Prevalence and Trends in Obesity Among US Adults, 1999-2008

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Context The prevalence of obesity increased in the United States between 1976-1980 and 1988-1994 and again between 1988-1994 and 1999-2000.

Objective To examine trends in obesity from 1999 through 2008 and the current prevalence of obesity and overweight for 2007-2008.

Design, Setting, and Participants Analysis of height and weight measurements from 5555 adult men and women aged 20 years or older obtained in 2007-2008 as part of the National Health and Nutrition Examination Survey (NHANES), a nationally representative sample of the US population. Data from the NHANES obtained in 2007-2008 were compared with results obtained from 1999 through 2006.

Main Outcome Measure Estimates of the prevalence of overweight and obesity in adults. Overweight was defined as a body mass index (BMI) of 25.0 to 29.9. Obesity was defined as a BMI of 30.0 or higher.

Results In 2007-2008, the age-adjusted prevalence of obesity was 33.8% (95% confidence interval [CI], 31.6%-36.0%) overall, 32.2% (95% CI, 29.5%-35.0%) among men, and 35.5% (95% CI, 33.2%-37.7%) among women. The corresponding prevalence estimates for overweight and obesity combined (BMI ≥25) were 68.0% (95% CI, 66.3%-69.8%), 72.3% (95% CI, 70.4%-74.1%), and 64.1% (95% CI, 61.3%-66.9%). Obesity prevalence varied by age group and by racial and ethnic group for both men and women. Over the 10-year period, obesity showed no significant trend among women (adjusted odds ratio [AOR] for 2007-2008 vs 1999-2000, 1.12 [95% CI, 0.89-1.32]). For men, there was a significant linear trend (AOR for 2007-2008 vs 1999-2000, 1.32 [95% CI, 1.12-1.58]); however, the 3 most recent data points did not differ significantly from each other.

Conclusions In 2007-2008, the prevalence of obesity was 32.2% among adult men and 35.5% among adult women. The increases in the prevalence of obesity previously observed do not appear to be continuing at the same rate over the past 10 years, particularly for women and possibly for men.

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The National Health and Nutrition Examination Survey (NHANES) provides the opportunity to track trends in the prevalence of obesity in the United States by collecting data on height and weight measurements. Data from 1988-1994 showed that the prevalence of obesity in adults had increased by approximately 8 percentage points in the United States since 1976-1980, after being relatively stable over the period 1960-1980.[1,2] Analyses of data from 1999-2000 showed further increases in obesity for both men and women and in all age groups.[3]

The increases in obesity from 1976-1980 to 1988-1994 were statistically significant in all sex and age groups. The increases in obesity from 1988-1994 to 1999-2000 were statistically significant in all sex and age groups except men aged 40 to 59 years. Analyses of data from 2001-2002 and 2003-2004 suggested increasing trends since 1999-2000 among men but not among women.[4,5] Comparisons between 2003-2004 and 2005-2006 showed no significant changes but had limited statistical power.[6]

Herein we report the results from the latest NHANES data from 2007-2008 regarding population trends in obesity and compare the results over the 10-year period from 1999 through 2008.

See also pp 242 and 275.

METHODS

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. To obtain a nationally representative sample of the US civilian noninstitutionalized population, each survey period used a complex, stratified, multistage probability cluster sampling design. Beginning in 1999, NHANES became a continuous survey (without a break between cycles) and data are released in 2-year cycles, including 1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008.

In 2007-2008, the sample consisted of 8082 men and women aged 20 years or older; of whom 73.4% (n=5935) were interviewed and 70.6% (n=5707) were both interviewed and examined. Participants missing weight or height measurements (n=95) and pregnant women (n=57) were excluded from the analyses. This report uses data for 2750 adult men and 2805 nonpregnant adult women with measured weights and

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heights from the most recent 2 years of the continuous NHANES 2007-2008, in addition to data from NHANES 1999-2006. NHANES 1999-2008 received approval from the National Center for Health Statistics research ethics review board. Written informed consent was obtained.

Weight and height were measured in a mobile examination center using standardized techniques and equipment. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, rounded to the nearest tenth. For adults aged 20 years or older, overweight was defined as a BMI of 25.0 to 29.9 and obesity was defined as a BMI of 30.0 or higher.[7] Obesity may be divided into grade 1 (BMI, 30-<35), grade 2 (BMI, 35-<40), and grade 3 (BMI ≥40).[8]

Individuals were grouped by age at the interview: 20-39 years, 40-59 years, and 60 years or older. Race and ethnicity were self-reported; for the purposes of this report, race and ethnicity are classified as non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic, and other. Data for 2007-2008 are presented overall, including all racial and ethnic groups, and separately for non-Hispanic white, non-Hispanic black, all Hispanics (including both Mexican Americans and other Hispanics) and

Table 1. Sample Size for US Adults Aged 20 Years or Older[a]

Categories by Age	All (N = 5555)[b]	Non-Hispanic White (n = 2618)	Non-Hispanic Black (n = 1144)	All Hispanics (n = 1566)[c]	Mexican American (n = 945)
Men, age, y					
≥20	2750	1335	554	739	460
20-39	896	383	187	275	195
40-59	883	391	173	276	164
≥60	971	561	194	188	101
Women, age, y					
≥20	2805	1283	590	827	485
20-39	877	344	191	307	189
40-59	910	402	198	270	158
≥60	1018	537	201	250	138

[a] Based on data from the National Health and Nutrition Examination Survey (NHANES) 2007-2008.
[b] Includes racial and ethnic groups not shown separately.
[c] Includes Mexican Americans.

Table 2. Prevalence of Obesity and Overweight for Adults Aged 20 Years or Older[a]

Categories by Age	% of Adults (95% Confidence Interval)				
	All[b]	Non-Hispanic White	Non-Hispanic Black	All Hispanics[c]	Mexican American
BMI ≥30					
All, age, y					
≥20	33.9 (31.7-36.1)	32.8 (29.4-36.1)	44.1 (39.9-48.3)	37.9 (32.3-43.4)	39.3 (32.0-46.6)
≥20[d]	33.8 (31.6-36.0)	32.4 (28.9-35.9)	44.1 (40.0-48.2)	38.7 (33.5-43.9)	40.4 (34.2-46.6)
Men, age, y					
≥20[d]	32.2 (29.5-35.0)	31.9 (28.1-35.7)	37.3 (32.3-42.4)	34.3 (28.2-40.3)	35.9 (26.3-44.4)
20-39	27.5 (23.8-31.2)	26.3 (20.9-31.7)	34.7 (28.5-40.9)	32.3 (23.9-40.7)	33.8 (22.7-44.9)
40-59	34.3 (29.8-38.8)	34.0 (28.1-39.8)	39.7 (30.0-49.5)	37.4 (29.0-45.8)	38.2 (26.3-50.1)
≥60	37.1 (33.1-41.0)	38.4 (34.1-42.6)	38.0 (31.3-44.7)	32.6 (23.5-41.7)	35.8 (21.9-49.8)
Women, age, y					
≥20[d]	35.5 (33.2-37.7)	33.0 (29.3-36.6)	49.6 (45.5-53.7)	43.0 (37.9-48.2)	45.1 (38.9-51.2)
20-39	34.0 (29.0-39.1)	31.3 (23.3-39.3)	47.2 (41.3-53.1)	37.6 (32.3-42.8)	39.6 (33.7-45.5)
40-59	38.2 (33.8-42.6)	35.7 (29.7-41.7)	51.7 (47.2-56.1)	46.6 (37.3-55.9)	48.9 (38.0-59.8)
≥60	33.6 (30.2-36.9)	31.4 (27.3-35.5)	50.5 (40.5-60.5)	46.7 (41.0-52.3)	48.1 (43.0-53.3)
BMI ≥25					
All, age, y					
≥20	68.3 (66.6-70.0)	67.5 (65.0-70.1)	73.7 (71.2-76.2)	76.9 (72.9-80.8)	77.5 (73.4-81.6)
≥20[d]	68.0 (66.3-69.8)	66.7 (64.1-69.3)	73.8 (71.3-76.3)	77.9 (74.5-81.4)	78.8 (75.2-82.4)
Men, age, y					
≥20[d]	72.3 (70.4-74.1)	72.6 (69.9-75.3)	68.5 (65.2-71.8)	79.3 (74.7-83.9)	80.0 (75.5-84.5)
20-39	63.5 (60.8-66.2)	62.6 (58.0-67.2)	61.5 (54.6-68.5)	74.2 (66.8-81.5)	75.0 (67.4-82.7)
40-59	77.8 (74.0-81.7)	77.7 (72.8-82.6)	73.5 (65.9-81.2)	87.2 (81.4-93.0)	88.0 (80.8-95.1)
≥60	78.4 (74.8-81.9)	81.4 (77.9-84.9)	72.5 (65.2-79.8)	75.4 (70.2-80.7)	75.8 (68.4-83.1)
Women, age, y					
≥20[d]	64.1 (61.3-66.9)	61.2 (56.7-65.7)	78.2 (74.5-81.9)	76.1 (72.0-80.1)	76.9 (71.8-81.9)
20-39	59.5 (54.5-64.5)	54.9 (46.3-63.6)	78.0 (71.8-84.2)	68.5 (61.4-75.7)	70.3 (62.7-77.9)
40-59	66.3 (63.3-69.3)	63.8 (59.8-67.8)	78.4 (74.1-82.6)	81.2 (77.3-85.1)	80.3 (73.6-87.0)
≥60	68.6 (64.4-72.7)	67.6 (62.2-73.1)	78.2 (70.7-85.8)	80.7 (77.3-84.1)	82.6 (77.2-88.0)

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).
[a] Based on data from the National Health and Nutrition Examination Survey (NHANES) 2007-2008.
[b] Includes racial and ethnic groups not shown separately.
[c] Includes Mexican Americans.
[d] Age adjusted by the direct method to the year 2000 Census population using the age groups 20-39 years, 40-59 years, and 60 years or older.

Mexican Americans. In 2007-2008, non-Hispanic blacks and Hispanics were oversampled to provide adequate sample sizes for analyses of these groups. In surveys from 1999 through 2006, Mexican Americans but not all other Hispanics were oversampled, so trends are examined for Mexican Americans rather than for all Hispanics.

Statistical analyses were performed using SAS software version 9.2 (SAS Institute Inc, Cary, North Carolina) and SUDAAN software version 10.0 (RTI, Research Triangle Park, North Carolina). Calculation of sampling weights took into account unequal probabilities of selection resulting from the sample design, nonresponse, and noncoverage. All analyses took into account differential probabilities of selection and the complex sample design. Standard errors were estimated with SUDAAN software using Taylor series linearization. Statistical tests were 2-sided and a *P* value of less than .05 was considered statistically significant.

Linear trends over the five 2-year survey cycles and variations in the prevalence of obesity by age and racial and ethnic groups over the 10-year period were tested using sex-specific logistic regression models with adjustment for age group, racial and ethnic group, and survey period; survey was treated as a continuous (ordered categorical) variable.

Approximate power calculations were performed using POWER software version 3 (National Cancer Institute, Bethesda, Maryland), assuming a survey design effect of 2. These calculations indicated that the sex-specific sample sizes were adequate to detect an odds ratio (OR) equivalent to an increase of 5 percentage points between 1999-2000 and 2007-2008 with 80% power and an OR equivalent to an increase of 6 percentage points with greater than 90% power.

In addition, sex-specific logistic regression models were fitted that included survey as a categorical variable, with adjustment for age group and racial and ethnic group. Logistic models with survey as a continuous variable were fitted within sex, age, and racial and ethnic subgroups. For graphical presentation only, the frequency distributions of BMI were smoothed using a 4253 H nonparametric smoothing algorithm, based on sequential calculations of running medians for groups of adjacent points.[9]

RESULTS

Sample sizes for analyses from 2007-2008 are presented in **TABLE 1**. Detailed infor-

Table 3. Prevalence of Grade 2 and Grade 3 Obesity for Adults Aged 20 Years or Older[a]

Categories by Age	% of Adults (95% Confidence Interval)				
	All[b]	Non-Hispanic White	Non-Hispanic Black	All Hispanics[c]	Mexican American
BMI ≥35					
All, age, y					
≥20	14.3 (12.8-15.8)	13.6 (11.3-15.9)	21.9 (18.2-25.6)	15.5 (13.5-17.5)	16.0 (13.2-18.8)
≥20[d]	14.3 (12.7-15.8)	13.6 (11.2-16.0)	21.7 (18.1-25.4)	15.4 (13.3-17.5)	15.9 (13.3-18.6)
Men, age, y					
≥20[d]	10.7 (9.1-12.3)	10.5 (8.5-12.5)	14.4 (10.4-18.4)	12.0 (8.9-15.2)	12.4 (7.9-16.8)
20-39	9.4 (6.7-12.0)	8.5 (4.6-12.4)	14.2 (8.5-20.0)	12.5 (8.0-17.1)	12.5 (6.1-18.8)
40-59	11.6 (9.3-13.9)	11.6 (8.8-14.3)	13.8 (8.9-18.7)	13.2 (9.0-17.3)	13.8 (8.6-19.0)
≥60	11.6 (9.3-13.8)	12.0 (9.5-14.6)	15.5 (11.1-19.9)	9.3 (5.4-13.2)	9.8 (3.8-15.8)[e]
Women, age, y					
≥20[d]	17.8 (15.8-19.8)	16.6 (13.4-19.9)	27.9 (23.3-32.5)	18.9 (16.3-21.5)	19.9 (17.3-22.5)
20-39	18.9 (15.0-22.7)	17.2 (11.6-22.9)	30.2 (23.8-36.6)	19.1 (14.8-23.4)	20.9 (13.9-27.9)
40-59	19.5 (16.5-22.6)	18.7 (14.6-22.9)	29.1 (23.2-35.0)	19.1 (12.7-25.4)	19.0 (11.4-26.6)
≥60	13.3 (11.0-15.5)	12.3 (9.1-15.4)	22.0 (15.9-28.2)	18.3 (13.3-23.2)	19.6 (13.3-26.0)
BMI ≥40					
All, age, y					
≥20	5.7 (4.9-6.5)	5.2 (3.8-6.5)	11.1 (8.3-13.8)	5.7 (4.4-7.1)	6.0 (4.3-7.6)
≥20[d]	5.7 (4.9-6.6)	5.2 (3.8-6.6)	10.8 (8.2-13.5)	5.5 (4.3-6.8)	5.6 (4.3-6.9)
Men, age, y					
≥20[d]	4.2 (3.3-5.1)	4.0 (2.9-5.1)	7.0 (4.5-9.4)	3.8 (2.1-5.6)	4.4 (2.1-6.6)
20-39	4.2 (2.7-5.6)	3.4 (1.4-5.4)	7.5 (3.5-11.4)	6.1 (3.0-9.2)	7.0 (3.0-10.9)
40-59	4.2 (2.8-5.6)	4.4 (2.4-6.4)	5.6 (1.9-9.3)[e]	3.5 (1.4-5.7)[e]	3.7 (1.0-6.4)[e]
≥60	4.2 (2.9-5.6)	4.4 (3.0-5.9)	8.2 (3.7-12.7)	NA	NA
Women, age, y					
≥20[d]	7.2 (6.1-8.4)	6.4 (4.2-8.5)	14.2 (10.5-17.8)	7.0 (5.7-8.4)	6.7 (5.2-8.2)
20-39	7.6 (5.6-9.7)	6.8 (3.4-10.3)	15.0 (9.4-20.6)	6.2 (4.6-7.8)	6.8 (3.6-10.1)
40-59	8.4 (6.6-10.2)	7.3 (4.4-10.1)	17.7 (12.2-23.1)	8.0 (4.8-11.2)	5.9 (2.9-8.9)
≥60	4.7 (2.9-6.5)	4.1 (1.8-6.5)	7.2 (3.9-10.5)	7.0 (4.4-9.6)	7.6 (4.5-10.8)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NA, data not shown because the estimate does not meet the standard of statistical reliability and precision (relative standard error >40%).
[a] Based on data from the National Health and Nutrition Examination Survey (NHANES) 2007-2008.
[b] Includes racial and ethnic groups not shown separately.
[c] Includes Mexican Americans.
[d] Age adjusted by the direct method to the year 2000 Census population using the age groups 20-39 years, 40-59 years, and 60 years or older.
[e] Relative standard error of 30% or greater but less than 40%.

mation on the prevalence of obesity (BMI ≥30) and of overweight and obesity combined (BMI ≥25) overall and by age, sex, and racial and ethnic group from NHANES 2007-2008 is presented in TABLE 2.

The prevalence of obesity in the United States is high, exceeding 30% in most age and sex groups except for men aged 20 to 39 years. Among men, age-adjusted obesity prevalence was 32.2% overall (95% confidence interval [CI], 29.5%-35.0%) and within racial and ethnic groups ranged from 31.9% (95% CI, 28.1%-35.7%) among non-Hispanic white men to 37.3% (95% CI, 32.3%-42.4%) among non-Hispanic black men. For women, the age-adjusted prevalence was 35.5% (95% CI, 33.2%-37.7%), ranging from 33.0% (95% CI, 29.3%-36.6%) among non-Hispanic white women to 49.6% (95% CI, 45.5%-53.7%) among non-Hispanic black women. The age-adjusted prevalence of overweight and obesity combined was 68.0% (95% CI, 66.3%-69.8%) overall, 72.3% (95% CI, 70.4%-74.1%) among men, and 64.1% (95% CI, 61.3%-66.9%) among women.

Additional information on the age-adjusted prevalence of grades 2 and 3 obesity (BMI ≥35) and of grade 3 obesity (BMI ≥40) by age, sex, and racial and ethnic group from NHANES 2007-2008 is presented in TABLE 3. The age-adjusted values for grades 2 and 3 obesity combined (BMI ≥35) ranged from 10.5% (95% CI, 8.5%-12.5%) among non-Hispanic white men to 14.4% (95% CI, 10.4%-18.4%) for non-Hispanic black men; corresponding values for women were 16.6% (95% CI, 13.4%-19.9%) and 27.9% (95% CI, 23.3%-32.5%). The overall age-adjusted prevalence of grade 3 obesity (BMI ≥40) was 5.7% (95% CI, 4.9%-6.5%) overall, 4.2% (95% CI, 3.3%-5.1%) for men, and 7.2% (95% CI, 6.1%-8.4%) for women, with particularly high values 14.2% (95% CI, 10.5%-17.8%) among non-Hispanic black women.

The age-adjusted prevalence of obesity by 2-year survey cycles is presented overall and by age and racial and ethnic group in TABLE 4 for men and in TABLE 5 for women. Logistic regression analyses for men, adjusted for age group and racial and ethnic group, showed a significant linear trend across survey cycles as a continuous variable for 2007-2008 vs 1999-2000 (OR, 1.32 [95% CI, 1.12-1.58]; $P=.002$) and significant differences among survey cycles as a categorical variable for 2007-2008 vs 1999-2000 (OR, 1.24 [95% CI, 1.03-1.52], $P=.02$). However, in analyses adjusted for age and racial and ethnic group with survey cycle as a categorical variable, there were no significant differences between the last 3 survey cycles (2003-2004, 2005-2006, and 2007-2008) for men.

To examine these findings for men further, additional linear trend tests by survey cycle were fitted within race and ethnicity and age subgroups. Within age groups, linear trends adjusted for racial

Table 4. Trends in the Age-Adjusted and Age-Specific Prevalence of Obesity (BMI ≥30) in US Men Aged 20 Years or Older for 1999-2008

	No. (%) of Men [95% Confidence Interval]			
	Age ≥20 y[a]	Ages 20-39 y	Ages 40-59 y	Age ≥60 y
All[b]				
1999-2000	2043 (27.5) [24.4-30.6]	666 (23.7) [20.5-27.0]	595 (28.8) [23.0-34.7]	782 (31.8) [27.3-36.3]
2001-2002	2219 (27.8) [25.8-29.7]	750 (22.3) [19.4-25.1]	773 (32.2) [28.8-35.5]	696 (30.2) [26.5-33.9]
2003-2004	2237 (31.1) [28.5-33.7]	756 (28.0) [23.7-32.4]	649 (34.8) [29.9-39.7]	832 (30.4) [26.6-34.2]
2005-2006	2237 (33.3) [29.3-37.4]	793 (28.1) [22.3-33.8]	709 (39.7) [33.9-45.4]	735 (32.2) [28.1-36.3]
2007-2008	2750 (32.2) [29.5-35.0][c]	896 (27.5) [23.8-31.2][c]	883 (34.3) [29.8-38.8][c]	971 (37.1) [33.1-41.0][c]
Non-Hispanic white				
1999-2000	946 (27.3) [23.8-30.8]	276 (22.0) [17.3-26.7]	262 (28.5) [21.8-35.2]	408 (34.3) [28.8-39.9]
2001-2002	1157 (29.1) [26.5-31.7]	322 (23.9) [19.5-28.2]	407 (33.2) [29.5-36.9]	428 (31.5) [27.7-35.3]
2003-2004	1183 (31.1) [28.1-34.2]	336 (27.2) [21.4-33.0]	340 (35.6) [29.3-41.9]	507 (30.6) [26.3-35.0]
2005-2006	1145 (33.1) [28.7-37.5]	328 (25.8) [18.6-33.1]	368 (41.0) [35.0-47.0]	449 (32.9) [28.6-37.3]
2007-2008	1335 (31.9) [28.1-35.7][c]	383 (26.3) [20.9-31.7]	391 (34.0) [28.1-39.8]	561 (38.4) [34.1-42.6]
Non-Hispanic black				
1999-2000	374 (28.1) [24.8-31.5]	125 (27.4) [22.0-32.8]	127 (29.9) [23.3-36.4]	122 (26.4) [18.5-34.4]
2001-2002	435 (27.9) [24.0-31.8]	148 (22.2) [16.4-28.0]	161 (30.0) [23.9-36.1]	126 (34.2) [25.3-43.0]
2003-2004	432 (34.0) [27.1-40.9]	175 (32.3) [24.1-40.5]	146 (37.6) [31.6-43.6]	111 (31.1) [17.8-44.3]
2005-2006	507 (37.2) [32.5-41.8]	185 (39.7) [33.3-46.0]	170 (34.8) [26.2-43.3]	152 (36.8) [31.3-42.2]
2007-2008	554 (37.3) [32.3-42.4][c]	187 (34.7) [28.5-40.9][c]	173 (39.7) [30.0-49.5]	194 (38.0) [31.3-44.7][c]
Mexican American				
1999-2000	538 (28.9) [25.2-32.7]	184 (30.4) [24.2-36.5]	157 (27.0) [19.6-34.3]	197 (29.7) [22.0-37.4]
2001-2002	480 (25.9) [21.8-29.9]	215 (17.4) [11.1-23.8]	152 (34.8) [27.5-42.1]	113 (25.9) [19.5-32.2]
2003-2004	458 (31.6) [26.6-36.6]	165 (32.7) [23.0-42.3]	118 (31.8) [21.3-42.4]	175 (29.5) [22.0-36.9]
2005-2006	443 (27.0) [23.2-30.7]	210 (24.7) [19.5-29.9]	128 (27.6) [20.9-34.3]	105 (30.0) [20.7-39.2]
2007-2008	460 (35.9) [28.9-43.0]	195 (33.8) [22.7-44.9]	164 (38.2) [26.3-50.1]	101 (35.8) [21.9-49.8]

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).
[a] Age adjusted by the direct method to the year 2000 Census population using the age groups 20-39 years, 40-59 years, and 60 years or older.
[b] Includes racial and ethnic groups not shown separately.
[c] Indicates significant linear trend over survey cycle ($P<.05$).

Table 5. Trends in the Age-Adjusted and Age-Specific Prevalence of Obesity (BMI ≥30) in US Women Aged 20 Years or Older for 1999-2008

	No. (%) of Women (95% Confidence Interval)			
	Age ≥20 y[a]	Ages 20-39 y	Ages 40-59 y	Age ≥60 y
All[b]				
1999-2000	2072 (33.4) [30.0-36.8]	640 (28.4) [24.4-32.4]	653 (37.8) [31.2-44.4]	779 (35.0) [30.7-39.3]
2001-2002	2171 (33.3) [30.2-36.3]	712 (29.8) [25.6-34.1]	721 (35.7) [31.6-39.9]	738 (35.2) [31.2-39.2]
2003-2004	2194 (33.2) [29.7-36.6]	661 (28.9) [24.3-33.6]	662 (38.8) [33.4-44.1]	871 (31.5) [28.0-34.9]
2005-2006	2119 (35.3) [32.5-38.1]	707 (30.5) [25.9-35.0]	718 (41.1) [36.5-45.6]	694 (34.4) [29.7-39.1]
2007-2008	2805 (35.5) [33.2-37.7]	877 (34.0) [29.0-39.1]	910 (38.2) [33.8-42.6]	1018 (33.6) [30.2-36.9]
Non-Hispanic white				
1999-2000	885 (30.1) [25.9-34.3]	249 (24.4) [19.2-29.6]	249 (34.2) [25.1-43.3]	387 (33.3) [28.9-37.7]
2001-2002	1130 (31.3) [28.0-34.6]	313 (25.2) [20.5-29.8]	376 (35.4) [31.3-39.6]	441 (35.2) [29.6-40.8]
2003-2004	1174 (30.2) [25.9-34.4]	327 (23.8) [17.6-29.9]	333 (37.8) [31.1-44.5]	514 (28.9) [25.9-31.8]
2005-2006	1048 (32.9) [29.4-36.5]	288 (27.4) [20.5-34.2]	340 (39.3) [34.4-44.1]	420 (32.3) [27.2-37.4]
2007-2008	1283 (33.0) [29.3-36.6]	344 (31.3) [23.3-39.3]	402 (35.7) [29.7-41.7]	537 (31.4) [27.3-35.5]
Non-Hispanic black				
1999-2000	420 (49.7) [43.7-55.8]	140 (46.2) [38.3-54.1]	141 (53.2) [46.8-59.6]	139 (50.2) [36.1-64.4]
2001-2002	434 (48.3) [42.9-53.6]	157 (47.2) [39.6-54.9]	148 (47.8) [41.6-54.0]	129 (50.8) [37.8-63.8]
2003-2004	444 (53.9) [47.9-59.8]	153 (50.3) [41.1-59.6]	160 (57.5) [48.8-66.2]	131 (54.0) [43.9-64.2]
2005-2006	512 (52.9) [48.7-57.0]	175 (47.7) [40.3-55.1]	195 (53.3) [46.8-59.8]	142 (61.0) [54.3-67.7]
2007-2008	590 (49.6) [45.5-53.7]	191 (47.2) [41.3-53.1]	198 (51.7) [47.2-56.1]	201 (50.5) [40.5-60.5]
Mexican American				
1999-2000	567 (39.7) [32.1-47.2]	180 (30.6) [19.3-41.9]	193 (48.5) [38.9-58.1]	194 (41.0) [32.6-49.3]
2001-2002	445 (37.0) [30.6-43.4]	178 (31.5) [20.8-42.2]	139 (47.1) [38.8-55.4]	128 (30.2) [22.0-38.4]
2003-2004	415 (42.3) [36.8-47.7]	130 (35.7) [28.6-42.9]	110 (48.3) [38.5-58.1]	175 (43.8) [37.7-49.9]
2005-2006	400 (42.1) [36.4-47.7]	170 (36.5) [29.5-43.4]	124 (51.1) [42.2-60.0]	106 (37.1) [25.6-48.6]
2007-2008	485 (45.1) [38.9-51.2]	189 (39.6) [33.7-45.5]	158 (48.9) [38.0-59.8]	138 (48.1) [43.0-53.3]

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).
[a] Age adjusted by the direct method to the year 2000 Census population using the age groups 20-39 years, 40-59 years, and 60 years or older.
[b] Includes racial and ethnic groups not shown separately.

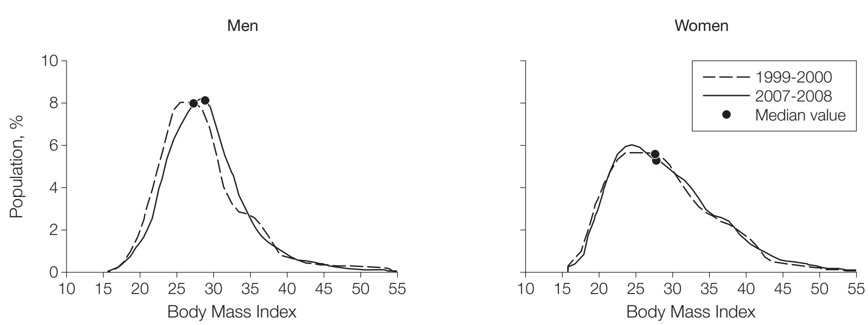
and ethnic group were significant for men aged 20 to 39 years (*P*=.03), aged 40 to 59 years (*P*=.03), and aged 60 years or older (*P*=.04). Within racial and ethnic groups, linear trends adjusted for age were significant for non-Hispanic whites (*P*=.02) and non-Hispanic blacks (*P*<.001), but not for Mexican American men (*P*=.15). Within racial and ethnic and age groups, linear trend tests across survey cycles were significant only for non-Hispanic black men aged 20 to 39 years (*P*=.001) and aged 60 years or older (*P*=.02). There may be limited power to detect statistically significant trends within subgroups.

For women overall, there were no significant differences by survey cycle either as a continuous variable (adjusted OR for 2007-2008 vs 1999-2000, 1.12 [95% CI, 0.89-1.32]; *P*=.21) or a categorical variable (*P*=.68). There were not any significant trends by survey cycle within any subgroup of women.

In analyses over the 10-year period adjusted for survey cycle for both men and women, the likelihood of being obese was significantly higher in the age group of 40-59 years (OR for men, 1.46 [95% CI, 1.29-1.66]; OR for women, 1.50 [95% CI, 1.31-1.72]) and in the age group of 60 years or older (OR for men, 1.35 [95% CI, 1.19-1.54]; OR for women, 1.26 [95% CI, 1.11-1.44]) than among those in the age group of 20-39 years. Relative to non-Hispanic whites, the likelihood of being obese was significantly greater among non-Hispanic blacks (OR for men, 1.13 [95% CI, 1.01-1.27]; OR for women, 2.26 [95% CI, 2.02-2.51]) and for Mexican American women (OR, 1.53; 95% CI, 1.31-1.78), but not for Mexican American men (OR, 1.01; 95% CI, 0.85-1.19).

Smoothed distributions of BMI in 1999-2000 and 2007-2008 are shown by age group in the FIGURE for men and women aged 40 to 59 years. (Distributions for men and women aged 20-39 years and aged ≥60 years are available online in eFigure 1 and eFigure 2 at http://www.jama.com.) For both men and women,

Figure. Smoothed Frequency Distributions of Body Mass Index for Men and Women Aged 40 to 59 Years in 1999-2000 and 2007-2008



the estimated median BMI (50th percentile) tended to be slightly higher in 2007-2008 than in 1999-2000 within all age groups; however, some of the differences were extremely small. In 1999-2000, the median BMI for men aged 20 to 39 years was 26.0 (95% CI, 25.6-26.7) vs 26.6 (95% CI, 26.1-27.2) in 2007-2008; for men aged 40 to 59 years, 27.4 (95% CI, 26.8-27.9) vs 28.3 (95% CI, 27.7-29.0); and for men aged 60 years or older, 27.5 (95% CI, 27.2-28.0) vs 28.3 (95% CI, 27.9-28.7). In 1999-2000, the median BMI for women aged 20 to 39 years was 25.6 (95% CI, 24.8-26.3) vs 26.5 (95% CI, 25.7-27.5) in 2007-2008; for women aged 40 to 59 years, 27.6 (95% CI, 26.2-28.8) vs 27.7 (95% CI, 27.0-28.5); and for women aged 60 years or older, 27.4 (95% CI, 26.8-28.1) vs 27.6 (95% CI, 26.9-28.3).

COMMENT

The prevalence of obesity in the United States continues to be high, exceeding 30% in most sex and age groups. Comparisons between Canada and the United States show that obesity prevalence was higher in the United States in 1999-2002 than in Canada in 2004, with the difference largely due to higher obesity prevalence among women.[10] Comparisons of obesity prevalence between Canada and the United States that are limited to white adults show no significant differences for men.[10] A review of prevalence estimates in European countries found that the prevalence of obesity based on measured weights and heights varies widely from country to country, with higher prevalences in Central, Eastern, and Southern Europe.[11] In most cases, the prevalence of obesity appeared lower in European countries than in the United States. However, estimates from other countries are not precisely comparable with US estimates because of differences in study methods, years of measurement and the age ranges, and methods of age adjustment or age categorization.

The prevalence of obesity shows significant variation by racial and ethnic groups. Racial and ethnic differences in the prevalence of obesity as defined by BMI should be interpreted cautiously because they do not necessarily correspond to differences in fat mass or percentage of body fat. Body mass index is a valuable tool to provide a standardized definition of obesity for the purposes of national surveillance and international comparisons.[12] In the NHANES surveys, BMI is highly correlated with percentage of body fat, slightly more so for women than for men.[13] However, BMI does not distinguish fat and lean tissue or represent adiposity directly.

The degree of adiposity associated with a given level of BMI varies by age, sex, and racial and ethnic group.[14] Relative to white men and women at the same BMI level, black men and women tend to have higher lean mass and lower fat mass.[13,15-17] The relative, although not absolute, health risks associated with a given BMI level may be lower for blacks than for whites.[18-20] Asian populations tend to have higher body fat percentages at a given BMI level and possible higher risks; however, this theory has been disputed.[21] Considerable discussion[22-24] has addressed the public health and policy issues of using different BMI cutoff points for different ethnic groups that have different relationships with BMI, body fat, and health risks.

For women, the prevalence of obesity showed no statistically significant changes over the 10-year period from 1999 through 2008. For men, there was a significant linear trend over the same period, but estimates for the period 2003-2004, 2005-2006, and 2007-2008 did not differ significantly from each other. These data suggest that the increases in the prevalence of obesity previously observed between 1976-1980 and 1988-1994[1,3] and between 1988-1994 and 1999-2000[3] may not be continuing at a similar level over the period 1999-2008, particularly for women but possibly for men.

The prevalence of obesity for adults aged 20 to 74 years increased by 7.9 percentage points for men and by 8.9 percentage points for women between 1976-1980 and 1988-1994, and subsequently by 7.1 percentage points for men and by 8.1 percentage points for women between 1988-1994 and 1999-2000.[1] If the trends between 1988-1994 and 1999-2000 continued at approximately the same annual level, an increase of 6 to 7 percentage points between 1999-2000 and 2008-2009 would be expected for both men and women. The sample size was sufficient to detect a linear increase of this magnitude with 90% power. Between 1999-2000 and 2007-2008, there was an increase of 4.7 percentage points (95% CI, 0.5 to 9.0) for men and a nonsignificant increase of 2.1 percentage points (95% CI, −2.1 to 6.3) for women.

In the United States, a study of data from military recruits, veterans, and national surveys suggests mean BMI has increased over a long period since the Civil War up to recent times, with increases in the last several decades perhaps less steep than those observed earlier.[25] Over the period 1960-1980 (covered by the earliest NHANES surveys and the National Health Examination Survey), obesity prevalence was relatively stable, but then it showed striking increases in the 1980s and 1990s. The data presented in our current study using 2007-2008 data suggest that the prevalence may have entered another period of relative stability, perhaps with small increases in obesity, although future large changes cannot be ruled out. Because relatively little is known about the causes of the trends previously observed, it is difficult to predict the future trends in obesity.

This study has several limitations. These data were obtained from a sample survey and like other survey data, they may be subject to sampling error or nonsampling error. In addition, the power of this study is limited to detect small changes in prevalence, particularly among subgroups defined by sex, age, and racial and ethnic group.

Obesity is a risk factor for a variety of chronic conditions including diabetes, hypertension, high cholesterol, stroke, heart disease, certain cancers, and arthritis.[26] Higher grades of obesity are associated with excess mortality, primarily from cardiovascular disease, diabetes, and certain cancers.[26-28] Trends in obesity-related health outcomes do not always parallel trends in the prevalence of obesity. Despite the increases in obesity prevalence, mortality rates and mortality from coronary heart disease and stroke have declined over several decades,[29] possibly due to improvements in public health and medical care and in other cardiovascular risk factors[30]; however, hypertension appears to be increasing.[31] Of these obesity-related conditions, diabetes may be most closely linked to obesity, and the increasing incidence of diabetes worldwide is of considerable concern.[32] In the United States, the prevalence of diagnosed diabetes increased significantly from 1988-1994 through 2005-2006, although the total prevalence of diabetes increased significantly only among non-Hispanic blacks.[33]

The prevention and treatment of overweight and obesity on a populationwide basis are challenging. Population-based strategies that improve social and physical environmental contexts for healthful eating and physical activity are complementary to clinical preventive strategies and to treatment programs for those who are already obese.[34] For example, innovative public policy approaches include a variety of policy and environmental initiatives designed to increase fruit and vegetable consumption in underserved areas.[35,36] Preventive population-level interventions having to do with the built environment and the food environment may lead to health benefits for the entire population, not only for the obese population; and some interventions may reduce excess body fat among the obese population even without large concomitant changes in weight.[37] Enhanced efforts to provide environmental interventions may lead to improved health and to future decreases in the prevalence of obesity.

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Analysis and interpretation of data: Flegal, Carroll, Ogden, Curtin.
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Online-Only Material: eFigure 1 and eFigure 2 are available at http://www.jama.com.

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