

Trends in Black–White Differentials in Dietary Intakes of U.S. Adults, 1971–2002

Ashima K. Kant, PhD, Barry I. Graubard, PhD, Shiriki K. Kumanyika, PhD, MPH

Background: Disparities in the health status of blacks and whites have persisted despite considerable gains in improved health of the U.S. population. Tracking changes in black–white differentials in dietary attributes over time may help in understanding the contribution of diet to these disparities.

Methods: Data were used from four National Health and Nutrition Examination Surveys conducted between 1971 and 2002 for trends in self-reported intakes of energy, macronutrients, micronutrients, fruits and vegetables, and the energy density of foods among U.S. non-Hispanic black ($n=7099$) and white ($n=23,314$) men and women aged 25 to 74 years. Logistic and linear regression methods were used to adjust for multiple covariates and survey design.

Results: Energy intake, amount of food, and carbohydrate energy increased, whereas percentage of energy from protein, fat, and saturated fat decreased over time in all race and gender groups ($p<0.001$). In whites and in black women, energy density increased ($p<0.001$) in parallel to increases in obesity prevalence. In all surveys, black men and women reported lower intakes of vegetables, potassium, and calcium ($p<0.001$) than their white counterparts. In men, the race differential in calcium intake increased across surveys ($p=0.004$).

Conclusions: Dietary intake trends in blacks and whites from 1971 to 2002 were similar, which suggests that previously identified dietary risk factors that differentially affect black Americans have not improved in a relative sense.

(Am J Prev Med 2007;32(4):xxx) © 2007 American Journal of Preventive Medicine

Introduction

Disparities in the health status of blacks and whites have persisted despite considerable gains in improved health of the U.S. population.^{1,2} For example, the age-adjusted death rates for heart disease, cancer, and stroke remain higher in black men and women relative to whites.² These disparities reflect a complex interaction of genetic, environmental, behavioral, and other societal factors such as access to health care, quality of health care, and discrimination.¹ There are also socioeconomic disparities in health status, but variables such as income or education cannot account for the entire race-related differential in health.^{3–7}

From the Department of Family, Nutrition, and Exercise Sciences, Queens College of the City University of New York (Kant), Flushing, New York; Division of Cancer Epidemiology and Genetics, Biostatistics Branch, National Cancer Institute, National Institutes of Health (Graubard), Bethesda, Maryland; and Department of Biostatistics and Epidemiology, University of Pennsylvania School of Medicine (Kumanyika), Philadelphia, Pennsylvania

Address correspondence and reprint requests to: Ashima K. Kant, PhD, Department of Family, Nutrition, and Exercise Sciences, Queens College of the City University of New York, Remsen Hall, Room 306E, Flushing NY 11367. E-mail: ashima.kant@qc.cuny.edu.

The full text of this article is available via AJPM Online at www.ajpm-online.net; 1 unit of Category-1 CME credit is also available, with details on the website.

Diet is associated with several leading causes of morbidity and mortality,^{1,8} and several studies have reported black–white differences in dietary intake that are in a direction parallel to observed health disparities.^{9–11} Furthermore, when examined within a black population, the associations of dietary variables with health outcomes are consistent with those expected based on data for whites,^{12–15} and the improvements in health outcomes among black and white participants in clinical trials of dietary change are similar.^{16–20} Hence, tracking changes in black–white differentials in dietary attributes over time may provide insights useful for understanding related risk factor and disease trends.

Relatively few studies of *trends* in the association of race with dietary profiles in the U.S. population have been published,^{21,22} and none include recent surveys. The objective of the present study was to examine education- and income-adjusted time *trends in black–white differentials* in self-reported dietary attributes in the U.S. population over a 30-year period.

Methods

The data used were collected in successive National Health and Nutrition Examination Surveys (NHANES) I (1971–1975), II (1976–1980), III (1988–1994), 1999–2000, and

2001–2002 conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention.²³ Each survey was a stratified, multistage, national probability sample of the civilian non-institutionalized population of the United States. The survey procedures consisted of a household interview and a health examination of the sample person in the mobile examination center (MEC). Weight and height measurements and the interview to collect a 24-hour dietary recall of each participant were obtained in the MEC. Survey response rates for MEC-examined individuals for the NHANES I, II, III, and 1999–2000 were 74%, 73%, 78%, and 76%, respectively.²³

Race/Ethnic Classification

The NHANES I and II provide only white, black, and other categories, based on interviewer observation. NHANES III and 1999–2002 provide self-reported race-specific categories (non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic, and all other). Given the primary objective of assessing trends in black–white reporting of dietary intake, respondents who reported Hispanic ancestry at the household interview in the NHANES I and I were excluded. Thus, the analytic sample included black and white (non-Hispanic) respondents from all surveys.

Dietary Methods

In all surveys, quantitative dietary information was collected using a 24-hour dietary recall tool administered by a trained dietary interviewer in the MEC.²³ Dietary interviewers used paper and pencil methods in NHANES I and II, which changed to computer-assisted methods in later surveys. Recall data collected for the NHANES 1999–2002 surveys used a computer-assisted multi-pass dietary interview.

Dietary Outcome Variables

To obtain a comprehensive picture of secular changes in diet and black–white associations, two types of dietary attributes were examined. The first group relates to quantity of food, which in turn may relate to energy intake and body weight; food quantity attributes may be especially relevant given recent reports suggesting that the portion sizes consumed by Americans have increased over the period of surveys examined in this study.²⁴ These variables included total amount (weight) of foods and beverages, energy intake, macronutrient composition, and energy density of the reported diet. Dietary energy density may correlate with total energy intake and body weight,^{25–29} and is also believed to have changed over the past three decades. However, the association of energy-density measures with nutrient profiles and body weight varies depending on how energy density variable is defined, and there is no consensus definition.^{27,28} In this study, the dietary energy density (energy content/gram) was assessed in two ways: (1) foods only (excluded all beverages), and (2) foods and nutritive beverages (i.e., milk and 100% juices, but excluding all alcoholic and other non-alcoholic energy-yielding or non–energy-yielding beverages—e.g., coffee, tea, sodas, juice drinks).

The second group of dietary variables included foods/nutrients potentially related to health, such as variables related to dietary composition and quality. Nutrients examined were limited to those available in all surveys and included intakes of saturated fat and the micronutrients vitamin C, calcium, and potassium. Other nutrients/dietary components of potential public health significance—dietary fiber, folate, vitamin E, trans fatty acids, and the glycemic index of foods—were not available for all surveys. Estimates of vitamin C, calcium, and potassium intake presented do not include the contribution of supplements. Whether respondents mentioned any food from the fruit or vegetable groups was also examined. The fruit group included all fresh, frozen, or canned fruits and 100% juices, but excluded fruit drinks and fruit desserts such as fruit pies. The vegetable group included all raw, canned, and frozen vegetables and juices.

Analytic Sample

The analytic sample included all nonpregnant, nonlactating respondents aged 25 to 74 years with a reliable, self-reported 24-hour dietary recall, with race classification of non-Hispanic black and white, and with information on poverty–income ratio (PIR) and education from each survey. The upper age cutoff of 74 years was necessary because the NHANES I and II did not include respondents aged >74 years. The total sample size for the four surveys was 30,413 (NHANES I=9638, NHANES II=9155, NHANES III=7657, and NHANES 1999–2002=3963).

See
related
commentary by
Nebeling in
this issue.

Analytical Methods

Gender-specific linear or logistic multiple regression models were used to assess the independent association of race with dietary attributes. Adjustment for covariates accounted for changes over time and race differences in the distributions of a number of variables potentially related to various outcomes: age, race (white, black), PIR, education, body mass index (BMI) (kg/m²), and survey (NHANES I, NHANES II, NHANES III, and NHANES 1999–2002). Changes in the association of race with dietary attributes across surveys were examined by including a race by survey interaction term in all regression models. In these models, survey was modeled as a trend variable. In an attempt to understand whether race differentials were dependent on education and PIR, regression models stratified by categories of education and PIR were run using data combined for all surveys to compensate for small sample size within some race–socioeconomic position categories in individual surveys. Respondents missing information on any variable were excluded from regression models. The mean estimates presented in tables and figures are predictive margins obtained from fully adjusted regression models.³⁰

Because the data from four surveys were combined for analysis of trends, data from these surveys were treated as *independent* samples from different populations. Therefore, the data in all analyses were weighted using the NCHS-assigned survey-specific sample weights so as to produce estimates that represented each population.³⁰ All statistical analyses included sample weights and were adjusted for

complex sample design of the four surveys by using SAS-callable SUDAAN, Release 9.0 (Research Triangle Institute, Research Triangle Park NC, 2005). All p values were two-sided.

Results

Respondent Characteristics

Characteristics of the study population are available in the online Appendix (www.ajpm-online.net). Overall, a higher proportion of black adults were women, aged 25 to 39 years, had <12 years of education or a PIR of <1, were current smokers, and reported no leisure-time physical activity; however, a lower proportion of blacks reported alcohol use or dietary supplements (for all variables, p value for χ^2 test of independence ≤ 0.0001). Time trends for white and black adults were similar for education, income, and dietary supplement use (all increased), as well as current smoking and no leisure time physical activity (both decreased) ($p < 0.0001$), although the pattern of race differences was unchanged.

Direction of time trends in self-reported dietary attributes within each race-gender group. In all race-gender groups, the percent obese, reported intakes of energy, amount of foods and beverages, energy from carbohydrate and energy density (except black men) increased, whereas the energy from protein, fat (total and saturated), and cholesterol decreased ($p \leq 0.05$) over time (Tables 1 and 2). The percentage of white men and women who mentioned a fruit declined ($p < 0.001$) across surveys; a similar trend was significant in black women ($p = 0.03$) but not men ($p = 0.07$). The percentage of white and black women who mentioned a vegetable increased across surveys ($p = 0.05$ and 0.002 , respectively). Reported vitamin C intake declined for white women ($p = 0.02$), but was unchanged in all other race-gender groups. Reported potassium and calcium intakes increased in all race-gender groups ($p < 0.001$), except calcium intake in black men ($p = 0.3$). With adjustment for energy intake, the observed trends in intakes of food groups and nutrients were attenuated (vegetable reporting, and vitamin C and potassium), and the inverse trend for calcium intake became significant in black men and women ($p \leq 0.01$).

The observation that the energy density of reported diets increased from 1971 to 2002 motivated a post hoc exploratory analysis comparing trends in energy density with trends in prevalence of obesity. Energy density of foods and nutritive beverages was a significant independent predictor of BMI in women ($p = 0.007$) but not in men. Energy density of foods was the only variable not associated with BMI in either gender. These logistic regression models included age, education, PIR, race, survey, smoking status, alcohol use, and leisure-time physical activity as covariates. Figure 1 shows that the

trajectory of prevalence rates of obesity from 1971 to 2002 roughly parallels adjusted mean energy density of foods and nutritive beverages, especially among women.

Time trends in race differentials in self-reported dietary attributes. The lack of significant race by survey interactions in Tables 1 and 2 suggests that the race differences or (lack thereof) in most dietary attributes examined in this study were unchanged from 1971 to 2002. Exceptions are discussed in the following paragraph.

In NHANES I, obesity was more prevalent among black men; in later surveys these differences were not significant (Table 1, survey by race interaction $p = 0.001$). The race differential in calcium intake increased from 1971 to 2002 was due to a significant increase in white but not black men (Table 1, survey by race interaction $p = 0.004$). Black women reported significantly lower energy intake in the NHANES I and II; in later surveys these differences were not significant (Table 2, survey by race interaction $p = 0.007$). The macronutrient composition of the diet was generally similar in all race groups in all surveys. However, race differences were noted for reported amount of food, energy from saturated fat, vegetables, vitamin C, potassium, and calcium intakes in most surveys in both men and women. In all surveys, blacks reported lower amount of foods, energy from saturated fat, vegetables, potassium, and calcium intakes relative to whites ($p < 0.05$).

Education and PIR differentials in selected dietary attributes between blacks and whites. In combined data from all surveys, significant race differentials were noted in reported intakes of potassium, calcium, and vegetable in all categories of income and education (Figure 2). Higher education and PIR predicted higher intakes of these attributes in both race groups (except that PIR did not relate to calcium intake in either race).

Discussion

The primary objective of this study was to determine if *race differentials* in dietary intake changed over time, for possible insights into trends in diet-related health disparities. Improved dietary attributes in blacks relative to whites could signify an eventual closing of gaps in related health outcomes. A static differential in the face of worsening trends would mean an absolute although not relative deterioration in dietary status of black Americans, while a static differential in the face of trends of improvement would mean an absolute but not relative improvement for black Americans. The goal of eliminating disparities is to close the black-white gap in the context of overall improved health status. Hence, to the extent possible the direction of the overall trends along with trends in race differentials was evaluated. Data on obesity prevalence were in-

Table 1. Adjusted^a percent obese and percent or mean \pm SE of dietary attributes among men, by race, NHANES I, II, III, and 1999–2002

	NHANES I	NHANES II	NHANES III	NHANES 1999–02	P _{trend} for survey effect
% with body mass index of $\geq 30^b$					
White	12 \pm 0.8	13 \pm 0.7	22 \pm 0.9	29 \pm 1	<0.001***
Black	19 \pm 2	16 \pm 2	23 \pm 1.2	26 \pm 2	0.002**
<i>p</i> for race effect	0.003**	0.2	0.5	0.2	
Energy (kcal)					
White	2391 \pm 29	2395 \pm 26	2684 \pm 27	2722 \pm 27	<0.001***
Black	2220 \pm 61	2175 \pm 53	2487 \pm 42	2525 \pm 47	<0.001***
<i>p</i> for race effect	0.005**	<0.001***	<0.001***	<0.001***	
Amount of all reported foods and beverages (g)					
White	2714 \pm 38	2790 \pm 33	3144 \pm 37	3224 \pm 53	<0.001***
Black	2050 \pm 71	2013 \pm 51	2314 \pm 36	2572 \pm 67	<0.001***
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	
Energy density (foods and nutritive beverages) (kcal/g)					
White	1.63 \pm 0.01	1.66 \pm 0.01	1.74 \pm 0.02	1.78 \pm 0.02	<0.001***
Black	1.69 \pm 0.04	1.73 \pm 0.04	1.78 \pm 0.02	1.80 \pm 0.04	0.06
<i>p</i> for race effect	0.08	0.07	0.11	0.63	
Energy density (foods only) (kcal/g)					
White	2.00 \pm 0.01	2.01 \pm 0.01	2.03 \pm 0.02	2.09 \pm 0.02	<0.001***
Black	1.98 \pm 0.03	2.03 \pm 0.04	2.00 \pm 0.02	2.01 \pm 0.04	0.7
<i>p</i> for race effect	0.5	0.7	0.2	0.1	
Energy (%) from carbohydrate					
White	42.0 \pm 0.2	42.3 \pm 0.2	48.0 \pm 0.5	48.4 \pm 0.4	<0.001***
Black	42.3 \pm 0.8	42.2 \pm 0.6	46.1 \pm 0.5	49.0 \pm 0.5	<0.001***
<i>p</i> for race effect	0.8	0.9	0.002**	0.3	
Energy (%) from protein					
White	16.6 \pm 0.1	16.2 \pm 0.1	15.2 \pm 0.1	15.2 \pm 0.1	<0.001***
Black	17.5 \pm 0.4	16.4 \pm 0.2	16.0 \pm 0.2	15.5 \pm 0.2	<0.001***
<i>p</i> for race effect	0.02*	0.5	<0.001***	0.3	
Energy (%) from total fat					
White	37.0 \pm 0.2	37.1 \pm 0.2	34.6 \pm 0.3	33.9 \pm 0.3	<0.001***
Black	36.0 \pm 0.8	36.5 \pm 0.7	34.3 \pm 0.2	31.7 \pm 0.5	<0.001***
<i>p</i> for race effect	0.2	0.4	0.3	<0.001***	
Energy (%) from saturated fat					
White	13.5 \pm 0.1	13.3 \pm 0.1	11.6 \pm 0.1	11.1 \pm 0.1	<0.001***
Black	12.5 \pm 0.3	12.7 \pm 0.2	11.0 \pm 0.1	9.7 \pm 0.2	<0.001***
<i>p</i> for race effect	0.004**	0.03*	<0.001***	<0.001***	
Dietary cholesterol (mg)					
White	479 \pm 8	430 \pm 8	344 \pm 10	359 \pm 9	<0.001***
Black	529 \pm 24	463 \pm 19	396 \pm 13	374 \pm 12	<0.001***
<i>p</i> for race effect	0.04*	0.11	<0.001***	0.3	
Mentioned any fruit (%)					
White	57 \pm 1	55 \pm 1	48 \pm 1	48 \pm 1	<0.001***
Black	56 \pm 4	54 \pm 3	49 \pm 1	50 \pm 1	0.07
<i>p</i> for race effect	0.7	0.8	0.8	0.3	
Mentioned any vegetable (%)					
White	93 \pm 0.5	91 \pm 0.5	93 \pm 0.7	91 \pm 0.9	0.7
Black	88 \pm 2	84 \pm 2	89 \pm 1	85 \pm 1	0.5
<i>p</i> for race effect	0.004**	<0.001***	<0.001***	<0.001***	
Vitamin C (mg)					
White	91 \pm 2	102 \pm 2	112 \pm 4	97 \pm 4	0.1
Black	103 \pm 6	118 \pm 9	127 \pm 4	120 \pm 9	0.1
<i>p</i> for race effect	0.05	0.11	0.01	0.007	
Potassium (mg)					
White	2820 \pm 40	2990 \pm 35	3488 \pm 42	3350 \pm 44	<0.001***
Black	2320 \pm 74	2434 \pm 64	2808 \pm 50	2776 \pm 65	<0.001***
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	
Calcium (mg)					
White	916 \pm 17	900 \pm 19	1017 \pm 19	1034 \pm 18	<0.001***
Black	669 \pm 29	663 \pm 26	717 \pm 19	688 \pm 19	0.3
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	

^aFrom gender-specific regression models with each variable in the table as a continuous or binary outcome, independent variables were age, age square, education (<12, 12, >12 years), poverty income ratio (<1, 1–<2, ≥ 2), body mass index, race (non-Hispanic white, non-Hispanic black), survey (NHANES I, II, III, 1999–2002), and race by survey interaction term. Models included respondents with complete covariate information ($n=13,655$). The interaction of race and survey (Race*Survey) was significant for BMI and calcium ($p \leq 0.004$).

^bFor body mass index as outcome, additional covariates were smoking status (never, former, current, unknown), any alcohol use (yes, no), and any leisure-time physical activity (yes, no) ($n=13,595$ with complete covariate information).

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (all bolded).

NHANES, National Health and Nutrition Examination Survey; SE, standard error.

Table 2. Adjusted^a percent obese, and percent or mean \pm SE of dietary attributes, among women, by race: NHANES I, II, III, and 1999–2002

	NHANES I	NHANES II	NHANES III	NHANES 1999–02	P _{trend} for survey effect
% with body mass index of $\geq 30^b$					
White	16 \pm 0.8	16 \pm 0.7	26 \pm 1.5	36 \pm 1.5	<0.001***
Black	24 \pm 1.6	27 \pm 2.0	35 \pm 1.7	47 \pm 2.5	<0.001***
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	
Energy (kcal)					
White	1530 \pm 16	1507 \pm 13	1759 \pm 16	1857 \pm 23	<0.001***
Black	1387 \pm 27	1427 \pm 30	1746 \pm 19	1843 \pm 36	<0.001***
<i>p</i> for race effect	<0.001***	0.01*	0.6	0.7	
Amount of all reported foods and beverages (g)					
White	1975 \pm 19	2014 \pm 23	2243 \pm 20	2306 \pm 34	<0.001***
Black	1489 \pm 40	1488 \pm 38	1766 \pm 22	1823 \pm 38	<0.001***
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	
Energy density (foods and nutritive beverages) (kcal/g)					
White	1.52 \pm 0.01	1.54 \pm 0.01	1.64 \pm 0.01	1.70 \pm 0.03	<0.001***
Black	1.57 \pm 0.03	1.60 \pm 0.03	1.71 \pm 0.02	1.73 \pm 0.03	<0.001***
<i>p</i> for race effect	0.1	0.1	0.01	0.4	
Energy density (foods only) (kcal/g)					
White	1.85 \pm 0.01	1.85 \pm 0.01	1.90 \pm 0.01	1.98 \pm 0.02	<0.001***
Black	1.83 \pm 0.03	1.88 \pm 0.04	1.91 \pm 0.02	1.98 \pm 0.04	0.002**
<i>p</i> for race effect	0.4	0.4	0.6	0.8	
Energy (%) from carbohydrate					
White	44.9 \pm 0.2	45.5 \pm 0.2	50.3 \pm 0.4	50.6 \pm 0.4	<0.001***
Black	45.1 \pm 0.7	45.8 \pm 0.8	49.7 \pm 0.3	51.5 \pm 0.5	<0.001***
<i>p</i> for race effect	0.8	0.7	0.3	0.2	
Energy (%) from protein					
White	17.1 \pm 0.1	16.1 \pm 0.1	15.3 \pm 0.1	14.7 \pm 0.1	<0.001***
Black	17.5 \pm 0.3	16.8 \pm 0.3	15.5 \pm 0.1	14.8 \pm 0.3	<0.001***
<i>p</i> for race effect	0.2	0.05	0.2	0.9	
Energy (%) from total fat					
White	36.2 \pm 0.1	36.3 \pm 0.2	33.8 \pm 0.3	34.3 \pm 0.3	<0.001***
Black	35.4 \pm 0.5	35.6 \pm 0.5	33.9 \pm 0.3	32.9 \pm 0.5	<0.001***
<i>p</i> for race effect	0.1	0.2	0.7	0.02*	
Percent energy from saturated fat					
White	13.0 \pm 0.1	12.5 \pm 0.1	11.3 \pm 0.1	11.2 \pm 0.1	<0.001***
Black	12.2 \pm 0.2	12.1 \pm 0.2	10.8 \pm 0.1	10.1 \pm 0.2	<0.001***
<i>p</i> for race effect	<0.001***	0.04*	0.004**	<0.001***	
Dietary cholesterol (mg)					
White	310 \pm 5	273 \pm 5	218 \pm 5	233 \pm 5	<0.001***
Black	310 \pm 13	288 \pm 11	244 \pm 6	260 \pm 8	<0.001***
<i>p</i> for race effect	0.9	0.2	<0.001***	0.02*	
Mentioned any fruit (%)					
White	65 \pm 1	63 \pm 1	54 \pm 1	51 \pm 2	<0.001***
Black	59 \pm 3	64 \pm 3	55 \pm 2	54 \pm 2	0.03*
<i>p</i> for race effect	0.04*	0.6	0.4	0.4	
Mentioned any vegetable (%)					
White	92 \pm 0.5	90 \pm 0.5	92 \pm 0.5	94 \pm 1	0.05
Black	85 \pm 1	85 \pm 2	89 \pm 0.8	89 \pm 1	0.002**
<i>p</i> for race effect	<0.001***	<0.001***	0.003**	0.003**	
Vitamin C (mg)					
White	86 \pm 2	96 \pm 2	89 \pm 2	78 \pm 3	0.02*
Black	88 \pm 4	111 \pm 4	99 \pm 3	94 \pm 3	0.9
<i>p</i> for race effect	0.7	0.003**	0.009**	<0.001***	
Potassium (mg)					
White	1997 \pm 23	2093 \pm 25	2511 \pm 29	2450 \pm 48	<0.001***
Black	1637 \pm 50	1775 \pm 53	2131 \pm 27	2101 \pm 38	<0.001***
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	
Calcium (mg)					
White	624 \pm 10	602 \pm 12	710 \pm 11	766 \pm 15	<0.001***
Black	454 \pm 16	478 \pm 19	556 \pm 9	568 \pm 16	<0.001***
<i>p</i> for race effect	<0.001***	<0.001***	<0.001***	<0.001***	

^aFrom gender-specific regression models with each variable in the table as a continuous or binary outcome; independent variables were age, age square, education (<12, 12, >12 years), poverty income ratio (<1, 1–<2, ≥ 2), race (non-Hispanic white, non-Hispanic black), body mass index, survey (NHANES I, II, III, 1999–2002), and race by survey interaction term. Models included respondents with complete covariate information ($n=16,674$). The interaction of race and survey (Race*Survey) was significant for energy intake ($p=0.007$).

^bFor body mass index as outcome, additional covariates were smoking status (never, former, current, unknown), any alcohol use (yes, no), any-leisure time physical activity (yes, no); ($n=16,575$ with complete covariate information).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (all bolded).

NHANES, National Health and Nutrition Examination Survey; SE, standard error.

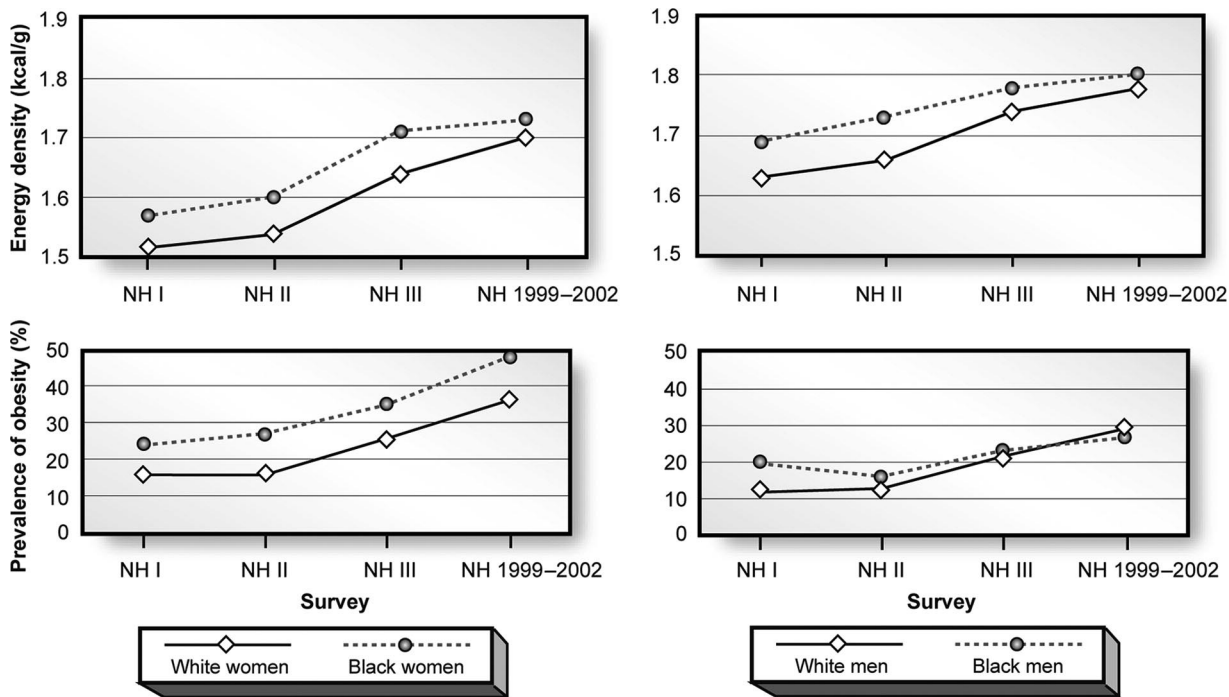


Figure 1. Secular trends in the prevalence of obesity and mean energy density of foods and nutritive beverages among men and women, NHANES I, 1971–1975 to NHANES 1999–2002. NH and NHANES, National Health and Nutrition Examination Survey.

cluded for context. Detailed analyses of trends in obesity in NHANES data by race and socioeconomic status are available elsewhere.^{31,32}

The results are remarkable for similarity of trajectories in self-reported food and nutrient intake in all race–gender groups. The quantity of food, total energy intake, energy from carbohydrate, and energy density increased, and energy from total and saturated fat and cholesterol intake decreased across the board. Similar trends in macronutrient intake have been reported from the Continuing Survey of Food Intakes by Individuals,³³ and among mostly white participants of the Minnesota Heart Survey.³⁴ These results suggest a population-wide shift in intake of energy and macronutrients over the 30-year span of the four surveys, and may reflect changes in availability and marketing of foods of lower fat but higher carbohydrate content that were adopted by all race–gender groups. Prevalence of obesity also increased over this period in all race–gender groups with trends parallel to energy density (especially in women). Trends in a favorable direction were noted for dietary potassium and calcium intake (except in black men).

In most surveys, the race differentials in reported saturated fat and vitamin C intake were favorable for blacks (lower energy from saturated fat and higher vitamin C intake). However, in all surveys, other food or nutrient intake differences between blacks and whites were in a direction suggestive of higher chronic disease risk in blacks: lower intakes of vegetables, potassium,

and calcium. The absence of a change in race differentials across surveys that might foretell a widening or narrowing of gaps in disparities between blacks and whites in diet-related health outcomes was striking, with only two noteworthy exceptions. The relative position of black compared to white men improved, in that the increase in obesity prevalence was steeper in white than black men. However, as suggested above, a small relative gain when attained by a relatively lesser *worsening* of a health problem is not really a gain in an absolute sense. For calcium intake in men, the disparity widened—white men improved while black men did not change their calcium intake. Overall then, these results indicate that essentially no progress has been made in reducing disparities in dietary intakes between U.S. blacks and whites, in either gender and, further, that adverse dietary changes in the U.S. population, when observed, will add to any underlying excess risk that is already present in the black population.

Differences in dairy food consumption between blacks and whites are well known and may have contributed to lower intakes of calcium and potassium. In the U.S. population, milk was the most important source of both calcium and potassium.³⁵ With potential advantages of a higher potassium intake in mitigating the effect of sodium sensitivity in black Americans,³⁶ the persistently low potassium intakes require attention. Although the fruit and vegetable intakes of black men and women were somewhat lower relative to whites, the dietary vitamin C intake was consistently

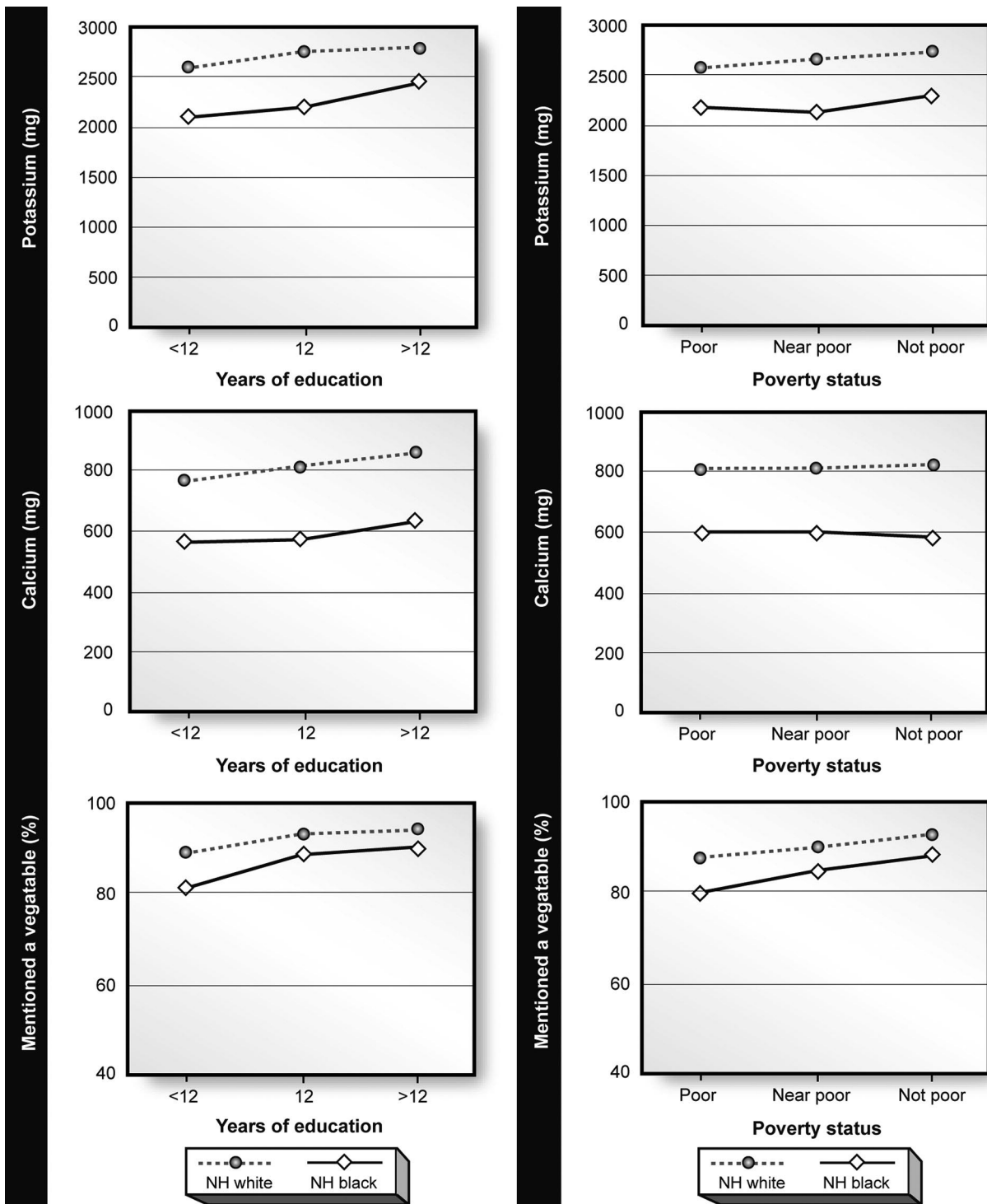


Figure 2. Multivariate-adjusted intakes of potassium (top row, mean intake), calcium (middle row, mean intake), and vegetables (bottom row, percent reporting any vegetable) for non-Hispanic white (solid line) and black (dotted line) adults by education and poverty level (all surveys combined). All education trends were significant for NH whites and blacks. Poverty level trends were significant for potassium and vegetable intake. All race differentials were significant for all categories of education and poverty. NH, non-Hispanic.

higher among blacks. Others have also reported higher vitamin C intake among black Americans.^{10,11} This differential may partially reflect higher contribution of non-fruit and vegetable sources of vitamin C (e.g.,

vitamin C-fortified beverages) to the total daily intake of this nutrient among blacks.³⁷

Race differences in dietary intakes reflect differences in food availability, selection, and preparation practices

that may be mediated by a number of economic, institutional, environmental, cultural, individual preferences, and health determinants.^{10,38} Income and especially education differentials were found to persist independently of race differentials in these surveys.³⁹ In the present study, the race differentials in intakes of potassium, calcium, and vegetables were present in all categories of education and PIR. Neighborhood rather than only individual socioeconomic position may be relevant as well, since neighborhood of residence may limit the ready accessibility and, therefore, consumption, of healthful foods or determine the excess availability of foods considered to be unhealthful.^{40–43} These effects may be more important in black than in white communities due to residential segregation.⁴⁴

The results of this study should be interpreted with due consideration for the following limitations. First, the methods used to collect the 24-hour dietary recall in the NHANES changed over the four surveys²³; newer surveys include automated methods and a multiple-pass approach. Second, the database on nutrient composition of foods has expanded and values of many nutrients may have changed because of improved analytic technology and food sampling methods.⁴⁵ Third, the recalls obtained in the NHANES I and II were limited to weekdays, whereas weekend days were included in later surveys.²³ Because NCHS did not conduct any bridging studies to determine the systematic effect of changes in dietary methodology on food and nutrient intakes, the confounding of time (survey) effect with the method effect remains a possibility. Due to these reasons, *quantitative changes* in dietary attributes across surveys should be interpreted cautiously. Within each survey, however, the methods used for data collected from all respondents were similar; therefore, while these data may be of limited value in estimating survey effect, they are valid for *comparing the direction* of time trends in the two race groups, and for an examination of *changes in race differentials* in self-reported dietary attributes across surveys. No data are available to help examine the possibility that changes in methodology may have a differential effect on different race–ethnicity groups.

Measurement error is a problem in *all* methods of assessing dietary intake.^{46,47} A 24-hour recall provides a valid estimate of usual intakes of groups but not individuals and overestimates prevalence of nutrient inadequacy.⁴⁸ Therefore, the assessment of race differences in dietary intakes in this study was limited to estimation of mean nutrient intakes and did not derive estimates of prevalence of nutrient inadequacy.

In conclusion, dietary intake trends in blacks and whites over the past several decades appear to be similar—suggesting that previously identified dietary risk factors that differentially affect black Americans have not improved in a relative sense. The differences observed need to be confirmed with biomarkers,⁴⁹ but

would seem sufficiently strong to warrant intensified study and action to better understand the sociocultural or environmental factors that anchor these persistent differentials and identify approaches to effect change while building on strengths of current dietary patterns where possible.^{50–52}

Funded in part by the National Institutes of Health (NIH) (grant CA108274, AKK), the intramural research program of the U.S. Department of Health and Human Services, NIH, National Cancer Institute (BIG), and the National Center for Minority Health and Health Disparities at NIH (grant P60 MD000209, SKK).

We thank Lisa Licitra Kahle for expert SAS and SUDAAN programming support.

No financial conflict of interest was reported by the authors of this paper.

References

1. U.S. Department of Health and Human Services. Healthy people 2010: understanding and improving health. 2nd ed. Washington DC: U.S. Government Printing Office, 2000.
2. Centers for Disease Control and Prevention. Health United States, 2005 with chartbook on trends in the health of Americans. Hyattsville MD: National Center for Health Statistics, 2005.
3. LaVeist TA. Disentangling race and socioeconomic status: A key to understanding health inequalities. *J Urban Health* 2005;82:iii26–34.
4. Williams DR. Race, socioeconomic status, and health. The added effects of racism and discrimination. *Ann N Y Acad Sci* 1999;896:173–88.
5. O'Malley CD, Le GM, Glaser SL, Shema SJ, West DW. Socioeconomic status and breast carcinoma survival in four racial/ethnic groups: a population-based study. *Cancer* 2003;97:1303–11.
6. Robbins AS, Whittemore AS, Thom DH. Differences in socioeconomic status and survival among white and black men with prostate cancer. *Am J Epidemiol* 2000;151:409–16.
7. Ng-Mak DS, Dohrenwend BP, Abraido-Lanza AF, Turner JB. A further analysis of race differences in the National Longitudinal Mortality Study. *Am J Public Health* 1999;89:1748–51.
8. Frazao E. High costs of eating patterns in the U.S. In: Frazao E, ed. *America's eating habits: changes and consequences*. Washington DC: U.S. Department of Agriculture, 1999:5–32.
9. Block G, Rosenberger WF, Patterson BH. Calories, fat, and cholesterol: intake patterns in the U.S. population by race, sex, and age. *Am J Public Health* 1988;78:1150–5.
10. Kumanyika SK, Krebs-Smith SM. Preventive nutrition issues in ethnic and socioeconomic groups in the United States. In: Bendich A, Deckelbaum RJ, eds. *Primary and secondary preventive nutrition*. Totowa NJ: Humana Press Inc., 2001:325–55.
11. Arab L, Carriquiry A, Steck-Scott S, Gaudet MM. Ethnic differences in the nutrient adequacy of premenopausal U.S. women: results from the Third National Health Examination Survey. *J Am Diet Assoc* 2003;103:1008–14.
12. Whittemore AS, Kolonel LN, Wu AH, et al. Prostate cancer in relation to diet, physical activity, and body size in blacks, whites, and Asians in the United States and Canada. *J Natl Cancer Inst* 1995;87:652–61.
13. Must A, Spandano S, Coakley EH, Field A, Colditz G, Dietz W. The disease burden associated with overweight and obesity. *JAMA* 1999;282:1523–9.
14. Hayes RB, Ziegler RG, Gridley G, et al. Dietary factors and risks for prostate cancer among blacks and whites in the United States. *Cancer Epidemiol Biomarkers Prev* 1999;8:25–34.
15. Giles WH, Croft JB, Greenlund KJ, Ford ES, Kittner SJ. Association between total homocyst(e)ine and the likelihood for a history of acute myocardial infarction by race and ethnicity: results from the Third National Health and Nutrition Examination Survey. *Am Heart J* 2000;139:446–53.
16. Obarzanek E, Sacks FM, Vollmer WM, et al. Effects on blood lipids of a blood pressure-lowering diet: the Dietary Approaches to Stop Hypertension (DASH) Trial. *Am J Clin Nutr* 2001;74:80–9.

17. Svetkey LP, Erlinger TP, Vollmer WM, et al. Effect of lifestyle modifications on blood pressure by race, sex, hypertension status, and age. *J Hum Hypertens* 2005;19:21–31.
18. Svetkey LP, Simons-Morton D, Vollmer WM, et al. Effects of dietary patterns on blood pressure: subgroup analysis of the Dietary Approaches to Stop Hypertension (DASH) randomized clinical trial. *Arch Intern Med* 1999;159:285–93.
19. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 2002;346:393–403.
20. Kumanyika SK, Cook NR, Cutler JA, et al. Sodium reduction for hypertension prevention in overweight adults: further results from the Trials of Hypertension Prevention Phase II. *J Hum Hypertens* 2005;19:33–45.
21. Popkin BM, Siega-Riz AM, Haines PS. A comparison of dietary trends among racial and socioeconomic groups in the United States. *N Engl J Med* 1996;335:716–20 (errata in *N Engl J Med* 1997;337:1846–8).
22. Popkin BM, Siega-Riz AM, Haines PS, Jahns L. Where's the fat? Trends in U.S. diets 1965–1996. *Prev Med* 2001;32:245–54.
23. Centers for Disease Control and Prevention, National Center for Health Statistics. National Health and Nutrition Examination Survey (NHANES), I, II, III, 1999–2000, and 2001–2002. Hyattsville MD: U.S. Department of Health and Human Services, various years. Available at: www.cdc.gov/nchs/about/major/nhanes.
24. Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. *Ann Rev Nutr* 2004;24:401–31.
25. Poppitt SD, Prentice AM. Energy density and its role in the control of food intake: evidence from metabolic and community studies. *Appetite* 1996;26:153–74.
26. Bell EA, Castellanos VH, Pelkman CL, Thorwart ML, Rolls BJ. Energy density of foods affects energy intake in normal-weight women. *Am J Clin Nutr* 1998;67:412–20.
27. Cox DN, Mela DJ. Determination of energy density of freely selected diets: methodological issues and implications. *Int J Obes Relat Metab Disord* 2000;24:49–54.
28. Kant AK, Graubard BI. Energy density of diets reported by American adults: association with food group intake, nutrient intake, and body weight. *Int J Obes Relat Metab Disord* 2005;29:950–6.
29. Rolls BJ, Bell EA, Thorwart ML. Water incorporated into a food but not served with a food decreases energy intake in lean women. *Am J Clin Nutr* 1999;70:448–55.
30. Korn EL, Graubard BI. Analysis of health surveys, 1999. New York: John Wiley and Sons, 1999. pp. 126–29 and 286–92.
31. Zhang Q, Wang Y. Trends in the association between obesity and socioeconomic status in U.S. adults: 1971–2000. *Obes Res* 2004;12:1622–32.
32. Chang VW, Lauderdale DS. Income disparities in body mass index and obesity in the United States, 1971–2002. *Arch Intern Med* 2005;165:2122–8.
33. Enns CW, Goldman JD, Cook A. Trends in food and nutrient intakes by adults: NFCS 1977–78, CSFII 1989–91, and CSFII 1994–95. *Fam Econ Nutr Rev* 1997;10:2–15.
34. Arnett DK, Xiong B, McGovern PG, Blackburn H, Luepker RV. Secular trends in dietary macronutrient intake in Minneapolis–St. Paul, Minnesota, 1980–1992. *Am J Epidemiol* 2000;152:868–73.
35. Cotton PA, Subar AF, Friday JE, Cook A. Dietary sources of nutrients among U.S. adults, 1994 to 1996. *J Am Diet Assoc* 2004;104:921–30.
36. Food and Nutrition Board, Institute of Medicine. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. Washington DC: National Academies Press, 2004.
37. Borrud LG, Pillow PC, Allen PK, McPherson RS, Nichman MZ, Newell GR. Food group contributions to nutrient intake in whites, blacks, and Mexican-Americans in Texas. *J Am Diet Assoc* 1989;89:1061–9.
38. Trudeau E, Kristal AR, Li S, Patterson RE. Demographic and psychosocial predictors of fruit and vegetable intakes differ: implications for dietary interventions. *J Am Diet Assoc* 1998;98:1412–7.
39. Kant AK, Graubard BI. Secular trends in the association of socioeconomic position with self-reported dietary attributes and biomarkers in the US population: NHANES 1971–1975 to NHANES 1990–2002. *Pub Health Nutr* 2007;10:158–67.
40. Morland K, Diez Roux AV, Wing S. Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. *Am J Prev Med* 2006;30:333–9.
41. Morland K, Wing S, Diez Roux A, Poole C. Neighborhood characteristics associated with the location of food stores and food service places. *Am J Prev Med* 2002;22:23–9.
42. Lewis LB, Sloane DC, Nascimento LM, et al. African Americans' access to healthy food options in South Los Angeles restaurants. *Am J Public Health* 2005;95:668–73.
43. Horowitz CR, Colson KA, Hebert PL, Lancaster K. Barriers to buying healthy foods for people with diabetes: evidence of environmental disparities. *Am J Public Health* 2004;94:1549–54.
44. Chang VW. Racial residential segregation and weight status among U.S. adults. *Soc Sci Med* 2006;63:1289–303.
45. Anderson E, Perloff B, Ahuja JKC, Raper N. Tracking nutrient changes for trends analysis in the United States. *J Food Comp Anal* 2001;14:287–94.
46. Bingham SA. The dietary assessment of individuals, new techniques and recommendations. *Nutr Abstr Rev* 1987;57:704–42.
47. Livingstone MBE. Assessment of food intakes: are we measuring what people eat? *Br J Biomed Sci* 1995;52:58–67.
48. Food and Nutrition Board, Institute of Medicine. Dietary Reference Intakes. applications in dietary assessments. Washington DC: National Academies Press, 2001.
49. Ford ES. Variations in serum carotenoid concentrations among United States adults by ethnicity and sex. *Ethn Dis* 2000;10:208–17.
50. Kumanyika S. Obesity, health disparities, and prevention paradigms: hard questions and hard choices. *Prev Chronic Dis* 2005;2:A02 (epub September 15, 2005).
51. Yancey AK, Kumanyika SK, Ponce NA, McCarthy WJ, Fielding JE, Leslie JP. Population-based interventions engaging communities of color in healthy eating and active living: a review. *Prev Chronic Dis* 2004;1:A09 (epub December 15, 2003).
52. Kumanyika S. Nutrition and chronic disease prevention: priorities for U.S. minority groups. *Nutr Rev* 2006;64:S9–14.

Appendix

Table 1. Characteristics (%±SE) of U.S. adult white (non-Hispanics), aged 25 to 74 years, NHANES I, II, III, and 1999–2002

	All surveys	NHANES I	NHANES II	NHANES III	NHANES 1999–2002
<i>n</i>	23,314	7940	8129	4447	2798
% women	51.0 ± 0.3	52.8 ± 0.6	51.5 ± 0.5	50.4 ± 0.6	49.8 ± 0.8
Age group (years)					
25–39	36.6 ± 0.6	35.5 ± 0.9	38.7 ± 0.9	40.5 ± 1.3	31.8 ± 1.3
40–59	42.8 ± 0.5	43.9 ± 0.9	39.2 ± 0.6	38.8 ± 0.9	49.0 ± 1.2
60–74	20.6 ± 0.5	20.6 ± 0.8	22.1 ± 0.7	20.6 ± 1.2	19.2 ± 1.0
Years of education					
<12	22.7 ± 0.6	35.0 ± 1.2	28.9 ± 1.2	17.9 ± 1.2	12.3 ± 1.1
12	34.8 ± 0.6	38.7 ± 0.9	38.5 ± 1.2	36.0 ± 0.9	27.2 ± 1.5
>12	42.5 ± 0.8	26.3 ± 1.2	32.7 ± 1.3	46.1 ± 1.5	60.4 ± 2.3
Poverty income ratio					
<1	6.9 ± 0.3	7.1 ± 0.6	7.1 ± 0.7	6.5 ± 0.7	7.0 ± 0.7
1–<2	18.8 ± 0.5	23.0 ± 0.9	22.0 ± 0.7	16.2 ± 0.8	15.3 ± 1.5
≥2	74.3 ± 0.7	69.9 ± 1.3	70.9 ± 1.2	77.3 ± 1.2	77.7 ± 1.9
Smoking status					
Never	40.9 ± 0.6	36.3 ± 0.8	38.1 ± 0.7	41.1 ± 1.0	46.8 ± 1.7
Former	26.2 ± 0.4	20.3 ± 0.7	25.3 ± 0.6	29.5 ± 0.7	28.5 ± 1.0
Current	30.9 ± 0.5	34.6 ± 0.9	36.5 ± 0.7	29.4 ± 1.1	24.6 ± 1.2
Unknown	1.9 ± 0.1	8.8 ± 0.5	0.01 ± 0.01	None	0.04 ± 0.04
Drink alcohol					
Yes	69.3 ± 0.9	77.4 ± 1.0	65.5 ± 1.3	59.5 ± 1.8	75.8 ± 2.0
Supplement use					
Yes	45.1 ± 0.6	35.0 ± 1.2	38.7 ± 0.8	44.8 ± 1.1	59.0 ± 1.4
Leisure-time physical activity					
None	30.0 ± 0.6	40.9 ± 1.2	35.7 ± 0.7	16.7 ± 1.0	29.7 ± 1.6

Note: The distribution of all variables in the table differed across surveys (*p* value for the χ^2 test of independence <0.0001). NHANES, National Health and Nutrition Examination Survey; SE, standard error.

Table 2. Characteristics (%±SE) of U.S. adult black (non-Hispanics), aged 25 to 74 years, NHANES I, II, III, and 1999–2002

	All surveys	NHANES I	NHANES II	NHANES III	NHANES 1999–2002
<i>n</i>	7099	1698	1026	3210	1165
% women	55.2 ± 0.8	58.1 ± 2.4	55.5 ± 2.1	54.4 ± 1.1	53.8 ± 1.5
Age group (years)					
25–39	43.0 ± 0.8	39.5 ± 1.9	44.1 ± 1.8	48.5 ± 1.1	39.0 ± 1.8
40–59	41.2 ± 0.8	42.7 ± 2.0	39.2 ± 1.5	36.7 ± 0.9	46.0 ± 1.5
60–74	15.8 ± 0.6	17.8 ± 1.6	16.6 ± 1.2	14.8 ± 1.0	14.9 ± 1.0
Years of education					
<12	42.5 ± 1.0	62.2 ± 2.1	52.1 ± 2.3	30.3 ± 1.3	34.8 ± 2.1
12	28.6 ± 0.8	23.5 ± 2.0	28.2 ± 2.0	38.3 ± 1.2	22.8 ± 1.4
>12	28.9 ± 1.0	14.3 ± 1.9	19.7 ± 2.4	31.4 ± 1.5	42.3 ± 2.2
Poverty income ratio					
<1	26.6 ± 1.1	32.9 ± 2.7	26.3 ± 1.9	26.1 ± 1.7	23.4 ± 2.4
1–<2	28.6 ± 0.8	32.8 ± 1.9	31.1 ± 1.8	28.3 ± 1.3	24.6 ± 1.8
>2	44.7 ± 1.3	34.3 ± 2.4	42.6 ± 3.0	45.6 ± 1.9	52.0 ± 2.6
Smoking status					
Never	46.5 ± 1.0	38.5 ± 2.0	41.5 ± 1.8	45.3 ± 1.4	56.4 ± 2.1
Former	15.0 ± 0.6	9.5 ± 1.3	17.0 ± 1.7	17.6 ± 0.9	14.6 ± 1.2
Current	35.4 ± 0.8	36.8 ± 1.9	41.3 ± 1.3	37.1 ± 1.4	29.0 ± 1.7
Unknown	3.0 ± 0.4	15.1 ± 1.8	0.3 ± 0.3	None	0.11 ± 0.09
Drink alcohol					
Yes	59.3 ± 1.0	71.1 ± 2.2	61.0 ± 3.0	52.4 ± 1.3	57.2 ± 2.0
Supplement use					
Yes	31.1 ± 0.9	20.8 ± 1.8	30.1 ± 2.2	34.8 ± 0.9	34.8 ± 2.0
Leisure-time physical activity					
None	45.0 ± 0.9	60.1 ± 2.6	43.9 ± 1.6	32.5 ± 1.6	48.2 ± 1.5

Notes: The distribution of all variables in the table (except gender) differed across surveys (*p* value for the χ^2 test of independence <0.0001). Black–white differences in distribution of all variables in Tables 1 and 2 were significant (*p*<0.0001), for all surveys combined and in each of the four surveys (except gender in NHANES II and smoking status in NHANES I). NHANES, National Health and Nutrition Examination Survey; SE, standard error.