Section One
THE BURDEN OF OBESITY

The *American Heritage Dictionary* defines "epidemic" as "a rapid spread, growth, or development" (1). No word more aptly describes the current course of obesity prevalence. The World Health Organization (WHO) estimates that 300 million people worldwide are obese and another 750 million are overweight (2). The health repercussions of the obesity epidemic are staggering. There is increasing global incidence of cardiovascular disease, type 2 diabetes, hypertension, certain cancers, and other obesity-related morbidities. The United States is the undisputed leader in obesity prevalence, with an estimated 97 million overweight or obese adults in this country alone (3).

The United States is a country obsessed with thinness, yet increasing numbers of people are becoming fat. This seeming contradiction has become the subject of thousands of research studies. The one obvious explanation for the increasing obesity rate is that more people are consuming more calories than they are using, i.e., their energy consumption is greater than their energy expenditure. This is simple enough; what is not simple are the reasons this phenomenon has happened so quickly and to such a surprising extent. The causes of obesity fall into two general categories, genetics and environment. The current epidemic is almost certainly a combination of the two.

Genetics. The fat in a person's body is stored in fat cells distributed throughout the body. A normal person has between 25 and 35 billion fat cells, but this number can increase in times of excessive weight gain, to as many as 100 to 150 billion cells. The number of fat cells in the body remains constant after their formation; the cells just expand and shrink in size during weight gain and loss. This has been suggested as one reason weight loss is so hard to maintain for many people, and research is under way to determine methods or medications that will reduce the actual number of cells. Four critical periods have been identified during which time the number of fat cells a person has will increase: between 12 and 18 months of age; between 12 and 16 years of age, especially in females (in fact, the best single predictor of adult obesity is adolescent obesity); in adulthood when an individual gains in excess of 60% of their healthy weight, and during pregnancy (4).

Recent studies of some extremely obese people have discovered a genetic basis for their obesity. In one study, the obese subjects were found to have a genetic defect in the gene coding for a hormone called leptin, which is involved in appetite regulation (5). In another, the subject was lacking an enzyme, PCI, the function of which is to convert another hormone, PMOC, into neuropeptides that regulate appetite. Without converting PMOC, the subject's body could not respond to the leptin (5). Researchers at the Medical College of Wisconsin have isolated an area on one of our 23 pairs of chromosomes that may be the source of abdominal obesity implicated in the development of a condition known as Syndrome X (see page 11) (6). While these findings are intriguing and offer small glimpses into the potential for genetic research into obesity, however, experts say that these genetic defects are rare and are not found in the vast majority of persons at risk from obesity in the U.S. today (4).

This is not to say that the susceptibility for weight gain is not genetic. There are many ways in which genes affect our weight, from our resting metabolic rate, to how we burn calories when we exercise, to how quickly our brains signal us that we are full. Age and gender significantly affect metabolic rate. As persons age, their metabolism normally slows down. Men generally have higher resting metabolic rates than women; women's rates slow down even more dramatically after menopause. In a study conducted by the National Institute of Diabetes and Digestive and Kidney Diseases, the resting metabolic rates of over 500 volunteers were analyzed and found to range from burning as few as 1,067 calories a day to as many as 3,015 calories (7).

Studies of persons adopted at birth have shown no relationship between the adult weights of adoptees and their adoptive parents; instead, the weights of the adoptees more closely resembled, first, the weights of their biological mothers and, secondly, that of their biological fathers (8). In fact, if a biologic mother is heavy as an adult, there is a 75% chance that her children will be heavy (4). In a British study by Parsons et al. maternal weight was found to account for the positive relation noted by many researchers between a larger birthweight and excess weight in adulthood (9).

Genes also play a role in how our bodies react to exercise. Researchers at Laval University in Quebec found a wide variation among young men in a four-month-long program studying the effects of exercise as measured in several ways, including maximal oxygen uptake, heart size, and muscle fiber size (7).

Obesogenic Environment. This all suggests that, while one person might be born with a stronger tendency to gain weight than another, the circumstances must be right for this to happen. Genetics play a role, but the gene pool in America has not changed significantly in the few decades during which obesity has become so prevalent. Genetics must be combined with an environment conducive to gaining weight, an environment that has been termed "obesogenic" (10), in order for the explosive increase in both childhood and adult overweight and obesity to have occurred.

The evolution of our "obesogenic" environment has been both rapid and multifactorial. There has been a tremendous increase in the availability of food, especially high-fat and/or high-calorie food, at the same time that there has been a decrease in the amount of individual physical activity. Researcher James O. Hill of the University of Colorado has observed that, if the obesity epidemic in America is not checked, almost every American will be overweight within just a few more generations. To quote Dr. Hill, "Becoming obese is a normal response to the American environment" (11).

Changing Food Consumption. The home-cooked family dinner is no longer the norm it once was. The increase in one-person households, single-parent families, and families with two working parents has fueled the demand for easily accessible, inexpensive take-out meals. Of the 30 fastest growing franchises in the United States in 1999, 12 were fast food companies (12). According to Dr. David Hunnicutt, president of the Wellness Councils of America, part of McDonald's corporate mission is the goal of establishing enough outlets that Americans are never more than 4.5 minutes from the nearest franchise (12). In 1970, food eaten away from home accounted for 34%

of the average American's food budget; by the late 1990s, this had grown to 47% (13). Snacking has become a way of life in the United States; in 1999, Americans consumed 54.5 gallons of soft drinks, 10.3 pounds of chocolate, and 21.4 pounds of chips, pretzels, and nuts per capita (12).

Not only have our opportunities to find food away from home increased, so have the portion sizes of those foods. In fact, large sizes are now the focus of advertising to lure customers in, whether in the form of supersized meals, 32-, 48-, or even 64-ounce soft drinks, or all-you-can-eat buffets. Dr. Hunnicutt observes that McDonald's original meal of a burger, fries, and a 12-ounce Coke had 590 calories; today, a quarter-pounder with cheese, super-sized fries, and a super-sized Coke packs a walloping 1,550 calories (12), three-quarters of the 2,000 calories a day recommended for many adult women for weight maintenance. Even some "diet" meals are now advertised as larger sized (13), the more the better, it seems, regardless of the consequences.

The additional attraction of the fast food industry is the low cost of many of the items, making this high-fat, calorie-dense diet available to just about everyone. Families can eat out for a reasonable price, teenagers can fit in an extra meal after school, and many workers can afford lunch out on a daily basis. Availability, large portions, and low cost present a combination of factors that many Americans can't resist.

Physical Inactivity. At the same time our diets have taken a turn for the worse, the amount of physical activity in our lives has decreased. A number of studies have suggested that the increasing prevalence of obesity is in fact more strongly related to decreased energy expenditure than to increased energy consumption (14). It is clear that an active lifestyle decreases the risk of several chronic diseases and certain physical and mental disabilities, contributes to more efficient functioning of many of our body's systems, and improves our overall quality of life. The positive benefits of regular physical activity are present throughout life, during childhood, adolescence, and adulthood. None of these benefits is more important than the critical role physical activity plays in weight maintenance throughout the life span.

<u>Childhood and Adolescence.</u> The best way to avoid obesity is to become active in childhood and then maintain an active lifestyle. Regular exercise in childhood and adolescence provides many benefits, including building strong bones and muscles, improving strength and endurance, increasing self-esteem and reducing stress and depression, and conferring some of the same positive effects as with adults, e.g., lower blood pressure and cholesterol levels. Adolescence, in particular, is seen as a critical period for physical activity for several reasons: excess weight in adolescence is a risk factor for adult obesity; physical activity during these years is more likely to be sustained into adulthood; and adolescence is a key time for the development of such risk factors as the onset of coronary artery disease as well as the years of peak development of bone mineral density (15). Unfortunately, these are also the years when levels of activity decline markedly, especially among females. A 1993 study concluded that during the school-age years daily physical activity decreases an average of 2.7% among males and 7.4% among females (15). The daily energy expenditure (relative to body size) of the average 18-year-old is only half of what is was when he or she was 6 years old (15). On the

positive side, leisure-time physical activity at the age of 16 among males decreased by one-half the risk of being sedentary at age 34 (15).

At least three periods of strenuous exercise a week are recommended for children by health experts, but one in every five (20%) children aged eight through 16 in the United States today fails to achieve this (16). According to data provided by the CDC through the School Health Policies and Programs Study 2000 (17), only 71.4% of the states (including the District of Columbia) provided regularly scheduled recess for students in grades kindergarten through five; 82.4% required physical education, but just 8.0% of elementary schools provided daily physical education or its equivalent (150 minutes per week). Among middle/junior high schools, 84.3% of states required students to take physical education, with 6.4% of schools providing it on a daily basis (or 225 minutes per week). Eighty-six (86.3%) of states required students to take physical education in senior high school, with 5.8% providing daily classes (or 225 minutes per week).

Watching television is now the number one leisure-time activity among America's school-age children. A study by researchers at Johns Hopkins University School of Medicine, in collaboration with the CDC, concluded that over one-fourth (26%) of U.S. children watch four or more hours of television a day, and these hours don't include time spent playing video games or sitting at a computer, additional sedentary leisure-time activities. The average high school graduate will have spent approximately 15,000 to 18,000 hours in front of a television set but only about 12,000 hours in school (16). The contribution of TV viewing to childhood obesity is twofold: energy expenditure is decreased through the sedentary nature of the pastime and energy consumption is increased by either eating during viewing or responding to advertisements of high-carbohydrate, high-fat foods aimed at children.

<u>Adulthood.</u> The percentage of adults who are sedentary increases approximately twofold between the ages of 20 and 65. The Behavioral Risk Factor Surveillance System (BRFSS)[1] data from 2000 show a direct association between age and physical inactivity. Only 18.0% of U.S. adults aged 18-24 reported no participation in any physical activity during the month preceding their interview, compared with 34.6% of those aged 65 and older (18). In West Virginia, 13.8% of persons aged 18-24 reported no activity, compared with 36.8% of those aged 65+. The most inactive group in West Virginia, however, were adults aged 35-44; nearly one in four (39.3%) of these individuals reported no activity in 2000 (19). As an individual approaches middle age, weight gains can be particularly hazardous. Many of the chronic illnesses that frequently emerge in middle adulthood have a strong relationship with excess weight, such as type 2 diabetes, cardiovascular disease, osteoarthritis, and hypertension.

The benefits of regular physical activity among older Americans are tremendous. The World Health Organization addressed these benefits in guidelines published in 1997 (20). Among them are

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[1]The BRFSS is a monthly telephone survey established by the CDC that allows states to monitor health behaviors among their adult population (18+). The BRFSS was begun in 1984 with 15 participating states and has monitored obesity since that time, expanding to 52 states and territories in 1997.

improved muscle strength and endurance, balance and coordination, and flexibility, lower blood pressure and blood lipids, and improved cardiovascular fitness, as well as psychological benefits in terms of better cognitive functioning and overall feeling of well-being.

Fewer adults of all ages, however, are expending energy at a rate commensurate with weight maintenance, with our increasing rates of obesity as a result. Just as our increased consumption of fast food has a multifactorial basis, so does our decrease in daily physical activity. Physical activity has decreased in both work- and leisure-related activities, and labor-saving devices abound in our society.

Work-Related Physical Activity. Work no longer provides the opportunity for physical activity that it once did for many Americans. A century ago in the United States there were 11,553,000 farmers; now there are about 851,000 (12). West Virginia employed 59,700 coal miners in 1980. The same amount or more coal is now mined using just 17,600 miners (21). Employment in the steel industry nationwide in the 1990s was less than half of what it was in 1980 (12). And this trend toward sedentary jobs is continuing. While in 1900 80% of the workforce worked in jobs demanding physical labor and 20% in cerebral jobs, it has been estimated that by 2020 the opposite will be true: 80% of the jobs will be cerebral and 20% manual (12).

At the same time that jobs are becoming more sedentary, the work week has been expanding, allowing even less time for leisure-time physical activity. According to research presented by Dr. Hunnicutt of the Wellness Councils of America, the average worker in the United States now works the equivalent of one extra month per year compared to workers in 1970 (12).

Leisure-time Physical Activity. Even as leisure-time activity has become more vital, given our sedentary jobs, the percentage of the adult population reporting such activity has not changed significantly over the past decade. National BRFSS data from 1990 show 71.3% of respondents engaged in some type of leisure-time physical activity; by 2000, this had only risen to 73.1%, meaning that over one-fourth (26.9%) of all adult Americans reported no activity at all (18). In West Virginia, an even higher percentage of adults, 33.6%, reported no activity in 2000 (19).

The CDC and the Surgeon General recommend that *all sedentary adults should accumulate at least 30 minutes of at least moderate-intensity physical activity over the course of most, preferably all, days of the week* (22). Experts agree that to be beneficial, activity does not need to be of high intensity or done all in one session. An example of a "moderate intensity" activity could be moderate to brisk walking, i.e., at a pace of 15-20 minutes per mile, for the recommended 30 minutes. The 30 minutes can be further divided into three walks of 10 minutes each and still meet the recommendation. The emphasis is now on "lifestyle physical activity," that which can be maintained throughout an individual's lifetime.

Without question, a sedentary lifestyle increases the risk of several chronic diseases, depression, a loss of physical functioning, and even premature mortality (22), and, as previously noted, contributes substantially to the risk for obesity. While a review of studies examining the link between physical activity and weight loss concludes that exercise does not significantly increase initial weight loss over and above that obtained with diet alone, physical activity has been determined to be essential in the prevention of weight gain (23). In addition to this benefit, however, physical activity has been found to provide a protective effect on the health risks associated with obesity, conferring health benefits independent of weight changes. In a recent review of studies examining fitness and health outcomes of all-cause mortality, heart disease, type 2 diabetes, hypertension, and cancer, the researchers concluded, "active obese individuals actually have lower morbidity and mortality than normal weight individuals who are sedentary" (14).

DEFINITION OF OBESITY

While the United States and Europe have by far the highest rates of obesity, nonindustrialized countries are also experiencing an increase, particularly those countries undergoing economic transitions and whose residents are becoming more affluent (23). Because obesity is increasingly a worldwide problem, a single international standard has become necessary to monitor its rise. Only with comparable definitions of overweight and obesity can trends be noted and interventions and treatments evaluated.

Definition of Obesity. The World Health Organization adopted the weight classifications developed by the National Institutes of Health (NIH) through an expert panel convened in 1995 that reviewed data from approximately 394 studies to clinically assess the association between weight levels and disease risk (3). These classifications were published in the *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults* in 1998. The panel recommended the use of Body Mass Index (BMI), a measure of weight in relation to height. An individual's BMI is calculated as his or her weight in pounds divided by the square of his /her height in inches times 703. (BMI is also calculated as weight in kilograms divided by the square of height in meters.) Using this measure, the weight categories are

Underweight		<18.5
Normal		18.5 - 24.9
Overweight		25.0 - 29.9
Obesity	Class I	30.0 - 34.9
	Class II	35.0 - 39.9
	Class III	40+

A single measurement that needs only two factors, weight and height, makes it possible to conduct surveillance on a worldwide basis. There are limitations to BMI, of course. It can be overestimated among persons who are very athletic and have large muscle mass, on the one hand, and underestimated among persons who have lost muscle mass, such as the ill and the elderly. It has been recommended that different BMI cutoff points be used to determine overweight and obesity in certain racial groups (25). In general, however, BMI is considered to be a reliable indication of total body fat content for most adults, regardless of sex. A body mass index chart of height and weight is found on page 8.

BMI-for-Age. Participants at a workshop on childhood obesity convened by the International Task Force on Obesity agreed upon the use of BMI as a reasonable index of excess weight in children and adolescents (26). However, as children grow, their body fat composition changes, so BMI must be applied differently among this population, dependent upon the age of the child. Since boys and girls also differ in their body fatness during the growth period, it is necessary to plot BMI-for-age by sex. In general, BMI tends to decrease during the preschool years, reaching a minimum from ages four to six, and then gradually increases through adolescence into adulthood. Centers for Disease Control and Prevention growth charts for children and adolescents aged two to 20 are used to indicate the percentile into which the child's BMI falls; it is this percentile that determines whether or not the child is considered underweight, normal weight, or overweight. Growth charts are found on page 9.

Cutoff points were established by a committee of experts representing professions that treat obese children and adolescents (27). The cutoff points recommended by the expert committee were

Underweight	BMI-for-age $<5^{th}$ percentile
At risk of overweight	BMI-for-age >or = 85^{th} percentile
Overweight	BMI-for-age > or = 95^{th} percentile

Other Body Fat Measurements. Other body fat measurements include waist circumference, ratio of waist circumference to hip circumference, and skinfold thicknesses. It has been suggested that excess abdominal (visceral) fat poses an additional and independent risk for certain obesity-related diseases such as type 2 diabetes and cardiovascular disease (28); waist circumference and waist/hip circumference ratio can specifically target abdominal fat. Measurements of skinfold thicknesses can be helpful in providing an assessment of percentage of body fat, as well as location of fat. Both these measurements, however, are more difficult to obtain than simple weight and height, and many researchers do not believe them to be superior to BMI as an overall indicator of disease risk from excess adiposity, or fat.

U.S. OBESITY PREVALENCE

Obesity Prevalence among Adults. The United States has the unwanted distinction of leading the way in obesity prevalence. The National Center for Health Statistics (NCHS), CDC, used data from the National Health Examination Survey (NHES I: 1960-62) and the National Health and Nutrition Examination Surveys I, II, and III (NHANES I: 1971-74; NHANES II: 1976-80; NHANES III: 1988-94) to compare prevalences of overweight and obesity among the nation's adults over nearly half a century (29). The researchers used the BMI categories listed on page 6. Overall, the

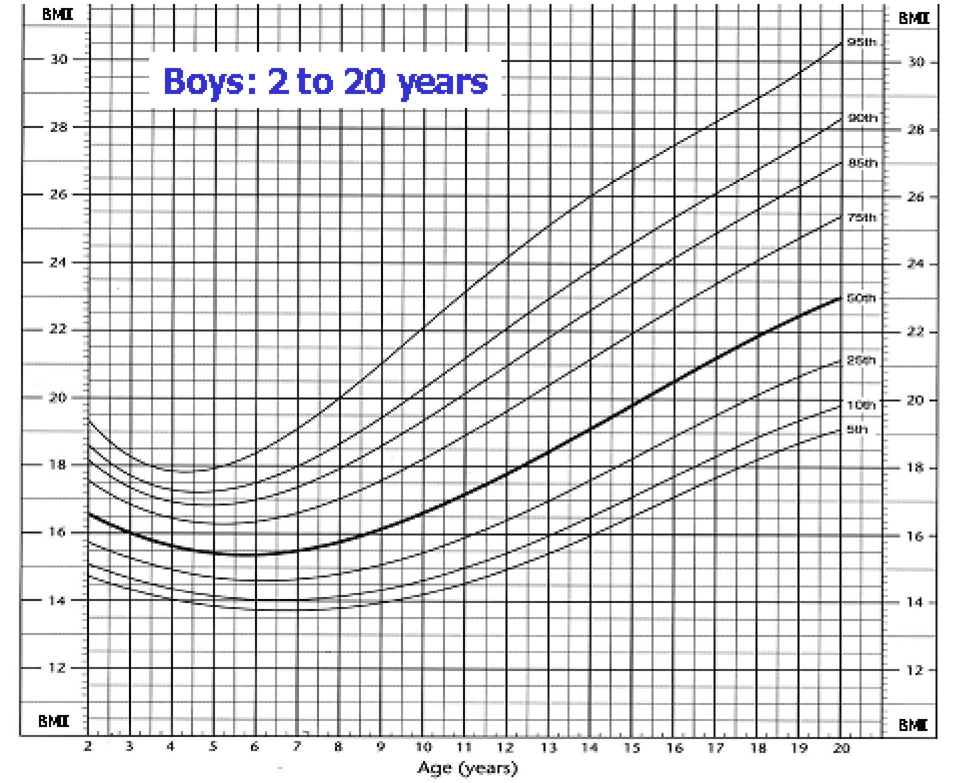
Under weight	Healthy Weight	Over Weight	Obese

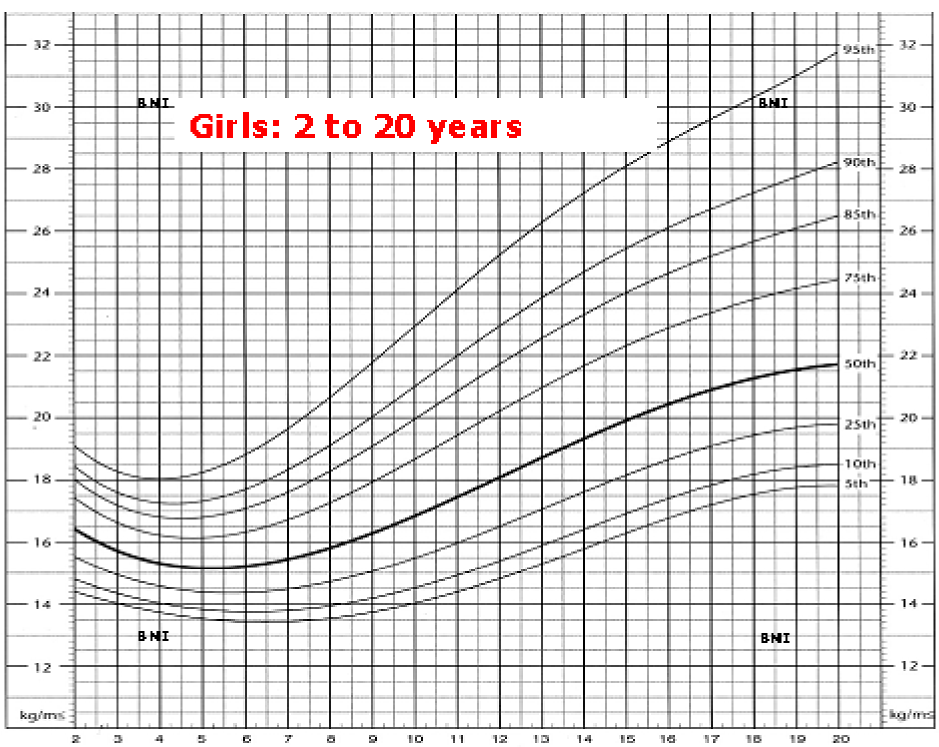
Body Mass Chart

Weight x Height

BMI	Height																		
	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
Weight	4'10"	4'11"	5'0"	5'1"	5'2"	5'3"	5'4"	5'5"	5'6"	5'7"	5'8"	5'9"	5'10"	5'11"	6'0"	6'1"	6'2"	6'3"	6'4"
100	21	20	20	19	18	18	17	17	16	16	15	15	14	14	14	13	13	13	12
105	22	21	21	20	19	18	18	18	17	16	16	16	15	15	14	14	14	13	13
110	23	22	22	21	20	20	19	18	18	17	17	16	16	15	15	15	14	14	13
115	24	23	23	22	21	20	20	19	19	18	18	17	17	16	16	15	15	14	14
120	25	24	23	23	22	21	21	20	19	19	18	18	17	17	16	16	15	15	15
125	26	25	24	24	23	22	22	21	20	20	19	18	18	17	17	17	16	16	15
130	27	26	25	25	24	23	22	22	21	20	20	19	19	18	18	17	17	16	16
135	28	27	26	26	25	24	23	23	22	21	21	20	19	19	18	18	17	17	16
140	29	28	27	27	26	25	24	23	23	22	21	21	20	20	19	19	18	18	17
145	30	29	28	27	27	26	25	24	23	23	22	21	21	20	20	19	19	18	18
150	31	30	29	28	27	27	26	25	24	24	23	22	22	21	20	20	19	19	18
155	32	31	30	29	28	28	27	26	25	24	24	23	22	22	21	20	20	19	19
160	33	32	31	30	29	28	28	27	26	25	24	24	23	22	22	21	21	20	20
165	35	33	32	31	30	29	28	28	27	26	25	24	24	23	22	22	21	21	20
170	36	34	33	32	31	30	29	28	27	27	26	25	24	24	23	22	22	21	21
175	37	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	23	22	21
180	38	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	23	22
185	39	37	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23	23
190	40	38	37	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24	23
195	41	39	38	37	36	35	34	33	32	31	30	29	28	27	27	26	25	24	24
200	42	40	39	38	37	36	34	33	32	31	30	30	29	28	27	26	26	25	24
205	43	41	40	39	38	36	35	34	33	32	31	30	29	29	28	27	26	26	25
210	44	43	41	40	38	37	36	35	34	33	32	31	30	29	29	28	27	26	26
215	45	44	42	41	39	38	37	36	35	34	33	32	31	30	29	28	28	27	26
220	46	45	43	42	40	39	38	37	36	35	34	33	32	31	30	29	28	28	27
225	47	46	44	43	41	40	39	38	36	35	34	33	32	31	31	30	29	28	27
230	48	47	45	44	42	41	40	38	37	36	35	34	33	32	31	30	30	29	28
235	49	48	46	44	43	42	40	39	38	37	36	35	34	33	32	31	30	29	29
240	50	49	47	45	44	43	41	40	39	38	37	36	35	34	33	32	31	30	29
245	51	50	48	46	45	43	42	41	40	38	37	36	35	34	33	32	32	31	30
250	52	51	49	47	46	44	43	42	40	39	38	37	36	35	34	33	32	31	30
255	53	52	50	48	47	45	44	43	41	40	39	38	37	36	35	34	33	32	31
260	54	53	51	49	48	46	45	43	42	41	40	38	37	36	35	34	33	33	32
265	56	54	52	50	49	47	46	44	43	42	40	39	38	37	36	35	34	33	32
270	57	55	53	51	49	48	46	45	44	42	41	40	39	38	37	36	35	34	33
275	58	56	54	52	50	49	47	46	44	43	42	41	40	38	37	36	35	34	34
280	59	57	55	53	51	50	48	47	45	44	43	41	40	39	38	37	36	35	34
285	60	58	56	54	52	51	49	48	46	45	43	42	41	40	39	38	37	36	35
290	61	59	57	55	53	51	50	48	47	46	44	43	42	41	39	38	37	36	35
295	62	60	58	56	54	52	51	49	48	46	45	44	42	41	40	39	38	37	36
300	63	61	59	57	55	53	52	50	49	47	46	44	43	42	41	40	39	38	37

GROWTH CHARTS FOR CHILDREN AND ADOLESCENTS





age-adjusted prevalence of overweight among adults aged 20-74 changed little over the time period (NHES I: 30.5%; NHANES I: 32.0%; NHANES II: 31.5%: and NHANES III: 32%). Obesity prevalence (BMI 30.0+), however, increased dramatically between NHANES II and NHANES III (NHES I: 12.8%: NHANES I: 14.1%; NHANES II: 14.5%; and NHANES III: 22.5%). The trends were consistent for all age, gender, and racial groups.

In 2000, the BRFSS (18) estimated a median obesity prevalence of 20.4% among adults, a slightly lower prevalence than that from NHANES III due to the inclusion of adults aged 18-19 and 75+, two groups traditionally less likely to be overweight or obese[2]. Overweight (BMI 25.0-29.9) was estimated at 36.7%, leaving only 42.9% of adult Americans not at risk for health problems related to excess weight. In West Virginia, the obesity prevalence in 2000 was 23.2%, 5th highest in the nation. Another 36.5% of adults were overweight (19).

Overweight Prevalence among Children and Adolescents. The number of overweight children and adolescents, i.e., those with a BMI of equal to or greater than the 95th percentile for children of the same age and sex, increased by 100% between NHANES II in 1980 and NHANES III in 1994 (31). According to NHANES III data, approximately 14% of children in the U.S. were overweight at the beginning of the 1990s, increasing to about one in five by adolescence (32), and preliminary findings from NHANES IV suggest that childhood overweight continues to increase (31).

Strauss and Pollack analyzed data from the National Longitudinal Survey of Youth (NLSY) to ascertain trends in overweight prevalence among 8,270 U.S. children aged four to 12 in 1986 who were followed until 1998. The researchers examined overweight by sex, race/ethnicity (African American, Hispanic, and non-Hispanic white), family income level, and region of residence. Their findings showed that overweight increased from 1986-1998 among all demographic variables studied. The largest increases, however, occurred among boys, African Americans, Hispanics, and children living in the southern states (33). Over the study period, overweight increased more than 120% among African Americans and Hispanics and by more than 50% among white children. They also found that the relative weight of overweight children also increased, indicating that the severity as well as the prevalence of overweight has increased. The racial and ethnic disparities were found to remain even when controlling for family income. The same general trends appeared when the researchers examined those children at risk for overweight (BMI between the 85th and 95th percentiles).

OBESITY AND COMORBID CONDITIONS

Obesity contributes to numerous and varied comorbid conditions. Complications can occur in many organ systems, ranging from cardiovascular to respiratory to orthopedic and even

[2]While NHANES weight and height were measured by health professionals, BRFSS data are self reported, and several studies have found that participants in self-reported studies tend to underestimate their weight and overestimate their height; thus, the true rates of obesity are likely to be underestimated (30). In addition, persons without telephones are not surveyed through BRFSS. These persons are likely of lower socioeconomic status, a demographic factor associated with obesity.

ophthalmologic. Overweight and obesity are known risk factors for heart disease, diabetes, hypertension, gallbladder disease, osteoarthritis, sleep apnea and other breathing problems, and some cancers (uterine, breast, colorectal, kidney, and gallbladder). In addition, obesity is associated with pregnancy complications, high blood cholesterol, menstrual irregularities, hirsutism (excessive hair growth), stress incontinence, psychological disorders, and increased surgical risk. Social discrimination against obese persons has a strong negative effect on their quality of life.

Insulin Resistance Syndrome (Syndrome X). Obesity is one of a constellation of markers for coronary heart disease and type 2 diabetes collectively known as Syndrome X, metabolic syndrome, or insulin resistance syndrome. Visceral, or abdominal, fat is believed by many (but not all) researchers to be more strongly associated with Syndrome X than subcutaneous fat (34). Abdominal adiposity is an active metabolic tissue and releases fatty acids, which accumulate in the liver and peripheral tissues, reducing the effect of insulin on liver and muscle cells. The free fatty acids are utilized by the muscles at the expense of glucose, causing elevated levels of glucose in the blood that in turn result in increased insulin output by the pancreas (34). Those individuals unable to produce the large amounts of insulin needed to manage the elevated glucose levels in the blood go on to develop type 2 diabetes (35). However, even those individuals who do not develop type 2 diabetes are at increased risk for coronary heart disease; hyperinsulinemia (elevated levels of insulin) is associated with the other manifestations of Syndrome X: hypertension, increased total cholesterol levels with low HDL and high LDL, and increased triglyceride levels, all cardiovascular disease risk factors.

Data from the Bogalusa (Louisiana) Heart Study (36), an ongoing community-based study of CVD risk factors in early life begun in 1972, were examined to ascertain if childhood adiposity was also associated with Syndrome X. Researchers found that childhood BMI and insulin levels were significant predictors of adult Syndrome X clustering (obesity, hyperinsulinemia, high blood pressure, and adverse levels of total cholesterol and triglycerides). BMI was the strongest predictor, independent of familial insulin levels, reinforcing the need to control weight in childhood and adolescence. A separate study by Vanhala et al. found that children who were obese at age seven were four times more likely to have Syndrome X as adults (37).

Weight loss can dramatically improve insulin resistance in obese persons, with a resultant decrease in insulin and triglyceride levels, according to Gerald Reaven, the researcher who first described Syndrome X (35). A modest (15-pound) weight loss has been shown to improve Syndrome X manifestations, including hypertension and high cholesterol and triglyceride levels. Regular physical activity will also reduce Syndrome X risk factors . However, while physical activity and weight loss each independently reduce insulin resistance, the benefits of physical activity are reversed when the exercise is stopped while weight loss benefits remain as long as weight is not regained.

Diabetes. Obesity is the single most reliable predictor of type 2 diabetes. As noted above, excess weight, especially abdominal weight, causes insulin resistance, in part from increased fatty acid levels released by adipose tissue. Higher levels of blood fats inhibit glucose utilization by the muscles, increase accumulation of fats in the liver, and stimulate insulin secretion, causing hyperinsulinemia, which plays a significant role in the development of type 2 diabetes.

The link between elevated BMI and an increased risk for type 2 diabetes has been demonstrated in various populations, including those with both traditionally low and high rates of diabetes. Type 2 diabetes was formerly called adult-onset diabetes, a designation no longer applicable as it is now being diagnosed with alarming frequency among young adults, adolescents, and even younger children (38). A recent study by researchers at Yale University of 167 obese children and adolescents found that 25% of the children and 21% of the adolescents had impaired glucose tolerance, an established risk factor of type 2 diabetes (38). Pediatric type 2 diabetes has been found to occur most frequently among obese females aged 12 to 14 years (39). As the prevalence of obesity increases across all ages, races, and ethnicities, so does the risk of diabetes and its complications.

According to researchers presenting to the Academy of Managed Care Pharmacy in 1999, obesity is responsible for 61% of type 2 diabetes reported in the United States. Wolf and Colditz found that obese individuals have a 27.6-times excess risk of developing type 2 than do normal-weight persons (40). Severely obese people, those with BMIs of 40+, are over 53 times at risk for type 2 diabetes. Even minimal overweight poses a risk; the Nurses' Health Study reported that women with BMIs in the range of 24-24.9 had a 5-fold greater risk of diabetes when compared with women with BMIs of less than 22 (41). Data from the Professionals Health Study demonstrated the same relationship between body weight and type 2 diabetes among men. The risk of diabetes among men with a BMI of 35+ was 42 times that of men with a BMI of less than 23 (42).

Among both men and women in the aforementioned studies, changing body weight was a significant predictor of the risk for type 2 diabetes. Those individuals who gained weight in adulthood were more likely than those who maintained a stable weight to develop diabetes. Conversely, persons who lost that extra weight lowered their risk.

In an article published in 2001 in *Diabetes Care*, Boyle, Honeycutt et al. projected that the number of persons in the United Sates with diagnosed diabetes will increase 165% between 2000 and 2052, from approximately 11 million persons to 29 million persons (43). Their estimates, which utilize demographic, population growth, and prevalence rate projections, are based on a linear increase; they point out, however, that prevalence increased 16% between 1980 and 1984 and 33% between 1990 and 1998. If the rate of increase continues to be nonlinear, their projections are underestimates and the problem will be even more severe. In 2000, it was reported that Eli Lilly & Co. was building the largest pharmaceutical factory in the history of the industry to be dedicated to the production of a single drug: insulin (11).

Hypertension. High blood pressure is one of the most common complications of obesity, especially abdominal adiposity. Obesity-related hypertension appears to be associated with the same hormonal substances (cytokines) produced by adipose tissue that result in hyperinsulinemia and the frequent development of type 2 diabetes. It has been suggested that hyperinsulinemia increases sodium absorption; kidney abnormalities affecting sodium and water reabsorption are significantly correlated with obesity-related hypertension. Increased cardiac output, heart rate, and increased circulating blood volume are also associated with obesity-related hypertension. All of the mechanisms by which obesity influences blood pressure are to date not totally understood; what is clear is that obesity-related hypertension is a well-documented phenomenon that is multifactorial and complex.

King and Wofford write that one-third of all hypertension cases are related to obesity, while being obese raises the risk for developing hypertension threefold (44). Data from the cohort of 5,209 men and women in the Framingham Heart Study indicate that for every 10-pound weight gain, systolic blood pressure rose by an average of 4.5 mm Hg (44). Conversely, a decrease of 1 kg. (2.2 pounds) in body weight results in a decrease of 0.3 to 1 mm Hg.

Even a modest weight loss (i.e., 5%-10% of body weight) can reduce blood pressure, and this appears to be independent of sodium reduction (45). The Nurses' Health Study reinforced the findings that weight gain in middle age is a risk factor for hypertension (46). According to that study, women gaining only 2.1 to 4.9 kg in middle age had a 29% increase in risk; women gaining 5.0 to 9.9 kg had a 74% increase in risk. A dramatic fivefold increase was found among women who gained 25 kg or more after the age of 18. A weight loss of 10 or more kg resulted in a 26% reduction in risk. Researchers using data from the Bogalusa Heart Study of five to 17-year-olds found that overweight children were 2.4 times as likely to have elevated diastolic blood pressures and 4.5 times as likely to have elevated systolic blood pressures as were their normal-weight counterparts (47).

Hypercholesterolemia. Elevated cholesterol levels have long been recognized as having an association with obesity. Obesity tends to result in an elevation in total cholesterol and triglycerides and a reduction in high-density cholesterol (HDL). Abdominal obesity can cause an increased production of low-density cholesterol (LDL) particles that are smaller and denser than normal, putting an individual at greater risk of atherosclerosis, as well as increased very-low-density lipoprotein (VLDL) and decreased HDL (48). It has been estimated that, on average, each 10 pounds of excess fat produces an additional 10 mg. of cholesterol daily, the equivalent of eating one extra egg yolk every day (49).

Data from the Third National Health and Nutrition Examination Survey (NHANES III) indicate that the prevalence of elevated cholesterol levels increased among younger men and women (less than 55 years of age) in all overweight and obese classes compared with the reference group (BMI of 18.5-24.9), but levels did not increase significantly with increasing weight class. Among older persons, elevated cholesterol levels were significantly increased only among overweight subjects (BMI of 25-29.9) (50). Overweight children in the Bogalusa Study were 2.4 times more likely to have total cholesterol levels of greater than 200 mg/dl than normal-weight children and adolescents (47).

Low-Grade Inflammation. Recent studies have indicated that obesity is also associated with low-grade systemic inflammation. Adipose tissue produces interleukin-6, a component of the immune system that stimulates chronic inflammation, a condition that can increase an individual's risk for cardiovascular disease. This inflammation can be measured through the concentration of C-reactive protein (CRP) in the blood, with an increased risk of CVD directly associated with increasing CRP levels. A 1999 study by Visser et al. examined NHANES III data collected on over 16,000 adults from 1988-94 and found that both overweight and obese men and women were more likely to have elevated CRP levels than their lower-weight counterparts (51). A separate study by Visser et al. of 3,512 children aged eight to 16 showed that overweight children were also more likely to have elevated CRP than normal-weight children (52). The overweight children also had higher white blood cell counts, a further indication of low-grade inflammation.

Cardiovascular Disease. Obesity leads to an increase in both heart attacks and strokes, independent of the effects associated with diabetes, hypertension, and elevated cholesterol (49). As with diabetes and hypertension, abdominal fat appears to be of special concern in the development of cardiovascular disease. Both young and middle-aged men and women have been found to be more likely to develop heart disease than their leaner counterparts (53). Again using data from the Nurses' Health Study, the risk for developing coronary heart disease (CHD) almost doubled among women with a BMI between 25 and 29 and more than tripled among those with a BMI of greater than 29 when compared with women whose BMI was less than 21 (48). In a study of British men published in the *British Medical Journal* in 1997, an increase of 1 kg/m in BMI above 22 was associated with a 10% increase in CHD incidence (48).

In addition to an increased risk of CHD, obesity has been associated with myocardial hypertrophy, cardiomyopathy, and congestive heart failure (48). Excess adipose tissue requires an increase in blood flow, the supply of which requires greater cardiac output and increased cardiac workload. As with hypertension, weight gain after the young adult years results in additional risk independent of initial weight or other risk factors associated with the gain (54).

Gallbladder Disease. The increased production of cholesterol in obese persons also results in the increased incidence of gallstones in both men and women. Approximately one in four obese individuals develops gallstones, often necessitating surgery (49). Women of all ages and men under the age of 55 exhibited the strongest association between increasing obesity and increased incidence of gallbladder disease, according to NHANES III data (53).

Liver Disease. Obesity is also a risk factor for liver disease, in particular nonalcoholic steatohepatitis (NASH) or "fatty liver." The degree of fatty change in the liver is directly related to the category of obesity and is thought to result from the accumulation of triglycerides in the liver. According to one study, 80% of morbidly obese (BMI>40) individuals were found to have fatty changes in the liver (48). If not identified and treated, NASH can progress to cirrhosis. It is estimated that approximately 12% of all cirrhosis cases are related to obesity (55).

Cancer. The World Health Organization estimates that between one-fourth and one-third of cancer cases in the world are attributable to excess weight and physical inactivity (56). Even moderate weight gain can put an individual at risk for certain cancers. "Gaining half a pound a year or five pounds per decade" can be dangerous, according to Dr. George Bray of Louisiana State University Medical Center (56). The American Cancer Society has published data showing increased mortality for colorectal and prostate cancer among obese men and for postmenopausal breast, endometrial, cervical, ovarian, and gallbladder cancer among obese women (48). Recent data have suggested a link between obesity and colon cancer for both sexes (53). In fact, the Centers for Disease Control and Prevention released data showing odds ratios for colon cancer of 1.79 for an individual with a BMI of 22-24 and 3.72 for one with a BMI of 28-30 when compared with both men and women with BMIs of less than 22 (48).

Obesity increases the risk of women developing hormone-related cancers. Among postmenopausal women, women who gained more than 44 pounds (20 kg) after the age of 18 were twice as likely as other women to get breast cancer. As adipose tissue is the main source of estrogen for postmenopausal women, this risk is limited to those women who do not use hormone replacement therapy (48). Endometrial cancer is the most common gynecological cancer among U.S. women, and obesity has been shown to increase the risk of developing this cancer, especially in older women (53).

Female Reproductive System Disorders. Decreased fertility has been noted among obese premenopausal women, along with pregnancy complications, menstrual irregularity, and anovulatory cycles (48). Hirsutism (the presence of excess body and facial hair) has been associated with obesity, as has stress incontinence caused by weak pelvic-floor muscles (57).

Osteoarthritis. The Arthritis Foundation estimated that approximately 16 million people in the United States had osteoarthritis, the breakdown of cartilage in the joints, in 2000 (53). Osteoarthritis is most commonly found in the hip, knee, and carpometacarpal joint of the hand. A study of middle-aged women published in 1996 in the *Journal of Rheumatology* estimated that for every 1 kg of weight gained, the risk of osteoarthritis of the knee and hand increased by 9%-11% (48). A Finnish study of 7,000 adults found that the odds ratio for osteoarthritis was 2.8 among persons with a BMI of 35 compared with those with a BMI of 25 (48). Conversely, the Framingham study reported that a decrease in BMI of 2 or more, even over a 10-year period, reduced the risk of developing osteoarthritis in the knee by more than 50% (48).

Asthma. A 1999 study of NHANES II data examined the link between childhood obesity and increased asthma incidence and found that the heaviest children were 77% more likely to have asthma symptoms (58). Researchers have suggested that the increased weight on the lungs compromises the airways, causing asthma symptoms; in addition, excess weight could lead to inflammation in the respiratory tract.

Obstructive Sleep Apnea. It has been estimated that as many as 60% to 70% of persons suffering from obstructive sleep apnea (OSA), a condition characterized by short repetitive episodes of impaired breathing during sleep, are obese (59). Obesity, especially in the upper body, increases the risk for OSA by narrowing the individual's upper airway. OSA can result in systemic hypertension, myocardial ischemia, cardiac arrhythmia, and stroke.

Pseudotumor Cerebri. Pseudotumor cerebri, or idiopathic intracranial hypertension, refers to a condition of elevated cerebrospinal fluid pressure without having a mass in the brain. Pseudotumor cerebri is characterized by headache, neck and back pain, double vision, and episodes of vision loss due to swollen optic nerves. Unless treated, the condition can lead to blindness. While the cause for the condition is as yet unknown, it occurs most frequently among overweight and obese females of childbearing age. Approximately 90% of affected persons are obese, with women two to eight times more at risk than men (60).

Psychological Disorders. There are numerous theories concerning the link between obesity and depression. Many causes have been proposed, including social stigma, negative self-image, dieting issues, the poor health that often accompanies obesity, and a neurochemical connection between the two conditions.

Obesity has been associated with compulsive eating and binge eating disorders, each of which is independently linked to major depression. These disorders are forms of food addiction, a behavior typified by a loss of control over the amount of food consumed, whether on a consistent basis or in the form of binging. It has been estimated that over 30% of persons seeking medical treatment for obesity are binge eaters, as are 50% of persons seen in nonmedical weight-reduction programs (61). Binge eaters often crave and subsequently overeat carbohydrates, avoiding foods that are protein-rich; perhaps two-thirds of all obese persons are carbohydrate cravers (62).

Social Disorders. In general, the obese have poorer prospects than their leaner counterparts in many endeavors. Landlords are less likely to rent to obese individuals (63). In the workplace, there is increased absenteeism among obese persons (63). Several studies have found that heavier women earn less than normal-weight women (64). This association, however, held true only among obese versus nonobese white women; little difference in income was found among African-American women. In their examination of discrimination against the obese in the workplace, Roe and Eichwort reported that 16% of employers interviewed would not employ obese persons and 44% would only employ such persons under special circumstances (63).

Two studies found that, even with comparable scholastic achievements, obese students were not accepted at prestigious colleges as often as normal-weight students (63). A study of 1,500 white, black, and Hispanic children followed from age 10 until age 14 reported that significantly lower self-esteem was observed by age 14 among obese children of all races. These children were also found to be more likely to engage in risky behaviors such as alcohol and tobacco use (65). Early adolescence was determined to be a critical time for overweight and obese children, for it is during these years that they are developing their sense of self-worth.

OBESITY AND MORTALITY

According to the National Institutes of Health, obesity and overweight together are the second leading cause of preventable death in the United States, close behind tobacco use (3). An estimated 300,000 deaths per year are due to the obesity epidemic (57).

The results of two extensive studies examining obesity-attributable deaths in the United States were published in 1999. Allison, Fontaine, and Manson et al., reporting in the *Journal of the American Medical Society*, used data from a number of prospective cohort studies, including the Alameda Community Health Study, the Framingham Heart Study, the Tecumseh Community Health Study, the American Cancer Society's Cancer Prevention Study I, the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study, and the Nurses' Health Study, to estimate the number of deaths attributable to obesity in the United States on an annual basis (66). Their initial analyses, which examined deaths occurring among persons aged 18 and older in 1991, were adjusted only for age, sex, and smoking status. The weight categories used were overweight (BMI of 25-29.9), obese (BMI of 30-35), and severely obese (BMI >35).

Using data on all eligible subjects from all six studies, Allison et al. estimated that 280,184 obesity-attributable deaths occurred in the U.S. annually. When risk ratios calculated for nonsmokers and never-smokers were applied to the entire population (assuming these ratios to produce the best estimate for all subjects, regardless of smoking status, i.e., that obesity would exert the same deleterious effects across all smoking categories), the mean estimate for deaths due to obesity was 324,940.

Additional analyses were performed controlling for prevalent chronic disease at baseline using data from the CPS1 and NHS. After controlling for preexisting disease, the mean annual number of obesity-attributable deaths was estimated to be 374,239 (330,324 based on CPS1 data and 418,154 based on NHS data).

Calle, Thun et al. selected their study subjects from over one million participants in the Cancer Prevention Study II, a prospective study of mortality among adults in the U.S. begun by the American Cancer Society in 1982 (67). Calle et al. examined deaths occurring between 1982 and 1996 among four cohorts: (1) current or former smokers with no history of disease[3], (2) current or former smokers with a history of disease, (3) nonsmokers with no history of disease, and (4) nonsmokers with a history of disease. Weight categories were normal range (18.5-24.9), grade 1 overweight (25.0-29.9), grade 2 overweight (30.0-39.9), and grade 3 overweight (40.0+). All cause mortality, cardiovascular disease (CVD) mortality, and cancer mortality were examined.

The lowest mortality rates from all causes were found among study subjects having a BMI of between 23.5-24.9 for men and 22.0-23.4 for women. The risk of mortality increased with increasing BMI at all ages and for all categories of death. The strongest association between obesity and death from all causes was found among study subjects who had never smoked and had no history of disease, with the highest rates among the heaviest men and women, i.e., those with a BMI of 40+. The relative risk (RR) was 2.68 among men and 1.89 among women, compared with the reference groups (a BMI of 23.5-24.9 among men and 22.0-23.4 among women). This association was stronger in whites than among blacks.

Obesity was associated with higher mortality rates for both cardiovascular disease and cancer. BMI was most strongly associated with cardiovascular disease mortality among men (RR=2.90), but significantly increased risks of CVD death were found at all BMIs of greater than 25.0 in women and 26.5 in men. The findings showed an increase of 40% to 80% in risk of dying from cancer among both men and women in the highest weight categories.

Calle et al.'s study supports the need for further research to ascertain the differences in the effect of obesity on mortality among the black population, especially among black women. Their data also support the use of a single recommended range of body weight throughout life.

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[3]Cancer (excluding nonmelanoma skin cancer), heart disease, stroke, respiratory disease, current illness of any type, or a weight loss of at least 10 pounds in the preceding year.

An earlier (1995) study by Manson, Willett, and Stamfer et al. examined data from the Nurses' Health Study, looking at 4,726 deaths occurring from 1976 through 1992, 881 from cardiovascular disease, 2,586 from cancer, and 1,259 from other causes (68). A direct association was observed between BMI and mortality among women who had never smoked. Using a BMI of <19.0 as the reference group (relative risk [RR]=1.0), women with BMIs of 19.0-21.9 and 22.0-24.9 had a RR of 1.2; women with a BMI of 25.0-26.9 had a RR of 1.3; women with a BMI of 27.0-28.9 had a RR of 1.6; those with a BMI of 29.0-31.9 had a RR of 2.1; and those with a BMI of >32.0 had a RR of 2.2. Among never smokers, women with a BMI of >32 had a RR of 4.1 of dying from cardiovascular disease and a RR of 2.1 of dying from cancer.

THE ECONOMIC COSTS OF OBESITY

There have been numerous estimates of the economic costs of overweight and obesity. Among the most frequently cited are the direct and indirect health care costs calculated by Wolf and Colditz and published in *Obesity Research* in 1998 (69). The researchers based their estimates on weighted data from the 1988 and 1994 National Health Interview Surveys, inflating the results to reflect 1995 dollars. These estimates were those utilized by the National Institutes of Health at the time this report was undertaken.

To estimate health care costs attributable to obesity, Wolf and Colditz used a prevalence-based approach including the obesity-related diseases of type 2 diabetes, coronary heart disease, hypertension, gallbladder disease, colon, breast, and endometrial cancers, and osteoarthritis. The total costs of each of these diseases to the economy were divided among direct medical costs (i.e., preventive, diagnostic, and treatment services such as personal health care, physician visits, hospital care, medications, nursing home care, and the like) and indirect health care costs (i.e., costs resulting from a reduction or cessation of productivity due to disease such as lost wages, lost future earnings, etc.).

The total cost of overweight and obesity to the U.S. economy in 1995 dollars was $99.2 billion, approximately $51.6 billion in direct costs and $47.6 billion in indirect costs. By disease, the authors estimated the following breakdowns:

- Type 2 diabetes: $63.1 billion
  - direct cost: $32.4 billion
  - indirect cost: $30.7 billion

- coronary heart disease: $7.0 billion (direct cost)

- colon cancer: $2.8 billion
  - direct cost: $1 billion
  - indirect cost: $1.8 billion

- post-menopausal breast cancer: $2.3 billion
  - direct cost: $840 million
  - indirect cost: $1.5 billion

- endometrial cancer: $790 million
  - direct cost: $286 million
  - indirect cost: $504 million

- hypertension: $3.2 billion (direct cost)

- osteoarthritis: $17.2 billion
  - direct cost: $4.3 billion
  - indirect cost: $12.9 billion

Using 1994 NHIS data, Wolf and Colditz estimated that nationally 39.3 million workdays were lost annually to obesity-related causes; in addition, obesity was responsible for 239.0 million restricted-activity days, 89.5 million bed-days, and 62.7 million physician visits. Compared with the 1988 NHIS data, the number of restricted-activity days increased 36%, bed-days increased 28%, lost work days increased 50%, and physician visits increased by 88%.

While Wolf and Colditz estimated that the $51.6 billion in direct medical costs attributable to obesity represented 5.7% of total health care expenditures in 1995, researchers from Columbia University have recently refuted their statistics, estimating direct health care costs at approximately $39 billion, or 4.3% of total annual U.S. health care expenditures (70). They point out that the higher mortality rates of obese persons decrease direct medical costs; because of this, however, the indirect costs of obesity may be larger than originally estimated due to lost productivity.

Two related studies have been conducted using data from Kaiser Permanente, a large health maintenance organization operating in nine states and the District of Columbia at the time of this report. In a 1993 analysis by Quesenberry et al. of cost and service utilization of 17,118 members of Kaiser Permanente, Northern California Region, significant associations were found between having a BMI of 30 or greater and higher inpatient and outpatient costs, increased physician visits, medication costs, laboratory services, and number of inpatient days (71). Total excess costs to the health plan among obese participants amounted to $220 million, or about 6% of the total outlay for all plan members.

A 1998 retrospective cohort study by Thompson et al. examined future health care costs among 1,286 members of Kaiser Permanente Northwest who, when surveyed in 1990, were 35 to 64 years old, had a BMI of 20 or greater, did not smoke cigarettes, and did not have a history of cancer, AIDS, stroke, or coronary heart disease (72). Health care costs were then tallied for these subjects over the nine-year period from 1990-98 and compared by 1990 BMI category (20-24.9, 25-29.9, and 30+). The researchers found that cumulative total health care costs over the time period increased with BMI. Total costs for subjects having BMIs of 20-24.9 were $15,583, compared with $18,484 and $21,711 for subjects with BMIs of 25-29.9 and 30+, respectively. Higher cumulative costs were found among obese plan members for pharmacy services, outpatient services, and inpatient care.

Health economist Roland Sturm of the Rand Corporation compared the effects of obesity with those of smoking, heavy drinking, and poverty on chronic health conditions and health care expenditures. His results, published in the April 2002 issue of *Health Affairs*, showed obesity to be the most serious health problem both in terms of chronic illness and health spending (73). Sturm's findings were based on data obtained from approximately 10,000 respondents to Healthcare for Communities, a national household telephone survey conducted in 1998. Obese persons, those having a BMI of 30 or greater, reported an increase in chronic conditions (diabetes, hypertension, asthma, heart disease, and/or cancer) of 67% compared with normal-weight persons with similar social demographics. Normal-weight smokers reported 25% more chronic conditions, while normal-weight heavy drinkers reported 12% more chronic conditions. Living in poverty came closer to the effect created by obesity, resulting in an increase of chronic conditions of 58%. Only aging from 30 to 50 resulted in a comparable number of chronic conditions being reported.

Health care expenditures included health services such as inpatient hospital care and physician visits and medications, both prescription and over-the-counter drugs. Obese respondents reported spending approximately 36% more on health services and 77% more on medications than normal-weight individuals. In contrast, smokers spent 21% more on services and 28% more on medications. Only aging resulted in higher expenditures on medications than did being obese.

The economic burden imposed by obesity on U.S. businesses was assessed by David Thompson of Policy Analysis, Inc., in terms of increased health insurance costs, disability insurance, sick leave, and higher life insurance premiums (74). In a 1998 article in the *American Journal of Health Promotion*, Thompson estimated the annual total cost of obesity to the American business economy to be $12.7 billion. The largest share of this amount was $7.7 billion in increased health insurance premiums, with $2.4 billion in paid sick leave, $1.8 billion in higher life insurance premiums, and $0.8 billion in disability insurance.

Wang and Dietz analyzed data from the National Hospital Discharge Survey from 1979-99 to estimate the increasing economic burden of obesity in youths aged six through 17 (75). Principal diagnoses of diabetes, obesity, sleep apnea, and gallbladder disease were examined, as well as other diseases for which obesity was listed as a secondary diagnosis. The percentage of discharges with obesity-related diagnoses increased in every category from 1979-81 to 1997-99. Discharges with diabetes as the principal diagnosis nearly doubled, obesity and gallbladder diseases tripled, and sleep apnea diagnoses increased fivefold over the 20-year period. The associated hospital costs more than tripled, from $35 million in 1979-81 to $127 million in 1997-99.

The significant increase in the number of morbidly obese patients has put additional strains on the health care system, many of which have not yet been studied. Injuries among physical therapists, nurses, and other hospital staffers are on the rise, as well as hospital expenditures for special beds, lifts, scales, operating tables, wheelchairs, and other equipment that will accommodate very heavy patients (76). Some diagnostic facilities are not able to serve the morbidly obese, resulting in a lack of preventive and imaging services available to a portion of the bariatric population. The rapid rise in the numbers of morbidly obese patients has caught many sectors of the health care system unable to provide appropriate and sufficient services.

TREATMENT OF OBESITY

Treatment for obesity has not generally been successful. The majority of individuals who lose weight gain it back within a short time period. According to a report by the Institute of Medicine entitled *Weighing the Options*, typically over two-thirds of weight lost by an individual will be regained within one year and almost all within five years (77). Many of these persons will lose the weight again, only to regain it once more. This is referred to as weight cycling, or yo-yo dieting. There has been much debate on the health consequences of loss and regain. A review of studies conducted by the National Task Force on the Prevention and Treatment of Obesity between 1964 and 1994, however, does not support the idea that yo-yo dieting has long-term detrimental effects on an individual's health. The consensus was that weight cycling does not result in an increase in body fat nor does it have negative effects on cholesterol and insulin levels or on blood pressure (78).

Part of the problem with weight regain lies with changes that occur to a person's "set point," or resting metabolic rate, following a weight loss. Numerous studies have shown that energy expenditure decreases with weight loss, producing the weight cycling described above. An analysis by Leibel et al. measured the 24-hour total energy expenditure among both obese and nonobese individuals at their usual body weight, after losing 10% to 20% of initial weight, and after gaining 10% of initial weight through overfeeding. All subjects, obese and nonobese, showed an increase in metabolic rate with weight gain and a decrease in metabolism with weight loss. These changes occurred in both resting and nonresting metabolism and were in a direction tending to return the subject to his or her initial weight (79). The decrease in metabolic rate following a weight loss served us well in times when we did not have unlimited access to food. As Kelly Brownell of Yale University explains, "In an ancient environment that was a way to survive the next famine" (80). That same mechanism, however, makes it harder for dieters to maintain a healthy weight today.

Wing and Hill, in a study using data from the National Weight Control Registry, found that more than 20% of overweight persons who lost at least 10% of their initial body weight were able to maintain the loss for at least one year, a more optimistic estimate than many previous studies (81). In addition, they found that weight loss maintenance appears to get easier over time; once a weight loss was maintained for two to five years, long-term success was more likely. The persons who were successful in long-term weight loss studied by Wing and Hill shared important maintenance strategies: (1) a low-fat diet; (2) frequent self-monitoring of body weight and food intake, and (3) high levels of physical activity. As noted, physical activity is crucial in maintaining a weight loss, especially with a reduced metabolic rate.

Low-Calorie Diet. It has been estimated that at any given time approximately 50% of women and 25% of men are trying to lose weight, with an annual expenditure of $30 billion on weight loss treatments (82). Not surprisingly, there has been a proliferation of diets in the past decade or so, ranging from high-protein to low-carbohydrate to high-carbohydrate to low-fat, to diets based on the glycemic index, and to hundreds of others, most of which limit one's consumption to particular food groups at the expense of the others. While recognizing that dietary therapy should be tailored to the individual's needs, the National Institutes of Health recommends a low-calorie diet utilizing foods from all food groups that creates a deficit of 500 to 1,000 kcal/day as an integral part of any weight loss regimen (3). Saturated fat should be decreased, with total fat consumption of 30%

or less of total calories. Fat reduction must be accompanied by reduced dietary carbohydrate consumption to produce the caloric deficit necessary to lose weight. A balanced diet integrating all food groups is viewed as necessary to promote long-term adherence to a weight management program.

The NIH recommends that "the initial goal of weight loss therapy should be to reduce body weight by approximately 10% from baseline. With success, further weight loss can be attempted if indicated through further assessment (3)." In addition, a reasonable time line for a 10% reduction in body weight is six months of therapy. To prevent weight cycling, the NIH recommends a weight maintenance program that combines dietary therapy, physical activity, and behavior therapy, i.e., learning life-long eating skills, the same strategies found among successful dieters by Wing and Hill.

Pharmacologic Treatment of Obesity. Drug therapy is often used as a component of weight-loss treatment, along with diet, physical activity, and behavior modification. Normally drug therapy is recommended only if the subject has a BMI of 30 or greater, or 27 or greater with at least one comorbid condition (83). The four classes of medications currently available or under investigation for the treatment of obesity include:

- appetite suppressants such as sibutramine (Meridia®, Reductil®)
- thermogenic or metabolism-raising agents (e.g., nonprescription ephedrine/caffeine agents)
- digestive inhibitors, which block the absorption of fat in the digestive tract (e.g., Xenical®)
- peptides that have been shown to reduce appetite (e.g., leptin and cholecystokinin), none of which were approved by the FDA at time of this report.

Drug therapy requires physician monitoring to assure patient safety because of possible side effects associated with the medications. Sibutramine currently is the only appetite-suppressing drug approved by the FDA for long-term use, i.e., up to one year; all others are primarily useful in initiating treatment or in helping a patient who is relapsing.

Bariatric Surgery. For the severely obese, those with a BMI of 40 or greater or a BMI of 35 or greater with comorbid conditions, surgical treatment is the only proven long-term weight-control (84). Bariatric surgery involves limiting the amount of food an individual can consume at one sitting by one of two methods. The Vertical Banded Gastroplasty uses restrictive bands to create a small pouch in the stomach that empties into the remaining larger portion of the stomach. The patient feels full as soon as the small pouch is filled and will experience nausea, vomiting, or pain if he or she continues to eat. The Roux-en-Y Gastric Bypass decreases the size of the stomach by stapling across the top. A portion of the small intestine is then attached directly to the pouch created, thus bypassing the larger portion of the stomach and part of the small intestine.

Patients typically lose from 50% to 60% of their initial weight, and weight maintenance has been found to be successful in most cases (85). As the prevalence of obesity, and severe obesity in particular, increases, so does the number of bariatric procedures performed. According to Dr. Kenneth Jones, president of the American Society for Bariatric Surgery, some 75,000 procedures will be performed in 2002, up from approximately 45,000 in 2001 and 25,000 in 1999 (86). Bariatric patients require medical monitoring for the rest of their lives as medical complications such as vitamin B-12 deficiency and anemia can occur.

Prevention of Obesity. Because obesity is so hard to treat, much emphasis is now being placed on the primary prevention of overweight and obesity in both children and adults. Research suggests that there are many promising areas for interventions for obesity prevention. For example, while breast feeding is acknowledged as superior to bottle feeding for many reasons, recent studies have found that breast-fed babies are less likely to be overweight at the age of five or six (87). Additionally, breast-feeding mothers lose weight after pregnancy more effectively than other mothers. Limiting television viewing time among children is an important strategy; a recent study from Stanford University showed that third- and fourth-graders who reduced their television viewing had statistically significant decreases in BMI, regardless of how they spent the reallocated time (88). Results from the Child and Adolescent Trial for Cardiovascular Health (CATCH), which included nutritional interventions at 96 elementary schools (56 with interventions and 40 control schools) throughout the U.S. between 1991-94, showed significant reductions in total and saturated fat consumption among those students at the schools with the interventions (89).

Work site interventions can have a marked impact on adult dietary habits. The WellWorks Study, a two-year randomized, controlled study of interventions implemented at 24 work sites in Massachusetts, showed significant reductions in the percentage of calories consumed as fat and increased consumption of fruits and vegetables among workers at the intervention sites (90). Although the results were not sustained when the campaign ended, an intervention combining a community-based educational program with public relations activities that was aimed at persuading consumers to switch from high-fat to low-fat milk succeeded in changing milk-drinking habits during the campaign, providing evidence that such coverage can be helpful (91).

In addition to work site, school, and other microenvironmental interventions, macroenvironmental and public health policy changes have been suggested as potential obesity prevention approaches. Examples of these include mass media campaigns, increased availability of fitness facilities, taxes on high-fat and high-sugar foods, controlling of junk food advertising during children's television programming, and restoration of daily physical activity in all schools. Section Three of this document discusses the public health approach in addressing policy and environmental changes in West Virginia.

The obesity epidemic is a result of many factors coming together; the solution lies in addressing all of these factors on all levels. Change must occur within the individual, the community, and our culture. The obesity problem in West Virginia is severe, as the data presented in Section Two indicate. The health consequences for our state residents are already evident and alarming and will only worsen without rapid and intensive intervention on every level of society.