

Prevalence and Trends in Obesity Among US Adults, 1999-2000

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DATA FROM THE THIRD NATIONAL Health and Nutrition Examination Survey (NHANES III; 1988-1994) showed that the prevalence of obesity, defined as a body mass index (BMI) of 30 or higher, had increased by approximately 8 percentage points in the United States after being relatively stable from 1960 to 1980.^{1,2} Since those data were published, additional reports from other sources have suggested that these trends are continuing.³⁻⁶ However, those reports from the Behavioral Risk Factor Surveillance System (BRFSS) and the Harris Poll have limitations because they are based on self-reported weight and height. Obesity prevalence estimates based on self-reported data tend to be lower than those based on measured data.⁴ For example, the BRFSS showed a prevalence of obesity of 12% to 14.4% during 1991 to 1994⁴; the corresponding NHANES estimate of 22.5% for 1988 to 1994² was more than 50% higher than the BRFSS estimates. National examination survey data based on measured weight and height data provide the best opportunity to track trends in weight in the United States. In this article we report the results from the latest NHANES data from 1999-2000 regarding population trends in obesity and in the frequency distribution of BMI.

See also pp 1728, 1758, and 1772.

Context The prevalence of obesity and overweight increased in the United States between 1978 and 1991. More recent reports have suggested continued increases but are based on self-reported data.

Objective To examine trends and prevalences of overweight (body mass index [BMI] ≥ 25) and obesity (BMI ≥ 30), using measured height and weight data.

Design, Setting, and Participants Survey of 4115 adult men and women conducted in 1999 and 2000 as part of the National Health and Nutrition Examination Survey (NHANES), a nationally representative sample of the US population.

Main Outcome Measure Age-adjusted prevalence of overweight, obesity, and extreme obesity compared with prior surveys, and sex-, age-, and race/ethnicity-specific estimates.

Results The age-adjusted prevalence of obesity was 30.5% in 1999-2000 compared with 22.9% in NHANES III (1988-1994; $P < .001$). The prevalence of overweight also increased during this period from 55.9% to 64.5% ($P < .001$). Extreme obesity (BMI ≥ 40) also increased significantly in the population, from 2.9% to 4.7% ($P = .002$). Although not all changes were statistically significant, increases occurred for both men and women in all age groups and for non-Hispanic whites, non-Hispanic blacks, and Mexican Americans. Racial/ethnic groups did not differ significantly in the prevalence of obesity or overweight for men. Among women, obesity and overweight prevalences were highest among non-Hispanic black women. More than half of non-Hispanic black women aged 40 years or older were obese and more than 80% were overweight.

Conclusions The increases in the prevalences of obesity and overweight previously observed continued in 1999-2000. The potential health benefits from reduction in overweight and obesity are of considerable public health importance.

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METHODS

Surveys

The NHANES program of the National Center for Health Statistics, Centers for Disease Control and Prevention, includes a series of cross-sectional nationally representative health examination surveys beginning in 1960. Each cross-sectional survey provides a national estimate for the US population at the time of the survey, enabling examination of trends over time in the US population. In each survey a nationally representative sample of the US civilian noninstitutionalized population was selected using a complex, stratified, multistage probability cluster sampling design. Previous national surveys include the first

National Health Examination Survey (NHES I, 1960-1962) and the first, second, and third NHANES surveys (NHANES I, 1971-1974; NHANES II, 1976-1980; and NHANES III, 1988-1994).⁷⁻¹⁰

Beginning in 1999, NHANES became a continuous survey without a break between cycles. The procedures followed to select the sample and conduct the interview and examination were similar to those for previous sur-

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veys. This report is based on data for 4115 adult men and women from the first 2 years of the continuous NHANES (1999-2000). Two or more years of data are necessary to have adequate sample sizes for subgroup analyses.

BMI and Obesity

Weight and height were measured in a mobile examination center using standardized techniques and equipment. Body mass index was calculated as weight in kilograms divided by the square of height in meters. For adults, overweight was defined as a BMI of 25.0 or higher, obesity as a BMI of 30.0 or higher, and extreme obesity as a BMI of 40 or higher.² These definitions are consistent with those of the National Heart, Lung, and Blood Institute and the World Health Organization.^{11,12}

Data Analysis and Statistical Methods

Statistical analyses were carried out using SAS for Windows software (SAS Institute, Cary, NC) and SUDAAN software (RTI, Research Triangle Park, NC). For all surveys, sampling weights had been calculated that took into account unequal probabilities of selection resulting from the sample design, from nonresponse, and from planned oversampling of certain subgroups. All analyses took into account differential probabilities of selection and the complex sample design. Standard errors

were calculated with SUDAAN using Taylor series linearization for NHANES III.¹³ For NHANES 1999-2000, SEs were calculated using the delete 1 jackknife method,¹³ partitioning the sample into 52 sampling units and forming 52 replicates by deleting one unit at a time. Statistical hypotheses were tested univariately at the .05 level using a *t* statistic. To adjust for multiple comparisons when 3 racial/ethnic groups were compared, the Bonferroni method was used. For graphical comparison, the frequency distributions of BMI from both surveys were smoothed using a non-parametric smoothing algorithm, based on sequential calculations of running medians for groups of adjacent points.¹⁴

RESULTS

The prevalence of obesity (BMI ≥30) during 1960 to 2000 in the United States by age and sex categories for those aged 20 to 74 years is shown in TABLE 1. For surveys up through NHANES II, data were available only for respondents younger than 75 years. The prevalence of obesity was relatively constant from 1960 to 1980, then increased as reported by NHANES III in 1988-1994. The most recent data, from NHANES 1999-2000, show further increases for both men and women and in all age groups. The increases from NHANES II to NHANES III were statistically significant in all sex-age groups. Statistically significant increases also occurred from

NHANES III to NHANES 1999-2000, except for the increase for men aged 40 to 59 years, which was not statistically significant but showed the same trend. The increases between NHANES III and NHANES 1999-2000 were almost as large as the increases between NHANES II and NHANES III and were not significantly different.

A more detailed examination of trends by age over a broader age range between NHANES III and NHANES 1999-2000 is possible because both surveys had no upper age limit. The prevalence of obesity for both surveys for all adults and by sex and 10-year age groups is shown in TABLE 2. Increases in the prevalence of obesity occurred for both men and women and in all age groups. Because the SEs are relatively large, particularly for NHANES 1999-2000, the differences are not always statistically significant, but the trends are similar across all subgroups.

The changes in the prevalence of obesity and extreme obesity between NHANES III and NHANES 1999-2000 by sex and racial/ethnic group for 3 groups—non-Hispanic whites, non-Hispanic blacks, and Mexican Americans—are shown in TABLE 3. In each subgroup the prevalence of both obesity and extreme obesity increased between NHANES III and NHANES 1999-2000. The increases were generally similar across all groups, although there was a nonsignificant trend for a larger

Table 1. Trends in the Age-Adjusted and Age-Specific Prevalence of Obesity for Adults Aged 20-74 Years, 1960-2000*

| Sex | Age, y† | Prevalence, % | | | | | Change, % (95% CI)‡ | |
|------------|---------|------------------------------|---------------------------------|----------------------------------|-----------------------------------|---|-------------------------|--------------------------------|
| | | NHES I, 1960-1962 (n = 6126) | NHANES I, 1971-1974 (n = 12911) | NHANES II, 1976-1980 (n = 11765) | NHANES III, 1988-1994 (n = 14468) | NHANES Continuous, 1999-2000 (n = 3601) | NHANES II to NHANES III | NHANES III to NHANES 1999-2000 |
| Both sexes | 20-74 | 13.4 | 14.5 | 15.0 | 23.3 | 30.9 | 8.3 (6.6-10.0) | 7.6 (4.2-11.0) |
| Men | 20-74 | 10.7 | 12.1 | 12.7 | 20.6 | 27.7 | 7.9 (6.0-9.8) | 7.1 (3.4-10.8) |
| | 20-39 | 9.8 | 10.2 | 9.8 | 14.9 | 23.7 | 5.1 (2.9-7.2) | 8.8 (4.8-12.8) |
| | 40-59 | 12.6 | 14.7 | 15.4 | 25.4 | 28.8 | 10.0 (6.9-13.0) | 3.4 (-2.8-9.6) |
| | 60-74 | 8.4 | 10.5 | 13.5 | 23.8 | 35.8 | 10.3 (6.3-14.3) | 12.0 (5.0-19.0) |
| Women | 20-74 | 15.8 | 16.6 | 17.0 | 25.9 | 34.0 | 8.9 (6.5-11.3) | 8.1 (3.7-12.5) |
| | 20-39 | 9.3 | 11.2 | 12.3 | 20.6 | 28.4 | 8.3 (5.2-11.4) | 7.8 (2.5-13.1) |
| | 40-59 | 18.5 | 19.7 | 20.4 | 30.4 | 37.8 | 10.0 (6.1-13.9) | 7.4 (0.5-14.3) |
| | 60-74 | 26.2 | 23.4 | 21.3 | 28.6 | 39.6 | 7.3 (3.9-10.6) | 11.0 (4.6-17.4) |

*NHES indicates National Health Examination Survey; NHANES, National Health and Nutrition Examination Survey; and CI, confidence interval.
 †Estimated prevalences for ages 20-74 years were age-standardized by the direct method to the 2000 Census population using age groups 20-39, 40-59, and 60-74 years.
 ‡Overall and within each age-sex group, the changes between 1988-1994 and 1999-2000 are not significantly different from the changes between 1976-1980 and 1988-1994.

increase in non-Hispanic black women. For obesity, the increases were not statistically significant for Mexican Americans, although trends were in the same direction as for the other racial/ethnic groups. For extreme obesity, the increases were significant for men and women overall and for non-Hispanic black women. In other racial/ethnic groups, the increases were not statistically significant, although the trends were in the same direction.

More detailed information on the prevalence of overweight and obesity by age, sex, and racial/ethnic group from NHANES 1999-2000 is shown in TABLE 4. The prevalence of overweight, which was 55.9% in NHANES III, increased to 64.5% ($P<.001$). The prevalences of overweight and obesity among men varied little by racial/ethnic group and there were no significant differences. Among women, non-Hispanic black women had a higher prevalence of both overweight and obesity than did non-Hispanic white women. For Mexican American women, the prevalence was intermediate between the other 2 groups and was not significantly different from either non-Hispanic white women or non-Hispanic black women. Data on extreme obesity are not shown because the estimates within subgroups were statistically unreliable.

The distribution of BMI in the population was also evaluated. For men aged 60 to 79 years, the distribution of BMI between NHANES III and NHANES 1999-2000 has shifted to the right (FIGURE), but the shift is greater at the upper percentiles of the distribution, indicating that the distribution has become more skewed. This pattern was also seen for men and women aged 20

to 39 years and 40 to 59 years (data not shown). For women aged 60 to 79 years the shift is more uniform (Figure).

COMMENT

These data indicate that the trends in BMI and the prevalence of obesity previously observed between the 1976-1980 NHANES II survey and the 1988-1994 NHANES III survey appear to be

Table 2. Changes in the Prevalence of Obesity Between NHANES III and NHANES 1999-2000 by Sex and Age*

| Sex | Age, y† | NHANES III, 1988-1994 | | NHANES 1999-2000 | | Change, % (95% CI) |
|------------|---------|-----------------------|-------------|------------------|-------------|--------------------|
| | | No. | % (SE) | No. | % (SE) | |
| Both sexes | ≥20 | 16 681 | 22.9 (0.68) | 4115 | 30.5 (1.43) | 7.6 (4.4 to 10.8) |
| Men | ≥20 | 7933 | 20.2 (0.72) | 2043 | 27.5 (1.61) | 7.3 (3.8 to 10.8) |
| | 20-29 | 1639 | 12.5 (1.14) | 324 | 21.1 (2.42) | 8.6 (3.2 to 14.0) |
| | 30-39 | 1470 | 17.0 (1.34) | 342 | 26.0 (2.66) | 9.0 (3.0 to 15.0) |
| | 40-49 | 1222 | 23.1 (1.57) | 335 | 26.3 (3.28) | 3.2 (-4.1 to 10.5) |
| | 50-59 | 858 | 28.9 (1.94) | 260 | 32.2 (4.24) | 3.3 (-6.1 to 12.7) |
| | 60-69 | 1179 | 24.8 (2.19) | 374 | 38.1 (3.12) | 13.3 (5.6 to 21.0) |
| | 70-79 | 870 | 20.0 (2.41) | 261 | 28.9 (3.78) | 8.9 (-0.1 to 17.9) |
| | ≥80 | 695 | 8.0 (1.17) | 147 | 9.6 (2.02) | 1.6 (-2.4 to 5.6) |
| Women | ≥20 | 8748 | 25.4 (0.95) | 2072 | 33.4 (1.81) | 8.0 (3.9 to 12.1) |
| | 20-29 | 1669 | 14.6 (1.47) | 304 | 23.3 (3.00) | 8.7 (2.0 to 15.4) |
| | 30-39 | 1776 | 25.8 (1.99) | 336 | 32.5 (3.07) | 6.7 (-0.7 to 14.1) |
| | 40-49 | 1358 | 26.9 (1.97) | 369 | 35.4 (3.90) | 8.5 (-0.3 to 17.3) |
| | 50-59 | 1005 | 35.6 (2.08) | 284 | 41.2 (4.59) | 5.6 (-4.5 to 15.7) |
| | 60-69 | 1174 | 29.8 (1.53) | 374 | 42.5 (3.46) | 12.7 (5.1 to 20.3) |
| | 70-79 | 985 | 25.0 (1.51) | 250 | 31.9 (3.79) | 6.9 (-1.3 to 15.1) |
| | ≥80 | 781 | 15.1 (1.41) | 155 | 19.5 (3.70) | 4.4 (-3.6 to 12.4) |

*NHANES indicates National Health and Nutrition Examination Survey; CI, confidence interval.
 †Estimated prevalences for ages ≥20 years were age-standardized by the direct method to the 2000 Census population using the age groups 20-39, 40-59, and ≥60 years.

Table 3. Changes in Age-Adjusted Prevalence of Obesity and Extreme Obesity by Sex and Racial/Ethnic Group for Adults Aged 20 Years and Older*

| Sex | Racial/Ethnic Group | Obesity (BMI ≥30) | | | | | Extreme Obesity (BMI ≥40) | | |
|------------|---------------------|-----------------------|-------------|------------------|-------------|--------------------|-------------------------------|--------------------------|--------------------|
| | | NHANES III, 1988-1994 | | NHANES 1999-2000 | | Change, % (95% CI) | NHANES III, 1988-1994, % (SE) | NHANES 1999-2000, % (SE) | Change, % (95% CI) |
| | | No. | % (SE) | No. | % (SE) | | | | |
| Both sexes | All† | 16 681 | 22.9 (0.68) | 4115 | 30.5 (1.43) | 7.6 (4.4 to 10.8) | 2.9 (0.23) | 4.7 (0.56) | 1.8 (0.6 to 3.0) |
| Men | All† | 7933 | 20.2 (0.72) | 2043 | 27.5 (1.61) | 7.3 (3.8 to 10.8) | 1.7 (0.32) | 3.1 (0.58) | 1.4 (0.1 to 2.7) |
| | Non-Hispanic white | 3285 | 20.3 (0.85) | 946 | 27.3 (1.82) | 7.0 (3.0 to 11.0) | 1.8 (0.41) | 3.0 (0.75) | 1.2 (-0.5 to 2.9) |
| | Non-Hispanic black | 2112 | 21.1 (1.02) | 374 | 28.1 (2.27) | 7.0 (2.0 to 12.0) | 2.4 (0.38) | 3.5 (1.24)‡ | 1.1 (-1.5 to 3.7) |
| | Mexican American | 2250 | 23.9 (0.97) | 538 | 28.9 (2.25) | 5.0 (0.1 to 9.9) | 1.1 (0.33)‡ | 2.4 (0.74)‡ | 1.3 (-0.3 to 2.9) |
| Women | All† | 8748 | 25.4 (0.95) | 2072 | 33.4 (1.81) | 8.0 (3.9 to 12.1) | 4.0 (0.31) | 6.3 (0.78) | 2.3 (0.6 to 4.0) |
| | Non-Hispanic white | 3755 | 22.9 (1.15) | 885 | 30.1 (2.10) | 7.2 (2.4 to 12.0) | 3.4 (0.40) | 4.9 (0.89) | 1.5 (-0.5 to 3.5) |
| | Non-Hispanic black | 2490 | 38.2 (1.37) | 420 | 49.7 (2.79) | 11.5 (5.3 to 17.7) | 7.9 (0.51) | 15.1 (2.05) | 7.2 (3.0 to 11.4) |
| | Mexican American | 2128 | 35.3 (1.36) | 567 | 39.7 (3.65) | 4.4 (-3.4 to 12.2) | 4.8 (0.65) | 5.5 (1.04) | 0.7 (-1.8 to 3.2) |

*NHANES indicates National Health and Nutrition Examination Survey; CI, confidence interval.
 †Includes racial/ethnic groups not shown separately.
 ‡Does not meet the standard of statistical reliability and precision (relative SE >30%).

continuing at a similar level in 1999-2000. Although these increases in obesity observed in NHANES III and NHANES 1999-2000 appear dramatic compared with previous surveys, they may also be viewed as part of a longer-term trend for increases in body size in affluent and well-nourished societies. In the United States, mean BMI appears to have been increasing over a long time, with recent increases perhaps less steep than those earlier.¹⁵ Other developed countries are experiencing similar increases, and less developed countries also show increases in obesity as they become more affluent.¹² As with NHANES III, the increases seen in NHANES 1999-2000 appear to be occurring in both men and

women, in all age groups, and in all racial/ethnic groups studied.

The findings also reflect the difference in prevalence estimates based on measured vs self-reported height and weight. The 2000 BRFSS data³ estimate an obesity prevalence of 19.8% among adults compared with the estimated prevalence of 30.5% in our study. Relatively little is known about the precise causes of these trends.¹⁶⁻¹⁸ Although they must reflect energy imbalances in the sense that energy intake must exceed energy expenditure for weight to increase, the nature of the imbalances is not clear. Both dietary intake and physical activity are difficult to measure, and trends in these factors are not easy to evaluate. A more fundamental problem is to identify

the social, economic, and cultural forces leading to energy imbalance. Advances in technology, changes in work life, the advent of computers, trends in eating out vs food preparation at home, time pressures, fear of crime, decreases in tobacco use, and many other factors have been suggested, but definitive data are lacking that would clearly associate changes in these factors with the increase in obesity on an individual basis.

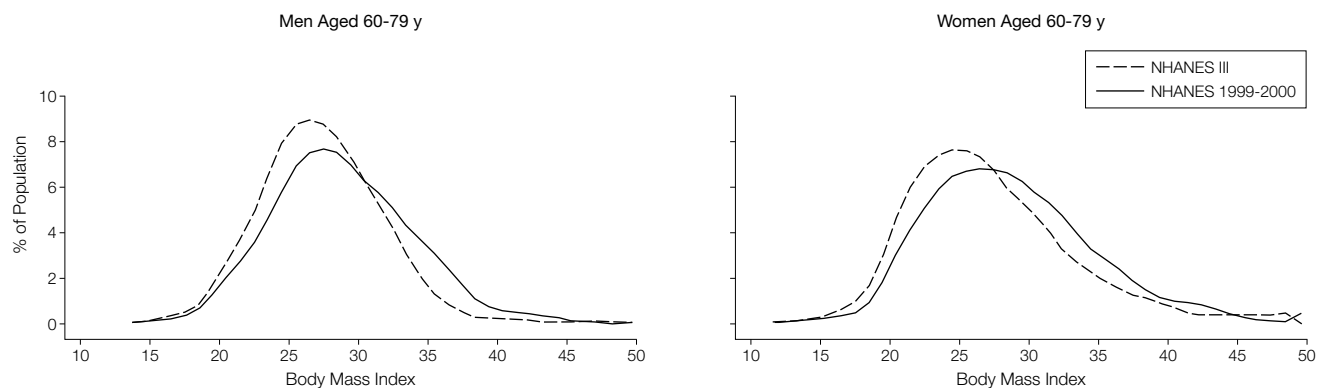
The increases in overweight and obesity raise questions about the implications of these trends for health outcomes. Obesity is a risk factor for many chronic conditions including diabetes, hypertension, hypercholesterolemia, stroke, heart disease, certain cancers, and arthritis. Of these conditions,

Table 4. Prevalence of Overweight and Obesity by Age, Sex, and Racial/Ethnic Group: United States, 1999-2000

| Sex | Age, y† | Sample Size, No. | | | Prevalence of Overweight (BMI ≥25), % | | | Prevalence of Obesity (BMI ≥30), % | | | | | |
|------------|---------|------------------|--------------------|--------------------|---------------------------------------|------|--------------------|------------------------------------|------------------|------|--------------------|--------------------|------------------|
| | | All* | Non-Hispanic White | Non-Hispanic Black | Mexican American | All* | Non-Hispanic White | Non-Hispanic Black | Mexican American | All* | Non-Hispanic White | Non-Hispanic Black | Mexican American |
| Both sexes | ≥20 | 4115 | 1831 | 794 | 1105 | 64.5 | 62.3 | 69.6 | 73.4‡ | 30.5 | 28.7 | 39.9‡ | 34.4 |
| Men | ≥20 | 2043 | 946 | 374 | 538 | 67.2 | 67.4 | 60.7 | 74.7 | 27.5 | 27.3 | 28.1 | 28.9 |
| | 20-39 | 666 | 276 | 125 | 184 | 60.5 | 61.0 | 52.6 | 67.5 | 23.7 | 22.0 | 27.4 | 30.4 |
| | 40-59 | 595 | 262 | 127 | 157 | 70.0 | 69.9 | 63.9 | 79.1 | 28.8 | 28.5 | 29.9 | 27.0 |
| | ≥60 | 782 | 408 | 122 | 197 | 74.1 | 74.3 | 69.1 | 79.6 | 31.8 | 34.3 | 26.4 | 29.7 |
| Women | ≥20 | 2072 | 885 | 420 | 567 | 61.9 | 57.3 | 77.3‡ | 71.9 | 33.4 | 30.1 | 49.7‡ | 39.7 |
| | 20-39 | 640 | 249 | 140 | 180 | 54.3 | 49.0 | 70.8‡ | 61.6 | 28.4 | 24.4 | 46.2‡ | 30.6 |
| | 40-59 | 653 | 249 | 141 | 193 | 66.1 | 61.0 | 81.5‡ | 79.3 | 37.8 | 34.2 | 53.2‡ | 48.5 |
| | ≥60 | 779 | 387 | 139 | 194 | 68.1 | 65.8 | 81.7‡ | 77.5 | 35.0 | 33.3 | 50.2‡ | 41.0 |

*Includes racial/ethnic groups not shown separately.
 †Estimated prevalences for ages ≥20 years were age-standardized by the direct method to the 2000 Census population using age groups 20-39, 40-59, and ≥60 years.
 ‡Significantly different from non-Hispanic whites, P<.05 (with Bonferroni correction).

Figure. Nonparametrically Smoothed Distributions of Body Mass Index From NHANES III and NHANES 1999-2000



NHANES indicates National Health and Nutrition Examination Survey.

diabetes may be most closely linked to obesity, and its prevalence appears to have increased as the prevalence of obesity increased.¹⁹ The increasing incidence of diabetes worldwide is of considerable concern.²⁰ Clinical trials have demonstrated that a structured lifestyle intervention including dietary change, weight loss, and increased physical activity can reduce the risk of progressing to diabetes mellitus from impaired glucose tolerance.^{21,22}

Other conditions, such as hypercholesterolemia and hypertension, declined between NHANES II and NHANES III at the same time that the prevalence of obesity was increasing.^{23,24} Total cardiovascular mortality and mortality from coronary heart disease and stroke have also declined over these years.²⁵ Obesity is a risk factor for these conditions; however, not everyone with these conditions is obese, and not all obese people have these conditions.^{26,27} There are several risk factors other than obesity for most of these health conditions, and intervening on these other risk factors may be necessary.^{11,26,27} Changes in other risk factors might also affect trends in these health conditions. It is also possible that some of the conditions associated with obesity may respond to interventions such as change in the fat content of the diet or increases in physical activity that are not necessarily accompanied by large changes in body weight.¹¹

Relatively little is known about the prevention and treatment of overweight and obesity on a population-wide basis.^{28,29} On an individual level, structured programs that emphasize lifestyle changes, including education, reduced fat and energy intake, regular physical activity, and regular staff contacts with participants, can produce modest long-term weight loss on the order of 5% to 10% of starting weight.³⁰

It likely will be difficult to reverse the increasing prevalence of overweight and obesity in the United States. Even as long ago as 1960, almost 50% of men and more than 40% of women were overweight, and 11% of men and 16% of women were obese. As was shown

previously for the shifts between NHANES II and NHANES III,³¹ the entire distribution of BMI appears to be affected, with a shift to the right occurring in all age-sex groups. Thus, these appear to be population-wide changes, not limited just to the upper portion of the distribution. Although the health implications of the increases in obesity and the costs and the risks and benefits associated with treatments and interventions have not been completely elucidated, the increase in the prevalence of obesity is clear. The potential health benefits from reduction in overweight and obesity are a matter of considerable public health importance.

Author Contributions: Study concept and design: Flegal.

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Analysis and interpretation of data: Flegal, Carroll, Ogden, Johnson.

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Statistical expertise: Flegal, Carroll,

Administrative, technical, or material support: Johnson.

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