bone density (Felson et al., 1993; Marcus et al., 1994) and a lower risk of fractures (Margolis et al., 2000; Ensrud et al., 1997). Mechanical loading is an important contributor to this effect (Thomas and Burguera, 2002). Bearing a larger amount of weight increases bone mass; bearing less weight decreases it. This is why astronauts in a weightless environment and patients on prolonged bed rest lose bone mass. Becoming obese increases the amount of weight that a person bears; thus, obesity can protect against osteoporosis.

Whether obesity influences osteoporosis by mechanisms other than mechanical loading is controversial. Some scientific evidence suggests that leptin, which is produced by cells in body fat, may have effects that protect the bones (Thomas and Burguera, 2002). On the other hand, a recent study indicated that once the effects of mechanical loading are taken into account, having a greater amount of body fat may actually be linked to lower bone mass (Zhao et al., 2007).

Health experts do not recommend that people who are at risk for osteoporosis maintain a higher-than-normal body weight in an effort to protect their bones. They do advise avoiding underweight, which is associated with increased osteoporosis

risk, and they recommend taking other measures to protect the bones, including being physically active, getting adequate amounts of calcium and vitamin D, avoiding excessive alcohol intake, abstaining from cigarette smoking, and taking safety precautions to reduce the risk of falls and the resulting fractures (U.S. Department of Health and Human Services, 2004).

## VITAMIN D DEFICIENCY

Vitamin D is essential for skeletal health. Deficiencies of this vitamin can cause rickets, a disease involving soft bones and skeletal deformities, in children, and osteomalacia, a disease characterized by weak bones, bone pain, and muscle weakness, in adults (NIH Office of Dietary Supplements, 2005). Vitamin D also performs many other essential functions in the body in addition to its role in bone maintenance.

Obese people may be at increased risk of vitamin D deficiency because vitamin D is a fat-soluble substance that may concentrate in body fat and be stored there, thus reducing its availability to the body (Holick, 2007). Data from a large national survey have confirmed that blood levels of vitamin D are lower among obese people than among those of normal weight (Martins et al., 2007).

## OTHER CONDITIONS

There is only a limited amount of scientific evidence on the relationship between obesity and musculoskeletal conditions other than osteoarthritis and osteoporosis.

Obesity has been linked to an increased risk of rotator cuff tendinitis, a disorder of the shoulder. One study of patients who needed surgery to treat this condition indicated that the risk of rotator cuff tendinitis was approximately doubled for moderately obese people and quadrupled for those whose BMI was 35 or above (Wendelboe et al., 2004). However, the relationship between obesity and rotator cuff tendinitis

has not yet been confirmed in other studies. One way in which obesity might promote rotator cuff tendinitis is by making it necessary for people to use their hands to push out of a chair, an action that can be harmful to the shoulder (Hooper, 2006). In addition, atherosclerosis, which is common in obese people, may result in decreased blood flow to the rotator cuff, making it more susceptible to trauma (Hooper, 2006).

There is limited scientific evidence suggesting that obesity, especially severe obesity, may be associated with an increased risk of lower back pain (Hooper, 2006).

## SUMMARY

Obesity increases the risk of osteoarthritis, especially in the knee joint, but probably also in the hips and possibly in the hands. Obese people have a lower risk of osteoporosis and the resulting bone fractures than people with lower BMIs do, but experts do not advise people to maintain a higher-than-normal body weight to protect against bone fractures. Obesity has been associated with reduced blood levels of vitamin D, possibly reflecting the sequestration of this fat-soluble vitamin in body fat. The scientific evidence on the relationship between obesity and musculoskeletal conditions other than osteoarthritis and osteoporosis is limited.

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# CHAPTER



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## Obstetrics and Gynecology

**Obstetricians and gynecologists are physicians who specialize in pregnancy, childbirth, and disorders of the female reproductive system.**

This chapter will discuss the relationship between obesity and certain obstetric and female reproductive problems. Other issues pertaining to the female reproductive system are covered in other chapters: Chapter 6 discusses cancers of the female reproductive system and Chapter 16 discusses the relationship between obesity and the timing of puberty in girls. Disorders of the male reproductive system are discussed in Chapter 11.

### COMPLICATIONS OF PREGNANCY

Numerous scientific studies have associated overweight and obesity with an increased risk of several complications of pregnancy, including gestational diabetes, gestational hypertension (high blood pressure), preeclampsia (a complex condition involving high blood pressure in combination with other factors), cesarean delivery, and undesirably high infant birth weight (Andreasen et al., 2004; Baeten, 2001; Cedergren, 2004; Linne, 2004; Weiss et al., 2004). The likelihood of these complications increases with increasing

degrees of obesity (Cedergren, 2004; Weiss et al., 2004), and some of these complications may place the mother or infant at risk for additional problems. For example, both vaginal tearing during delivery and a serious problem called shoulder dystocia, in which the fetus's shoulder gets "stuck" during delivery, are more common when birth weight is abnormally high; since obese mothers are more likely than other mothers to give birth to unusually large infants, their risk of these complications is increased.

Both miscarriages and stillbirths occur more commonly among obese women than among normal-weight women (Andreasen et al., 2004; Cedergren, 2004; Linne et al., 2004). An increased risk of death during the early neonatal (newborn) period has also been reported (Cedergren, 2004). Infants born to obese mothers have a higher rate of congenital abnormalities (birth defects), especially neural tube defects (Andreasen et al., 2004); this may be at least partly attributable to poor control of blood sugar levels during pregnancy in

obese women (King, 2006). A recent study conducted at multiple sites in the United States indicated that obesity in the mother was associated with a small to moderate increase in the risk of seven types of structural birth defects (including heart defects and spina bifida) and a decreased risk of one type of birth defect (gastroschisis, in which the intestines protrude from the body near the umbilical cord) (Waller et al., 2007). The reasons for these effects have not been established.

Another important risk that obese women face during pregnancy is the risk of giving birth to a child who will also become obese. Multiple scientific studies have shown that obese women and those who gain excessive amounts of weight during pregnancy have an increased likelihood of giving birth to infants who are larger than would be expected for their gestational age (number of weeks in the uterus) (ACOG, 2005). It is also known that infants who were large for gestational age at birth have an increased risk of becoming obese in childhood (ACOG, 2005). In addition, a very recent study (Oken et al., 2007) has directly linked higher maternal weight gain during pregnancy with higher levels of adiposity (fatness) in children at age three years. The researchers who performed this study suggested the possibility that greater weight gain by the mother during pregnancy may “program” the child for later obesity by modifying the environment in the uterus (Oken et al., 2007). Alternatively, women who gain weight easily because of genetic, dietary, or other factors may have children who also are more likely to gain weight (Oken et al., 2007). Childhood obesity is a major problem today in America (see Chapter 16). There is a need to make young women aware that if they are obese, this is not only a risk for themselves but also for their children.

As was discussed in Chapter 7, obese people are more likely than normal-weight people to experience a variety of problems connected with surgery and anesthesia. This applies to surgical procedures in connection with childbirth just as it does

with other types of operations (Andreasen et al., 2004). Complications related to anesthesia, complications during surgery, and complications occurring after surgery have all been reported to be more common among obese women undergoing cesarean sections or operative vaginal deliveries than among normal-weight women (Andreasen et al., 2004). One consequence of the increased complication rate is longer hospitalizations; in one study of women who underwent cesarean sections, 34.9 percent of severely obese women were hospitalized for more than four days, as compared to only 2.3 percent of normal-weight women (Perlow and Morgan, 1994).

## EFFECTS ON FERTILITY AND FERTILITY-RELATED TREATMENT

Obese women are more likely than normal-weight women to have difficulty becoming pregnant (Linne, 2004). In at least some instances, this reflects the presence of polycystic ovary syndrome, a condition discussed later in this chapter. Infertility problems due to failure to ovulate regularly may also be linked to high body mass index (BMI) in youth. In one large epidemiologic study, women who had been overweight or obese at age 18 were more likely to have fertility problems later in life, regardless of whether or not they had been diagnosed with polycystic ovary syndrome (Rich-Edwards et al., 1994).

In a recent study of about 3000 couples who had experienced difficulty in conceiving despite the fact that the woman was ovulating, the probability of a spontaneous pregnancy (that is, a pregnancy occurring without fertility treatment) occurring during a 12-month period decreased as the woman's BMI increased for women with a BMI of more than 29 (van der Steeg et al., 2008). For every BMI unit increase in obese women (e.g., from 32 to 33), the probability of pregnancy decreased by 4 percent.

Obese women who undergo treatment for infertility using assisted reproduction techniques such as in vitro fertilization have



poorer results than normal-weight women do (Bellver et al., 2006; Fedorcsak et al., 2004). Their lower probability of giving birth after using such techniques is believed to be a result of a combination of lower implantation and pregnancy rates, higher miscarriage rates, and increased complications during pregnancy (Bellver et al., 2006). Fortunately, though, recent research indicates that one form of assisted reproduction, oocyte donation, is not adversely affected by obesity (Styne-Gross et al., 2005).

## CONTRACEPTIVE FAILURE

Two studies have shown that contraceptive failure (unintended pregnancy) is more common in oral contraceptive users who are overweight or obese than in those of normal weight (Holt et al., 2002 and 2005). Similar trends have been observed among users of contraceptive implants (Gu et al., 1995; Grubb et al., 1995) and transdermal contraceptive patches (Zieman et al., 2002). All of these types of contraception rely on hormones for their effect, and there is evidence that blood levels of these hormones may be lower in obese women, perhaps because some of the hormones are sequestered in body fat or because they may be metabolized more rapidly (Holt et al., 2005).

## POLYCYSTIC OVARY SYNDROME (PCOS)

Polycystic ovary syndrome (PCOS) is a hormonal disorder that affects approximately 5 to 10 percent of premenopausal women (Boomsma et al., 2006). Characteristic features include insulin resistance, fertility problems, irregular menstrual periods, hirsutism (excessive hair growth in the pattern characteristic of men, for example on the chin and above the lip), acne, and male-pattern hair loss, as well as polycystic ovaries (Linne, 2004). Overweight is also characteristic of PCOS, although not all women with PCOS are overweight. Some symptoms of PCOS, such as changes in the pattern of hair growth, are related to an excess of

androgens (male sex hormones) (Lo et al., 2006). Women with PCOS who succeed in becoming pregnant face a higher risk of some complications of pregnancy, including gestational diabetes and preeclampsia (Boomsma et al., 2006).

About half of all women with PCOS are overweight or obese, but the interaction between PCOS and obesity is not completely understood; scientists do not know whether obesity promotes PCOS, whether PCOS promotes obesity, or both (Linne, 2004). Some evidence indicates that women with PCOS experience increased appetite and an increased tendency to gain weight, suggesting that PCOS is the initiating event, with obesity as a consequence (Linne, 2004). On the other hand, adipose tissue (body fat) appears to play an important role in the development and maintenance of the abnormalities of PCOS (Barber et al., 2006). Heavier women with PCOS tend to have more severe symptoms, and reductions in weight can lead to improved fertility, more regular menstrual cycles, decreased insulin resistance, and decreased symptoms of androgen excess in women with PCOS (Barber et al., 2006; Norman et al., 2002).

Women with PCOS are at increased risk of the metabolic syndrome, which in turn increases the risk of cardiovascular disease (Linne, 2004). (See Chapter 3 for a full discussion of the metabolic syndrome.) In fact, some scientists have suggested that PCOS may be a female-specific version of the metabolic syndrome (Sam and Dunaif, 2003). Women with PCOS have increased risks of hypertension (high blood pressure) and dyslipidemia (undesirable levels of cholesterol and related blood lipids) as well as higher rates of obesity and diabetes (Lo et al., 2006).

## MISCELLANEOUS CONDITIONS

Obesity was strongly associated with premenstrual syndrome in a study in the general population of women in the state of Virginia (Masho et al., 2005; Deuster et al., 1999). However, another study, conducted

among women serving on U.S. Navy ships, found no relationship between obesity and premenstrual syndrome (Kritz-Silverstein et al., 1999). Further investigation of this topic is needed.

A recent comprehensive review of research on obesity and sexual dysfunction (Larsen et al., 2007) found only a single study that investigated this relationship in women; that study found no evidence of an effect. However, a new study, not included in the review, did find evidence that higher BMI may be associated with greater degrees of sexual dysfunction in women (Esposito et al., 2007). Additional studies will be needed before any conclusions can be reached about this possible relationship.

## SUMMARY

Obese women have a higher risk of several complications of pregnancy, including gestational diabetes, preeclampsia, and high birth weight. Miscarriages, stillbirths, and birth defects, especially neural tube defects, occur more frequently when the mother is obese. Obese women and those who gain excessive weight during pregnancy also have an increased risk of giving birth to infants who will become obese themselves during childhood. Obese women are more likely than normal-weight women to require cesarean sections, and they experience more complications from cesarean sections and other obstetric surgical procedures.

Obese women are more likely than normal-weight women to have difficulty conceiving. Some types of fertility treatment/assisted reproduction have lower success rates in obese women.

Oral contraceptives and other types of hormonal contraceptives, such as implants and patches, are more likely to fail in obese women than in normal-weight women.

Obesity is one of the characteristic symptoms of polycystic ovary syndrome, a complex syndrome involving irregular

menstrual cycles, reduced fertility, insulin resistance, and symptoms attributable to excessive levels of androgens. Women with this syndrome are at increased risk of the metabolic syndrome, which is associated with increased cardiovascular risk. Weight loss in women with polycystic ovary syndrome improves fertility, reduces symptoms of androgen excess, and decreases insulin resistance.

Studies of the relationship of obesity to premenstrual syndrome and female sexual dysfunction have had inconsistent results. The amount of research that has been conducted on these topics is small, and more studies are needed.

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# CHAPTER



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## Obesity and Urology

**Urology is the medical specialty that deals with disorders of the urinary system and those of the male reproductive system. Obesity influences several conditions that fall within the specialty of urology.**

All are discussed in this chapter except for kidney cancer and prostate cancer, which are discussed in Chapter 6.

### URINARY INCONTINENCE

The term urinary incontinence refers to the involuntary loss of urine; it is a common problem among women. Urinary incontinence is usually classified as either stress incontinence, in which urine loss occurs in response to physical activity, coughing, laughing, sneezing, or lifting, or urge incontinence, in which urine loss is preceded by an urge to urinate that occurs so suddenly that the individual cannot get to the bathroom in time (Mallett, 2005). Individuals who have both types of incontinence are described as having mixed incontinence. Stress incontinence and mixed incontinence are more common than urge incontinence (Mallett, 2005).

Extensive data have associated obesity with an increased risk of stress incontinence in women (Dallosso et al., 2003; Lubert, 2004) and with an increased

severity of the problem in those who have it (Richter et al., 2005). The increased pressure on the bladder caused by excess weight in the abdominal area is believed to be partly responsible (Lubert, 2004; Mallett, 2005).

Weight loss can decrease stress incontinence. For example, in one group of severely obese women who lost substantial amounts of weight, the proportion of women with stress incontinence decreased from 61 percent before the weight loss to 12 percent afterwards (Deitel et al., 1988).

Obesity appears to be linked to urge incontinence as well (Mommensen and Foldspang, 1994; Alling Møller et al., 2000; Hannestad et al., 2003), although the data are not as extensive as for stress or mixed incontinence, and the relationship may not be as strong (Mommensen and Foldspang, 1994). For example, the results of a large survey conducted in Norway linked obesity with an increased risk of all types of incontinence in women, especially severe incontinence (Hannestad et al., 2003). The

relationship was strongest for severe mixed incontinence, with women in the highest BMI category (over 40) being six times more likely than those of normal weight to experience this problem, and weakest for urge incontinence. As is the case for stress incontinence, weight loss may lead to a decrease in urge incontinence (Bump et al., 1992).

## **BENIGN PROSTATIC HYPERPLASIA (BPH)**

As a man grows older, the size of his prostate gland may increase — sometimes to such an extent that it pushes against his bladder and urethra, causing troublesome urinary tract symptoms, such as increased frequency and urgency of urination and an increased need to urinate during the night. This condition is called benign prostatic hyperplasia (BPH), and its treatment may require medication or surgery.

Some epidemiological studies have indicated that obese men have an increased likelihood of BPH (Haidinger et al., 2000; Hammarsten et al., 1998; Parsons et al., 2006). Other studies, however, have indicated that this increase in risk is associated specifically with central obesity (obesity in which the excess weight is concentrated near the waist, leading to a high ratio of waist measurement to hip measurement), which is the type of obesity characteristic of the metabolic syndrome (for a complete discussion of the metabolic syndrome, see Chapter 3), rather than with obesity in general (Dahle et al., 2002; Giovannucci et al., 1994; Lee et al., 2006; Kristal et al., 2007). Other features of the metabolic syndrome, such as high blood glucose and insulin levels and high blood pressure, have also been associated with BPH (Dahle et al., 2002; Hammarsten et al., 1998; Hammarsten and Hogstedt, 2001; Parsons et al., 2006), and it has been speculated that elevated insulin levels may be the key factor (Hammarsten et al., 1998).

## **KIDNEY STONE FORMATION**

Kidney stones can form when substances in the urine crystallize into a solid mass. Although small stones usually pass out of the body on their own, they can be very painful, and both small and large stones quite often require surgical intervention. Some people have a tendency to develop kidney stones repeatedly.

Obesity may increase the risk of kidney stone formation (Mydlo, 2004), but the evidence for such a relationship is stronger in women than in men (Powell et al., 2000). Recent increases in the number of reported cases of kidney stones, especially in women, may be a result of the increased frequency of obesity (Scales et al., 2007). Obesity may influence kidney stone formation by changing the chemistry of the urine, especially by increasing the concentration of uric acid, a substance associated with stone formation (Taylor and Curhan, 2006). Dietary habits, such as high animal protein intake (greater than 6-8 ounces/day) and high salt intake, which can be linked to obesity, can also increase the tendency to form stones. Obesity has been directly linked to the formation of calcium oxalate and uric acid stones, particularly in diabetic and/or hypertensive patients (Ekeruo et al., 2004; Taylor et al., 2005).

## **CHRONIC KIDNEY DISEASE**

It has long been known that obese people are at increased risk of developing chronic kidney disease. Obesity promotes both hypertension and diabetes, and both of these diseases increase the risk of kidney disease. Recently, however, it has been recognized that obesity itself is an independent risk factor for chronic kidney disease, above and beyond the effects of diabetes and hypertension (Ross and McGill, 2006).

For example, in one large U.S. study, even after the effects of diabetes and hypertension were taken into account, obese people were found to be 40 percent more likely

than those of normal weight to develop chronic kidney disease (Kramer et al., 2005). An even stronger association has been observed for end-stage renal disease, the most advanced and serious form of chronic kidney disease, which may require treatment with dialysis or transplantation. In a large study in California, researchers found that even after the effects of blood pressure and diabetes were adjusted for in the analysis, people with a BMI of 30 to 34.9 were more than three times as likely as those of normal weight to develop end-stage renal disease, those with a BMI of 35 to 39.9 were six times as likely, and those with a BMI of 40 or over were seven times as likely (Hsu et al., 2006).

Ironically, when patients with end-stage renal disease are treated with dialysis, those who are obese survive longer than those of normal weight do; the reasons for this have not been clearly established (Kalantar-Zadeh et al., 2005). The same pattern does not occur, however, in patients who undergo kidney transplants. Outcomes in transplant recipients of normal weight are better than those in obese transplant recipients (Meier-Kriesche et al., 2002). This finding may reflect the fact that transplant recipients have only one functioning kidney; in general, obesity has particularly detrimental effects on kidney function in individuals who have only one kidney or who for other reasons have less than the normal amount of functioning kidney tissue (Rutkowski et al., 2006).

## ERECTILE DYSFUNCTION

Obese men are more likely than those of normal weight to have erectile dysfunction (Bacon et al, et al., 2006; Chung et al, et al., 1999; Larsen et al, et al., 2007). This appears to be part of a general pattern in which factors that increase the risk of atherosclerosis and cardiovascular disease also increase the risk of erectile dysfunction (Chung et al, et al., 1999; Mulhall et al, et al., 2006; Saigal, 2004). In fact, in many

instances, erectile dysfunction may be a manifestation of blood vessel disease affecting the arteries of the penis (Esposito and Guigliano, 2005).

A recent study of obese men who were participating in a weight loss program indicated that successful weight loss and increased physical activity reversed erectile dysfunction in about one-third of the men (Esposito et al, et al., 2004). It is unclear, however, whether this result can be generalized to the overall population of obese men. The researchers chose study participants who had no chronic health problems such as diabetes or hypertension; many obese men with erectile dysfunction do have these other problems as well. Also, the weight-loss program used was intense, and the participants may have been unusually highly motivated to lose weight (Evans, 2005; Saigal, 2004).

## MALE FERTILITY

Obesity may have a detrimental effect on male fertility above and beyond its association with erectile dysfunction. One possible mechanism is increased scrotal temperature (Mydlo, 2004). For a man to be fertile, his testicles must have a lower temperature than the core of his body. The presence of abundant extra skin and body fat may interfere with the necessary temperature difference. Another possible mechanism involves varicocele, an enlargement of the veins within the scrotum. This condition, which is associated with reduced fertility, is common among obese men (Mydlo, 2004). Obesity has also been associated with altered levels of reproductive hormones (Pasquali, 2006) in men and with reduced quantity and quality of sperm production (Kort et al., 2006).

Few epidemiological studies have examined the relationship between obesity and male fertility. However, the limited evidence currently available suggests that the partners of obese men have a reduced likelihood of conceiving during a year of unprotected intercourse (Ramlau-Hansen

et al., 2007; Sallmen et al., 2006) and that this trend is especially noticeable in couples in which both partners are obese (Ramlau-Hansen et al., 2007).

## SUMMARY

Obesity is associated with an increased risk of urinary incontinence in women. Central obesity and the metabolic syndrome are associated with an increased risk of BPH in men. There is evidence associating obesity with an increased risk of kidney stone formation, especially in women. Obesity is an independent risk factor for chronic kidney disease. In addition, hypertension and diabetes, both of which are promoted by obesity, are strong risk factors for chronic kidney disease. Obese men are more likely than those of normal weight to have erectile dysfunction; this association may reflect the increased prevalence of atherosclerosis among obese men. A limited amount of scientific evidence indicates that obese men may have reduced fertility.



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## CHAPTER



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# Obesity and Neurology

**Obesity is associated with an increased risk of several diseases that affect the nervous system, including stroke – a leading cause of death and disability.**

This chapter discusses the scientific evidence relating obesity to stroke, migraine, Parkinson's disease, and carpal tunnel syndrome. The relationship between obesity and dementia is discussed in Chapter 13, and the relationship between obesity and pseudotumor cerebri in children is discussed in Chapter 16.

### STROKE

A stroke occurs when the normal blood supply to a portion of the brain is compromised either by the blockage of a blood vessel or by bleeding from a burst blood vessel. The resulting impairment of brain function causes sudden, often severe symptoms, such as numbness or weakness on one side of the body, difficulty speaking or understanding speech, loss of balance, blurred vision, and/or severe headache (NINDS, 2007a). Stroke is the third-leading cause of death in the United States, accounting for more than 160,000 deaths each year (CDC, 2007). It is also a leading cause of serious disability. The risk of stroke is higher in older adults than in

younger ones; nearly threequarters of all strokes occur in people over the age of 65 (CDC, 2007).

In the United States, most strokes are ischemic strokes — the type caused by a blocked blood vessel. Like heart attacks, ischemic strokes result from narrowing and damage to an artery as a result of atherosclerosis. Although a stroke is a sudden event, the underlying atherosclerosis that leads to a stroke is a long-term process, occurring over a period of decades.

The four most important risk factors for ischemic stroke are hypertension (high blood pressure), heart disease, diabetes, and cigarette smoking (NINDS, 2007a). Obesity plays an important role in promoting stroke because it increases a person's likelihood of developing three of these four risk factors. As was discussed in Chapters 3 and 4, obesity is a strong risk factor for hypertension, heart disease, and diabetes.

Although obesity is strongly linked to three major risk factors for stroke, not all

epidemiologic studies have shown a link between obesity and stroke. When researchers have compared people who had strokes with others of the same age who did not have strokes, they have not always found a greater likelihood of obesity in the stroke victims. This inconsistency is believed to reflect two factors that can obscure the relationship between obesity and stroke: 1) cigarette smoking and 2) changes in body weight with aging and illness (Shinton et al, 1995).

Cigarette smoking, like hypertension, heart disease, and diabetes, is a major risk factor for stroke. However, unlike the other risk factors, it is not linked to obesity. In fact, smokers typically weigh less than nonsmokers do. The association of cigarette smoking with increased stroke risk but lower body weight makes it difficult to detect relationships between obesity and stroke in populations that include smokers. However, when smokers are excluded from consideration, the relationship between obesity and stroke risk often becomes clearly evident. For example, when British researchers investigated the relationship between body mass index (BMI) and stroke in a large group of male civil servants that included both smokers and nonsmokers, they found no difference in stroke risk between the heaviest fifth of the population and the thinnest fifth. But when the researchers looked at the data for nonsmokers separately, they found that the heaviest nonsmokers had a risk of stroke more than twice that of the thinnest nonsmokers (Shinton et al, 1991).

The other factor that may obscure the relationship between obesity and stroke is changes in weight with age and illness. Most strokes occur in elderly people. In this age group, deterioration in health is often accompanied by weight loss (see Chapter 17 for further discussion of this subject). Studies in which researchers collect data on the BMI of elderly people at the time that they have strokes may not be able to detect a relationship between obesity and stroke because of recent weight changes. However, studies in which researchers

collect data about middle-aged people and then observe them for many years often do detect such a relationship. For example, in a study in Scotland, data on BMI and a variety of other factors were collected from more than 15,000 people between the ages of 45 and 64. Information on deaths and hospitalizations in this group of people was then collected for the next 20 years. The results showed that people who were obese at the beginning of the study were 40 percent more likely than those of initially normal weight to die from or be hospitalized for a stroke (Murphy et al, 2006). Similarly, in a large study of U.S. women, a higher BMI was associated with a greater risk of having a stroke during 16 years of follow-up, with the greatest risks among the most obese women (Rexrode et al, 1997).

Whether obese people can reduce their risk of stroke by losing weight has not been established. No systematic studies of this topic have been reported (Curioni et al., 2006). Because both obesity and stroke are very common conditions, studies of this type are urgently needed.

## MIGRAINE

A limited amount of scientific evidence links obesity to chronic headaches, especially migraine. Studies involving relatively small groups of people have indicated that migraine is more common among those who are obese, especially those who are severely obese, than among those of normal weight (Peres et al., 2005; Horev et al., 2005), but the largest study of this type did not find any relationship between obesity and the occurrence of migraine (Bigal et al., 2006). That large study did find, however, that among people who have migraines, those who are obese have them more often and more severely than those of normal weight do (Bigal et al., 2006).

A link between obesity and migraine is plausible because obese people have elevated blood levels of several substances associated with inflammation that are important in the causation of migraine (Bigal et al., 2007). In addition, adipose

tissue produces estrogen and related hormones, which may play a role in the causation of migraine in women (Horev et al., 2005). Sleep apnea, which is more common among obese people than in those of normal weight (see Chapter 5), may also promote the occurrence of chronic headaches (Rains and Poceta, 2006).

## PARKINSON'S DISEASE

A large follow-up study in Finland found that higher BMI was associated with a higher risk of developing Parkinson's disease in both men and women (Hu et al., 2006). In American men and women, however, Parkinson's disease was associated only with central obesity (as determined by waist circumference and waist-to-hip ratio), not with BMI, and the association was seen only in nonsmokers (Chen et al., 2004). Further investigation is needed before any conclusions can be reached about the possible relationship between obesity and Parkinson's disease.

## CARPAL TUNNEL SYNDROME

Carpal tunnel syndrome occurs when the median nerve, which runs from the forearm into the hand through a narrow passageway called the carpal tunnel, becomes pressed or squeezed at the wrist. Symptoms can include pain, weakness, tingling, and numbness in the hand and wrist, along with decreased grip strength (NINDS, 2007b).

It is popularly believed that carpal tunnel syndrome is exclusively an occupational disease caused by repetitive hand motions. In actuality, repetitive motions do play a role, but there are other risk factors as well. For example, carpal tunnel syndrome occurs far more often in women than in men, perhaps because the carpal tunnel is smaller in women, making nerve compression more likely (NINDS, 2007b). Obesity is another risk factor; it has been associated with an increased risk of carpal tunnel syndrome in numerous studies (Atroshi et al., 1999; Becker et al., 2002; Lam and Thurston, 1998; Moghtaderi et al.,

2005; Stallings et al., 1997; Werner et al., 1994). Obesity may increase risk because the extra fatty tissue in the arm of an obese person compresses the median nerve. Obesity may also play a role through its association with diabetes, which can directly affect nerves and make them more susceptible to compression (NINDS, 2007b).

## SUMMARY

Obesity promotes the development of three major risk factors for stroke — hypertension, cardiovascular disease, and diabetes. Obesity is believed to increase the risk of stroke, although this relationship has sometimes been obscured in epidemiologic studies by confounding effects of cigarette smoking and illness-induced weight loss. Limited evidence suggests that obesity may be associated with increased risk and/or severity of migraine. The scientific evidence is inadequate to allow any conclusions to be reached about whether obesity influences the risk of Parkinson's disease. A substantial body of scientific evidence indicates that obese people have an increased likelihood of developing carpal tunnel syndrome.

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# CHAPTER



# 3

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## Obesity and Mental Health

**Although obesity is a cause for concern primarily because it increases the likelihood of a variety of physical health problems, there is also some evidence indicating that obese people may have an increased likelihood of suffering from certain types of mental health problems, as summarized in this chapter.**

### EFFECTS OF STIGMATIZATION

A substantial body of evidence indicates that obese people face significant stigmatization because of their obesity, including job discrimination, social exclusion, and poorer treatment in educational and health care settings (Myers and Rosen, 1999; Puhl and Brownell, 2001). How this stigmatization may affect psychological functioning is not well understood. Obese people who experience stigmatization develop coping strategies (Myers and Rosen, 1999), but some of these strategies, such as avoidance of medical treatment to minimize unpleasant encounters with health care professionals (Drury and Louis, 2002), may be detrimental to their well-being. A limited amount of scientific evidence indicates that obese individuals who experience more extensive stigmatization also report greater psychological distress (Myers and Rosen, 1999; Friedman et al., 2005). This evidence, however, comes primarily from studies of people who sought treatment for obesity and therefore may not be applicable to the

general population of obese people.

### DEPRESSION

Some epidemiological studies indicate that obese people are more likely than others to suffer from depression, and that this association may be stronger in women than in men. The evidence is not entirely consistent, though.

In one national U.S. survey, obesity was associated with an approximately 25 percent increase in the likelihood of having a mood disorder (major depression or bipolar disorder), with the strongest associations in non-Hispanic whites and no difference between men and women (Simon et al., 2006). Another large U.S. study found associations between obesity and depressed mood (not major depression) primarily in young, female study participants, especially those who were Hispanic (Heo et al., 2006). A third U.S. study found associations between obesity and depression primarily in women, with the association seen mainly among those

with severe obesity (body mass index [BMI] greater than 40) (Onyike et al., 2003). A Canadian study found that women with a history of ever having suffered from a mood disorder (major depression or bipolar disorder) were more likely to be obese than those with no such history; no relationship was observed in men (McIntyre et al., 2006). On the other hand, several studies have found no positive association between obesity and depression in either gender in the populations studied (Palinkas et al., 1996; Ross, 1994).

If a relationship does exist between obesity and depression, it is unclear which of these conditions might promote the development of the other. Increased appetite and weight gain are common symptoms of depression, which suggests that depression may promote obesity, but it is also possible that the stigma attached to obesity and/or limitations on activity due to obesity or obesity-related diseases may increase the risk of depression (Simon et al., 2006). The fact that some medications used in the treatment of depression may cause weight gain (Kennedy, 2006) further complicates understanding of the relationship between obesity and depression. The effects of medications used in the treatment of psychiatric disorders on weight gain are discussed more extensively in a special section near the end of this chapter.

## DEMENTIA

Older people who develop dementia often lose weight in the years immediately before their cognitive decline becomes obvious. This is believed to be due to the disease process itself, and weight loss often continues as dementia becomes more severe. Because of this pattern, studies that examine the relationship between body weight and dementia in groups of very elderly people, or those that observe their study participants for relatively short periods of time (such as 5 years) generally show that underweight and weight loss are associated with an increased likelihood of having dementia (Whitmer and Yaffe, 2006).

In contrast, studies that take a longer-term view of the relationship between body weight and dementia show a very different pattern. These studies have indicated that people who are obese in midlife have an increased risk of developing dementia later in life (Gorospe and Dave, 2007). Midlife obesity has been linked to increased chances of developing both Alzheimer disease and vascular dementia (Whitmer et al., 2007).

To some extent, the association between midlife obesity and later dementia may reflect the increased frequencies of cardiovascular risk factors, such as high blood pressure and diabetes, in obese people; these risk factors are known to be associated with an increased risk of dementia. In some studies, however, a link between obesity and dementia has been observed even after the effects of cardiovascular risk factors were taken into account, suggesting that some aspects of obesity itself may contribute to the relationship (Barrett-Connor, 2007). It has been suggested that biologically active substances produced by fat cells may play roles in the causation of dementia (Whitmer and Yaffe, 2006). Whether weight loss can decrease these effects has not been established (Whitmer and Yaffe, 2006).

## MEDICATIONS AND WEIGHT GAIN

The tendency of some psychotropic medications (medications used to treat mental disorders) to promote weight gain poses major problems in the treatment of serious mental illnesses, especially schizophrenia, and to a lesser extent bipolar disorder and depression. Several drugs in a group known as the second-generation or atypical antipsychotics strongly promote the development of obesity and other risk factors for cardiovascular disease, including hypertension (high blood pressure), dyslipidemia (abnormal levels of cholesterol and related blood lipids), and diabetes (Scheen and De Hert, 2007). In one recent study, the rates of obesity and metabolic syndrome in patients with chronic severe mental illness who were

receiving antipsychotic drug treatment were two to three times those in the general population (Tirupati and Chua, 2007). People with schizophrenia have lifespans substantially shorter than those of the general population — reported as 20 percent shorter in one recent study (Newcomer, 2007) and as a loss of up to 32 years of potential life in another (Miller et al., 2006). The leading cause of death among people with serious mental illnesses is not suicide or other problems related to their mental illness; it is cardiovascular disease (Miller et al., 2006; Newcomer, 2007), to which obesity is an important contributing factor.

Unfortunately, it is not always possible to avoid the use of the kinds of antipsychotic drugs that promote obesity; sometimes they are the only drugs that are effective for a particular patient. When these drugs must be used, their side effects pose a major challenge for both patients and the health professionals caring for them. Several recent publications in scientific journals have called for increased attention to the physical health problems, including obesity and cardiovascular disease, experienced by people with serious mental illnesses (Barnett et al., 2007; Miller et al., 2006; Newcomer, 2007; Scheen and De Hert, 2007; Tirupati and Chua, 2007).

## SUMMARY

Obese people face stigmatization in many areas of life, and limited scientific evidence suggests that those who are most stigmatized experience increased psychological distress. Obesity has been associated with an increased risk of depression, especially in women, in some but not all epidemiological studies that have examined this topic. Obesity in midlife is associated with increased risks of both Alzheimer disease and vascular dementia later in life. People being treated for severe mental illnesses have high rates of obesity, metabolic syndrome, diabetes, and related conditions; the weight-gain-promoting effects of some antipsychotic drugs are believed to be an important contributing factor.

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# CHAPTER



# 4

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## Obesity and Dermatology

**Dermatology is the medical specialty that deals with disorders of the skin. Obesity is associated with a variety of skin problems.**

### INTERTRIGO AND SKIN INFECTIONS

Skin folds — areas where skin touches skin, such as in the armpits, the groin, or under a woman's breasts — are susceptible to inflammation and infections promoted by friction, warmth, and moisture. Obese people are especially likely to develop skin fold problems because they have more and deeper skin folds and because they are more likely to have medical problems such as vascular disease or diabetes that further increase the risk of skin infections (Scheinfeld, 2004). In addition, obese people sweat more than lean people do because of the thick layers of fat under their skin; this leads to increased moisture in skin folds, which contributes to the risk of inflammation and infection in those areas (Hahler, 2006).

Inflammation of the top layers of skin in skin folds is called intertrigo. It is characterized by a red, itchy rash and may be complicated by infection with yeasts or other fungi or bacteria. Intertrigo and

related infections are common among obese people. A survey of 18,000 obese people in France indicated that 23 percent had fungal skin fold infections (Lecerf et al., 2003). Some researchers estimate that as many as 50 percent of obese people may have some type of skin infection (Mousa et al., 1977).

In addition to common infections of the top layers of the skin, obese people, particularly those with severe obesity, are also at increased risk of uncommon, deeper, more serious infections, including infectious cellulitis (an infection of the deepest layers of the skin), gas gangrene (a bacterial infection that causes rapid tissue destruction), and necrotizing fasciitis (the so-called flesh-eating bacteria) (Scheinfeld, 2004). These infections are associated with impaired circulation and diabetes, both of which are more common among obese people than among those of normal weight (Scheinfeld, 2004).

With today's problems with methicillin-resistant *Staphylococcus aureus* (the

drug-resistant bacterial strain, better known as MRSA, that can cause very serious infections), the increased susceptibility of obese people to skin infections is even more of a concern than it used to be, particularly if the patient has other health conditions or needs to undergo medical procedures.

## ACANTHOSIS NIGRICANS

Acanthosis nigricans is a condition involving darkening and roughening of localized areas of the skin, most commonly under the arms or on the back of the neck, although it may also occur at other sites, such as the scalp, elbows, or knees (Hahler, 2006). This condition is considered to be a marker for the presence of serious disease — often diabetes mellitus (or its precursor, insulin resistance) or stomach cancer — and is associated with obesity, which in turn is associated with insulin resistance and diabetes (Hahler, 2006). Acanthosis nigricans is more common among people with severe obesity than in those with milder obesity (Hud et al., 1992).

## PSORIASIS

Psoriasis is an inflammatory skin disease that causes sore or itchy patches of thick, red, scaly skin on various parts of the body. Approximately 10 to 30 percent of patients with psoriasis of the skin also develop psoriatic arthritis, an inflammation of the joints (National Psoriasis Foundation, 2005). Psoriasis usually occurs in adults and may recur throughout a person's life. More than 5 million Americans have psoriasis (Bren, 2004).

Physicians have long suspected that there is an association between obesity and psoriasis (Lebwohl and Callen, 2006), and a recent study from the University of Utah confirms this suspicion. The Utah researchers discovered that the prevalence of obesity was higher among a large group of psoriasis patients participating in a long-term study than among the general Utah population (34 percent vs. 18 percent;

Herron et al., 2005). Obesity was also more common among the psoriasis patients than among patients seeking care for other skin diseases.

Obesity does not seem to be involved in the causation of psoriasis, however. In the Utah research, the psoriasis patients were typically of normal weight at the time when they first developed psoriasis but then became overweight later.

Obesity may interfere with successful treatment of psoriasis because some of the drugs used in the treatment of psoriasis may be contraindicated in patients with certain obesity-related diseases, such as nonalcoholic liver disease or high blood pressure (Lebwohl and Callen, 2006).

## PRESSURE SORES

Pressure sores (also called bedsores, pressure ulcers, or decubitus ulcers) are injuries to the skin that result from constant pressure on an area due to impaired mobility. The pressure results in reduced blood flow, eventually leading to tissue damage and skin breakdown. People who spend most of their time in bed or in a wheelchair are at risk for pressure sores, which usually occur over bony areas, such as the tailbone, heels, back of the head, and elbows.

Obesity increases the likelihood of pressure sores because of poor blood supply to the fatty tissue (Hahler, 2006). In addition, pressure sores may develop in unusual places in obese people because of pressure created when skin folds touch. Pressure sores can also occur because equipment, such as beds or wheelchairs, may be too small for the obese person and may press against the skin.

Pressure sores are especially likely to be a problem among severely obese patients in intensive care units. The immobility of these patients promotes the development of pressure sores, but it is difficult for caregivers to help extremely large patients change positions frequently and safely.

## STRETCH MARKS AND SKIN TAGS

Obesity increases the risk of two common skin conditions that are primarily cosmetic issues — stretch marks and skin tags.

Stretch marks, also called striae, are a result of rapid stretching of the skin, such as during pregnancy, during the rapid growth of puberty, or during rapid weight gain. They consist of linear, smooth bands of depressed, scarlike tissue, usually red at first and later progressing to purple and then white, and their formation is believed to be due to stretching and thinning of the connective tissue (Hahler, 2006). Their presence in an obese person reflects the pressures on the skin from expanding deposits of body fat (Bray, 2004).

Skin tags are small, skin-colored benign growths that stick out of the skin and may have a small, narrow stalk connecting the tag to the surface of the skin. They are common, especially among older people, and are more likely to occur in people with diabetes. Their frequent occurrence in obese people may reflect the association of obesity with diabetes (Scheinfeld, 2004).

## OTHER SKIN CONDITIONS

Some people with severe obesity develop a condition called plantar hyperkeratosis, in which the skin on the sole of the foot forms an unusually thick callus. Plantar hyperkeratosis is caused by disruption of the foot anatomy by excess weight and may be a protective response to the mechanical trauma caused by bearing excessive weight (Hahler, 2006).

The healing of skin wounds may be slower in obese people than in those of normal weight. This topic is discussed in detail in Chapter 7 of this book.

Leg ulcers are more common in obese people than in those of normal weight (Scheinfeld, 2004). They may result from insufficient circulation and are promoted by diabetes. Since leg ulcers are primarily a circulatory problem, they are discussed

more extensively in Chapter 4, which focuses on circulation.

## SUMMARY

Obesity is associated with a variety of skin problems, including inflammation and infections in skin folds, acanthosis nigricans, pressure sores in people with limited mobility, stretch marks, and skin tags. There is an increased prevalence of psoriasis in people with obesity, but obesity does not seem to precede psoriasis and apparently is not a causative factor.

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# CHAPTER



# 5

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## Other Health Problems

**Chapters 3 through 14 of this book each focused on a particular medical specialty or organ system for which there is substantial evidence for adverse health effects of obesity.**

This chapter will briefly discuss some additional potential health effects of obesity for which the evidence is not extensive enough to justify chapter-length discussions. It will take a look at the effects of obesity on the eyes, ears, and teeth and at the possible relationship between obesity and injury.

### EYES

There is evidence associating obesity with increased risks of several diseases of the eye, although the evidence is not considered conclusive (Cheung and Wong, 2007). Among these diseases are diabetic retinopathy (a consequence of diabetes, which is strongly promoted by obesity), cataract (which is also linked to diabetes [Bunce et al., 1990]), and age-related maculopathy. Obesity is also associated with elevated pressure within the eye (intraocular pressure), which is a sign of glaucoma, but not with glaucoma itself (Bohlman, 2005). The higher intraocular pressures measured in obese patients may reflect the physical strain placed upon them

when they attempt to position themselves for intraocular pressure measurements made with conventional equipment (Bohlman, 2005).

### EARS

A recent study from Korea found that obesity was more common in children having surgery to treat otitis media with effusion (a condition in which fluid accumulates in the middle ear, often after an acute ear infection, and that is often treated by the surgical insertion of ear tubes) than in children having surgery for other problems (Kim et al., 2007). The researchers who conducted this study speculated that the recent increases in the prevalence of obesity in children may have contributed to the increase in the frequency of otitis media with effusion during the same time period.

### TEETH

Since overconsumption of carbohydrate-rich foods can predispose a person to both obesity and tooth decay, it might be

supposed that there would be a relationship between these two health problems, but in fact the evidence for such an association is limited. Of studies that have attempted to evaluate the relationship between obesity and dental caries, most have not found a positive correlation between the two conditions (Kantovitz et al., 2006; Macek and Mitola, 2006; Moreira et al., 2006). This may be due to subtle differences in causation (Palmer, 2005); although unhealthful eating patterns may contribute to both obesity and tooth decay, the quantity of consumption is more important with regard to obesity, while the pattern of intake (i.e., frequent snacking on carbohydrate-rich foods between meals) is the key factor with regard to tooth decay.

Several studies have linked obesity with an increased risk of periodontal disease (Al-Zahrani et al., 2003; Dalla Vecchia et al., 2005; Linden et al., 2007; Saito et al., 2005), although in some of these studies the relationship was seen only in some population subgroups. An association between obesity and periodontal disease is plausible because people with insulin resistance or diabetes have a higher risk of periodontal disease, and obesity promotes these conditions.

## INJURY

Several recent studies have found higher rates of unintentional physical injury in obese people, as compared to those of normal weight. This pattern has been observed among adults in the general population (Finkelstein et al., 2007; Xiang et al., 2005); among drivers with motor vehicle-related injuries (Whitlock et al., 2003); among workers injured on the job (Ostbye et al., 2007; Pollack et al., 2007); among male high school football players (Gomez et al., 1998; Kaplan et al., 1995); and among female (but not male) students injured in schools (Chau et al., 2007). The mechanism for the increase in risk has not been established, but the fact that the increase is greatest for those with severe obesity (Finkelstein et al., 2007; Xiang et al., 2005) suggests that the physical

limitations experienced by extremely obese people, such as difficulty in walking and climbing stairs, may be a factor. The higher prevalence of musculoskeletal problems, such as back pain and osteoarthritis of the knee, in obese people might also play a role. In one of the studies of on-the-job injuries, injuries to the leg or knee were especially prevalent among the most obese group of employees (Pollack et al., 2007). The difficulty obese people have in using furniture and equipment designed for smaller individuals could also be a contributing factor in their increased risk of injury.

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## CHAPTER



# 6

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## Obesity in Children and Adolescents

**Obesity is a significant problem in children as well as in adults. Contrary to popular belief, obesity in childhood is not just a cosmetic problem; it is associated with substantial adverse health effects both in the short term and later in the individual's life.**

This chapter discusses recent trends in the occurrence of obesity in children and the immediate and long-term health consequences of childhood obesity.

### THE PREVALENCE OF OBESITY IN CHILDREN

As was discussed in Chapter 1, the most common method of screening for overweight/obesity in adults is to measure height and weight, calculate body mass index (BMI), and compare BMI to established standards (25 to 29.9 kg/m<sup>2</sup> for overweight, 30 kg/m<sup>2</sup> or greater for obesity). In children and adolescents, screening is performed by assessing BMI, plotting the result on standard growth charts,

and determining the corresponding BMI percentile for the child's age and sex. A BMI at or above the 95th percentile for children of the same age and sex in the standard population that was used as the basis for the growth charts is defined as "overweight" (CDC, 2007). Children whose BMI is at or above the 85th percentile but less than the 95th percentile are considered "at risk of overweight." Health professionals use the term "overweight" instead of "obesity" to reflect the situation in children whose bodies are still growing and changing and to avoid the stigmatization that might occur if the word "obesity" was used, since "obesity" has such a negative connotation (Barlow and Dietz, 1998).<sup>1</sup> Classifications of over-

<sup>1</sup> While this book was in preparation, an expert committee of the American Medical Association suggested that the term "obese" rather than "overweight" should be used to refer to children and adolescents with BMI values at or above the 95th percentile for their age and sex and that the term "overweight" rather than "at risk of overweight" should be used for those with BMI values at or above the 85th percentile but below the 95th percentile (AMA, 2007). As noted by the Obesity Society, a co-signer of the AMA committee report, the traditional terms may have been counterproductive because they were too "fuzzy." In the words of the Obesity Society, "While no one is suggesting that doctors become less sensitive to kids or parents, there is a strong sentiment that fuzzy terms let everyone off the hook. The conclusion: There needs to be some middle and healthful ground between calling a child fat and not confronting unhealthy body weight" (Obesity Society, 2007).

**Table 4. Prevalence of Overweight among U.S. Children and Adolescents\***

	1971-1974	1976-1980	1988-1994	2003-2004
Ages 2 through 5 years	5%	5%	7.2%	13.9%
Ages 6 through 11 years	4%	6.5%	11.3%	18.8%
Ages 12 through 19 years	6.1%	5%	10.5%	17.4%

\*Sex- and age-specific BMI 95<sup>th</sup> percentile based on the CDC growth charts. Data from successive National Health and Nutrition Examination Surveys (NHANES). Source: CDC, 2007.

weight for children and adolescents depend on age and sex because children's body composition changes as they grow older and differs between boys and girls (CDC, 2007). For example, a BMI of 20 is well above the 95th percentile and therefore indicative of overweight in a six-year-old, but it is at around the 50th percentile and not indicative of overweight in a 15-year-old.

The prevalence of overweight among children and adolescents, as defined above, has more than doubled since the 1970s, as shown in Table 4. Experts regard this trend as a serious problem. The U.S. government's statement of national health objectives for the current decade, Healthy People 2010, calls for a reduction in the proportion of children and adolescents who are overweight to no more than 5 percent (Department of Health and Human Services, 2000). However, it does not appear that progress is being made toward that goal; the current prevalence of overweight among those aged 6 to 11 years and 12 to 19 years is more than three times the desired level (see Table 4). Given these trends, stopping the increase in the prevalence of overweight may be a more realistic goal than reducing it.

## CONSEQUENCES OF OBESITY

### *Persistence of Obesity into Adulthood*

One very important consequence of childhood obesity is that the obesity will probably continue into adulthood, subjecting the individual to all of the health risks and problems associated with adult obesity. In one study, 69 percent of individuals who were overweight when they were six to nine years old and 83 percent of those who were overweight when they were 10 to 14 years old became obese adults (Whitaker et al., 1997). Persistence of childhood obesity into adulthood is especially likely if the obesity is severe, if it is present at older ages (adolescence rather than childhood), and if at least one of the parents is obese (Reilly et al., 2003).

Persistence of adolescent obesity into adulthood increases the likelihood of a person's developing coronary heart disease. A recent study of more than 200,000 people born in Denmark in 1930 or later found that higher BMI in childhood for boys and in adolescence for both sexes (age 7 to 13 years for boys and age 10 to 13 years for girls) was associated with a higher risk of coronary heart disease in adulthood (Baker et al., 2007). In comparison with a boy of average size

at age 13, a boy who was the same height but 25 pounds heavier had a 33 percent higher risk of having a heart attack as an adult (Baker et al., 2007). It has been projected that if current trends in adolescent obesity and its impact on adult obesity continue, the prevalence of coronary heart disease will increase by between 5 and 16 percent by 2035 (Bibbins-Domingo et al., 2007).

### ***Early Development of Adult-Type Health Problems***

Obesity in childhood or adolescence can lead to the development of adult-type health problems early in life (Speiser et al., 2005). Diabetes is a key example.

Physicians and scientists used to refer to type 2 diabetes — the type that is associated with obesity — as “adult-onset diabetes” because it was seen only in adults, usually those age 40 or older. This terminology is no longer used. One reason for this change is that type 2 diabetes is no longer exclusively a disease of adults. Increasingly, it is also being diagnosed in children.

Various data indicate that type 2 diabetes may now account for between 8 percent and 46 percent of all cases of diabetes diagnosed in children and adolescents; the range of estimates is broad because type 2 diabetes is difficult to detect in children (CDC, 2005). It has been estimated that as many as 40,000 U.S. adolescents have type 2 diabetes, and 2.5 million more may have impaired fasting glucose, which indicates a risk of developing diabetes (Kreimer, 2006). Type 2 diabetes in youth is now the most rapidly growing form of diabetes in America, Europe, Japan, and Australasia (Speiser et al., 2005). Children and adolescents who are diagnosed with type 2 diabetes are usually between 10 and 19 years old, are obese, and have a family history of the disease (CDC, 2005).

In addition to diabetes, obese children and adolescents have an increased risk of developing other cardiovascular risk

factors, including hypertension (high blood pressure) and dyslipidemia (undesirable levels of cholesterol and related blood lipids) (Speiser et al., 2005). Overweight is the leading cause of high blood pressure in children (Speiser et al., 2005), and some data indicate that high blood pressure may be nine times more common among overweight children than in normal-weight children (Dietz, 1998). The characteristic pattern of blood lipid levels in obese children includes undesirable, elevated levels of low-density lipoprotein (LDL) cholesterol and triglycerides and unhealthy, lowered levels of high-density lipoprotein (HDL) cholesterol (Dietz, 1998).

Abnormalities of glucose metabolism, blood pressure, and blood lipids are all components of the metabolic syndrome. As is the case in adults, obesity is associated with the metabolic syndrome in children and adolescents. In a U.S. national survey, the overall prevalence of the metabolic syndrome in adolescents aged 12 to 19 years was 4.2 percent, but the syndrome was present in 28.7 percent of adolescents who were overweight (BMI 95th percentile or greater) and 6.8 percent of those at risk for overweight (BMI at least 85th percentile but less than 95th percentile), as compared to 0.1 percent of those with BMI values below the 85th percentile (Cook et al., 2003). The prevalence of the metabolic syndrome increases with increasing degrees of obesity; it may be present in 50 percent of children and adolescents who are most severely obese (Weiss et al., 2004). Rates are even higher in certain ethnic groups with a predisposition to diabetes, such as the Pima Indians.

Obesity in children can affect the liver and gallbladder in the same ways that it does in adults. High concentrations of liver enzymes — an early sign of nonalcoholic liver disease — are often found in obese children (Dietz, 1998). Gallstones, which are associated with obesity in adults, may also occur in obese children. It is not common for children to develop gallstones, but among those who do, about half are obese (Dietz, 1998).

Another problem common among obese adults that may also occur in obese children is sleep apnea. It has been estimated that 7 percent of severely obese children have sleep apnea (Mallory et al., 1989), and this condition is four to six times more common among obese children than in those of normal weight (Speiser et al., 2005). Sleep apnea in children is associated with an increased likelihood of academic (Chan et al., 2004) and behavioral (Mulvaney et al., 2006) problems, which may improve if the condition is successfully treated (Chan et al., 2004).

Obesity and asthma often coincide in children, as they do in adults (Reilly et al., 2003). As was discussed in Chapter 5, there is evidence that the development of obesity precedes the occurrence of asthma in children, suggesting that obesity may be a contributing factor in the causation of childhood asthma. In addition, some of the drugs used to treat severe asthma, such as steroids, can promote weight gain, thus worsening the problem.

As is the case in adult women, obesity is associated with polycystic ovary syndrome in adolescent girls (see Chapter 10 for a full discussion of this syndrome). Irregular menstrual cycles and high androgen (male sex hormone) levels typical of this syndrome often begin in adolescence (Dietz, 1998).

### ***Consequences Specific to Childhood and Adolescence***

In addition to causing adult-style health problems, obesity in childhood and adolescents may cause health problems that are specific to this age group.

Several scientific studies have associated increased body fatness with an earlier timing of puberty in girls (Lee et al., 2007; Morrison et al., 1994; Kaplowitz et al., 2001). Obesity at ages as young as 3 years has been shown to influence the timing of puberty years later (Lee et al., 2007). Earlier puberty in girls is considered undesirable because it has been associated with several adverse outcomes, including

increased rates of psychological problems; earlier initiation of alcohol use, sexual activity, and teenage pregnancy; adult obesity; and increased risks of reproductive cancers (Lee et al., 2007). Some evidence suggests that puberty has been occurring earlier in U.S. girls in recent decades (Herman-Giddens et al., 1997; Wattigney et al., 1999); the increasing prevalence of obesity may be an important contributing factor in this trend (Kaplowitz et al., 2001; Lee et al., 2007; Wattigney et al., 1999).

Obesity in children is associated with problems affecting the bones, some of which may predispose the person to continuing bone problems later in life (Dietz, 1998). One such problem is Blount's disease — a type of severe, rapidly developing bowing of the legs caused by the effects of weight on the growth plate of the bone (the area where growth actually occurs). Other bone problems associated with obesity in children and adolescents include spinal complications, an increased risk of bone fractures, and a hip problem called slipped capital femoral epiphysis (SCFE), which can require surgical correction (Wills, 2004).

Pseudotumor cerebri is a rare disorder of childhood and adolescence characterized by increased pressure from the cerebrospinal fluid that surrounds the brain. Its name reflects the fact that the symptoms are similar to those of brain tumors. Although no tumor is present in this condition, it is nevertheless a serious problem because the pressure can lead to permanent impairment of vision. Pseudotumor cerebri is associated with obesity; up to 50 percent of children with this condition are obese, but the onset of symptoms does not seem to be related to weight gain (Dietz, 1998).

Obesity in children and adolescents is associated with an increased risk of psychological and social problems, especially behavioral problems and low self esteem, which may be linked to the psychological stress of social stigmatization (Dietz, 1998; Reilly et al., 2003). Girls are at

greater risk than boys, and psychological problems are more common among adolescents than among younger children (Reilly et al., 2003). Discrimination against obese adolescents, in areas such as college acceptances and job opportunities, may contribute to these difficulties; there is evidence that substantial discrimination exists, particularly for obese girls (Deitz, 1998). In addition, individuals who were obese as adolescents may continue to view themselves as obese as adults even if they are successful in losing weight, a problem known as body size distortion (J. Stern, personal communication, June 15, 2007).

Obesity in girls is associated with the earlier onset of puberty. Obesity in children is associated with several problems affecting the bones and increases the risk of the rare condition pseudotumor cerebri. Obese children, and especially obese adolescents, have an increased risk of psychological problems linked to the stigmatization of obesity. Significant discrimination against obese young people, especially girls, has been reported.

## SUMMARY

The frequency of overweight, defined as a BMI above the 95<sup>th</sup> percentile for a child's age and sex, among U.S. children and adolescents has more than doubled since the 1970s.

Individuals who are obese in childhood or adolescence have an increased risk of becoming obese adults and therefore of facing all of the health consequences associated with adult obesity. The more extreme the obesity, the more likely these consequences are to occur.

There are 31 comorbidities (coexisting diseases) associated with obesity in adults; many of them also occur in obese children (J. Stern, personal communication, June 15, 2007). Children who are obese are at risk of developing health problems typical of adulthood, including type 2 diabetes mellitus (an especially serious concern because complications of diabetes become increasingly likely when the condition exists for a greater number of years), hypertension, dyslipidemia, abnormalities of liver function, gallbladder disease, and sleep apnea. The metabolic syndrome and asthma are also associated with obesity in children. Polycystic ovary syndrome, which is often associated with obesity in adult women, may begin in adolescence in obese girls.

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# CHAPTER



# 7

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## Obesity in the Elderly

**Overweight and obesity are common among older people in the United States, just as in younger adults.**

Statistics for 2003–2004 indicate that 30.4 percent of American men aged 60 years or older were obese (body mass index [BMI] 30 or higher), and an additional 43.4 percent were overweight (BMI between 25 and 30). Among women, 31.5 percent in this age group were obese, and an additional 37.4 percent were overweight (Ogden et al., 2006). These percentages do not differ greatly from those for middle-aged people in the United States.

Although the prevalence of obesity among older people is similar to that in younger adults, the health effects of obesity may differ with age. Many questions about the effects of obesity in elderly people have been raised, including the following: Does obesity have the same impact on mortality in old age as it does in younger adults? Do the effects of obesity on health (aside from mortality) change as people grow older? Should obese elderly people try to lose weight? This chapter reviews the scientific evidence pertaining to each of these questions.

### OBESITY AND MORTALITY IN THE ELDERLY

A substantial body of scientific evidence indicates that obesity is not as strongly associated with mortality in elderly people as it is in those who are younger.

In the large American Cancer Society follow-up study that was described in Chapter 2 (Calle et al., 1999), the relative increase in the risk of death associated with different degrees of obesity was substantially smaller among people over the age of 75 than among younger people. Similarly, a combined analysis of multiple studies indicated that in people aged 65 years or older, being overweight was not associated with increased mortality, and being moderately obese conferred only about a 10 percent increase in mortality risk (Janssen and Mark, 2007). An analysis of data from a large study of elderly Americans indicated that mortality was lowest for those with BMIs of 25 to 35 — the overweight to moderately obese range — with higher mortality rates for those with

BMI below 25 or above 35 (Al Snih et al., 2007). In another study, obesity had little or no effect on life expectancy in people aged 70 years or older (Reynolds et al., 2005).

Do data like these indicate that being overweight or obese in old age is safer than it is for younger people? Perhaps, but there may also be other factors involved (Zamboni et al., 2005).

Cigarette smoking, which is linked to increased mortality and decreased BMI, may influence the relationship between obesity and mortality in elderly people. Smokers typically weigh less than nonsmokers do, and they have higher mortality rates because of their higher rates of heart disease and many types of cancer. Although researchers try to take the effects of smoking into account when analyzing their data, there is disagreement about how best to do this, and it is possible that the effects of smoking have not been fully corrected for in some analyses. Any residual confounding by smoking could distort the relationship between obesity and mortality. Another factor that may affect the relationship between obesity and mortality in old age is the “survival effect”: obesity may be less strongly associated with mortality in the elderly because those who were obese for a long period of time and were susceptible to the adverse health effects of obesity have already died. Another potentially significant factor is that being thin may have different implications in old age than at earlier stages of life. Among elderly people, thinness or weight loss often reflects the presence of serious underlying health problems, such as cancer or dementia. Heavier people may have a lower mortality risk not because being heavy per se is desirable but because it is an indicator that they do not have a disease that would cause them to be underweight.

Because of the complex effects of factors such as these, the relationship between obesity and mortality in the elderly is a subject of much controversy in the scientific community. It remains uncertain whether

the lesser effect of obesity on mortality in elderly people indicates that obesity is truly less risky in old age or whether the relationship is due primarily to confounding factors such as smoking, the survival effect, or the presence of other illnesses.

## DISABILITY, CHRONIC DISEASE, AND QUALITY OF LIFE

Unlike the scientific evidence on the relationship between obesity and mortality in the elderly, the evidence pertaining to the relationship between obesity and disability, chronic illness, and quality of life in this age group is straightforward. Numerous studies that have examined a variety of aspects of health and functioning have shown that being obese is associated with higher rates of health problems and impairments in old age.

As people grow older, their physical functioning declines because of a decrease in muscle mass and strength and an increase in joint problems. Obesity can worsen this decline, leading to a poorer quality of life, decreased ability to perform everyday activities (including both the basic activities of daily living such as bathing and dressing and more challenging activities such as stair climbing and shopping), and an increased likelihood of needing to be admitted to a nursing home (Villareal et al., 2005).

Some, but not all, of the disability associated with obesity in older adults is due to osteoarthritis. Osteoarthritis is the leading cause of disability in older people (Villareal et al., 2005), and, as is discussed in Chapter 9, osteoarthritis, especially in the knees, is strongly linked to obesity.

Poorer physical functioning, increased disability, and/or knee osteoarthritis may increase an elderly person's risk of falling. Falls are a major health problem among the elderly. One of every three people aged 65 or older falls each year (CDC, 2007). Among elderly people, falls are the leading cause of injuries, hospital admissions for trauma, and deaths due to injury (CDC, 2007).

Obesity in old age is also linked to chronic illnesses, just as it is in younger people. In one study of men aged 60 to 79 years, those who were obese were twice as likely as those of normal weight to have heart disease and three times as likely to have diabetes or to need to take heart-disease-related medications (Wannamethee et al., 2004). The obese men were also twice as likely as the normal-weight men to have locomotor disabilities.

A study that assessed various aspects of health-related quality of life in men and women aged 65 or older showed that obesity was strongly associated with poorer scores for physical aspects of the quality of life — such as physical functioning, energy/fatigue, and pain — and with a poorer perception of one's own health status in both men and women, as well as with poorer social functioning in women only (Yan et al., 2004). In a large follow-up study of U.S. female nurses, data for those aged 65 or older indicated that obesity was associated with poorer health-related quality of life in terms of physical functioning, vitality, and limitations due to physical problems (Fine et al., 1999). In both of these quality-of-life studies, however, obesity in elderly people was not associated with poorer functioning related to mental health problems (Fine et al., 1999; Yan et al., 2004).

Because obesity is associated with multiple health problems in the elderly, it may lead to the increased use of medications, which in turn increases the risk of drug side effects and interactions. Elderly people are at increased risk for adverse effects of drugs because of changes in the way drugs are absorbed, metabolized, and excreted as people grow older (Food and Drug Administration, 2005). The increased proportion of body fat in an obese person influences the metabolism of many of the drugs typically prescribed for elderly people, further increasing the difficulties involved in drug therapy in this age group.

Because obesity is associated with

increased health problems, greater disability, and poorer quality of life in old age, avoiding obesity at this stage of life is worthwhile, despite the uncertainties about the relationship between obesity and mortality. Older people who keep their weight in the normal range may not be assured of living longer, but they have an increased likelihood of living well during their senior years.

## WEIGHT LOSS

The relationship between weight loss and health in older people depends on whether the weight loss is unintentional or intentional.

Unintentional weight loss is associated with poorer health and increased mortality in the elderly. This is to be expected since unintentional weight loss in elderly people is usually a result of physical diseases such as cancer, gastrointestinal diseases, or hyperthyroidism, or psychiatric disorders such as depression (Alibhai et al., 2005; Fischer and Johnson, 1990).

Intentional weight loss is a very different situation. The relatively small number of studies that have examined the effects of intentional weight loss on mortality in older people have either found no relationship or have found evidence of reduced mortality among those with certain chronic diseases such as diabetes (Villareal et al., 2005). Intentional weight loss in elderly people can prevent or improve diabetes and decrease the need for medication to treat high blood pressure (Zamboni et al., 2005). Moderate weight loss in conjunction with increased physical activity has been shown to improve physical function and health-related quality of life in obese older people, including both those who have knee osteoarthritis and those who do not (Villareal et al., 2005). Thus, obese elderly people who succeed in losing weight may be able to improve several aspects of their health and daily lives. Concerns have been raised, however, about the possibility that a poorly planned weight-loss regimen might induce bone loss in elderly people; including weight-bearing exercise in the weight-loss program can

help to prevent this problem (Villareal et al., 2005).

## SUMMARY

The association between obesity and increased mortality is not as strong in elderly people as it is in younger adults. Whether being obese is truly less risky in old age or whether the weaker relationship with mortality is due to confounding factors such as smoking, the survival effect, and other health problems is unclear. Obese elderly people have more chronic illnesses, have a higher risk of functional disabilities, and have a poorer health-related quality of life than normal-weight elderly people do. Preventing obesity in old age is justified on the grounds of avoiding these outcomes, even if it has no effect on mortality. Unintentional weight loss in the elderly is associated with poor health and increased mortality. On the other hand, intentional weight loss in old age may have beneficial effects on obesity-related diseases, physical functioning, and quality of life. Attention should be paid, however, to ensuring that weight-loss programs for older people do not have adverse effects on bone health.

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