



Applied nutritional investigation

Statistical review of US macronutrient consumption data, 1965–2011: Americans have been following dietary guidelines, coincident with the rise in obesity



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ABSTRACT

Background: For almost 50 y, the US National Health and Nutrition Examination Survey (NHANES) has measured the caloric consumption, and body heights and weights of Americans. The aim of this study was to determine, based on that data, how macronutrient consumption patterns and the weight and body mass index in the US adult population have evolved since the 1960s.

Methods: We conducted the first comprehensive analysis of the NHANES data, documenting how macronutrient consumption patterns and the weight and body mass index in the US adult population have evolved since the 1960s.

Results: Americans in general have been following the nutrition advice that the American Heart Association and the US Departments of Agriculture and Health and Human Services have been issuing for more than 40 y: Consumption of fats has dropped from 45% to 34% with a corresponding increase in carbohydrate consumption from 39% to 51% of total caloric intake. In addition, from 1971 to 2011, average weight and body mass index have increased dramatically, with the percentage of overweight or obese Americans increasing from 42% in 1971 to 66% in 2011.

Conclusions: Since 1971, the shift in macronutrient share from fat to carbohydrate is primarily due to an increase in absolute consumption of carbohydrate as opposed to a change in total fat consumption. General adherence to recommendations to reduce fat consumption has coincided with a substantial increase in obesity.

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Introduction

Since the late 1970s, the US government, following the American Heart Association (AHA) and much of academia, has consistently recommended lowering the dietary percentage of fat and saturated fat, as well as the absolute levels of dietary cholesterol, based on a theoretical link between those food components and higher risk for coronary heart disease [1]. This government guidance suggested that the reduction of dietary fat would be accompanied by a concurrent increase in the dietary share of carbohydrate. Taken together, these recommendations were also considered to be beneficial for the prevention of

overweight and obesity, along with diabetes, cancer, and other chronic diseases [1].

Since the introduction of these dietary recommendations, rates of obesity and diabetes have increased dramatically [2]. The rapid increase in obesity rates has been explained in a number of ways [3], but is frequently attributed to the supposition that Americans have failed to adhere to dietary recommendations [4]. However, others suggest that dietary patterns of Americans have changed in response to advice to reduce their intake of fat, saturated fat, and cholesterol [5]. To our knowledge, no comprehensive analysis of consumption levels both before and after the endorsement of reduced-fat diets has been undertaken.

In this study, we use a set of government surveys between 1965 and 2011 to document patterns and changes in the consumption of the average adult since the earliest recommendations. We have three major findings. First, on average, adults in the United States have adhered to the government's dietary

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recommendations by shifting their proportional consumption of total calories from fats to carbohydrates. Fat consumption dropped from 44.7% in 1965 to 33.6% in 2011, whereas carbohydrate intake increased from 39% to 50.5% over the same period. Second, the reduction in the proportion of fat and cholesterol consumption arose largely from an increase in the daily intake of carbohydrate by about 260 calories from 1965 to 2011. Third, there is a high correlation (close to 90%) between the change in dietary pattern and the rise of obesity over the last 40 y. From 1971 to 2011, average weight and body mass index (BMI) have increased dramatically, with the percentage of overweight Americans increasing from 42.3% in 1971 to 66.1% in 2011.

The sources of data for this study are 10 US National Health and Nutrition Examination Surveys (NHANES) conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) since the 1970s. We also analyzed their predecessor study, the 1965 US Department of Agriculture (USDA) Household Food Consumption Survey [6]. A 1997 study [7] using the 1976 to 1991 NHANES surveys showed that fat intake decreased and obesity increased during that 15-y period. However, contrary to our findings over a longer period, that study documented a concurrent drop in total caloric consumption. To our knowledge, except for the aforementioned article [7], this study presents the first comprehensive compilation of data from NHANES to examine the long-term trends in consumer dietary behaviors and concurrent obesity levels.

The second part of this study provides an overview of the US governmental dietary recommendations. We then describe the data source and research methods and present the results on consumer dietary patterns and correlation with significant increases in obesity.

History of macronutrient intake recommendations

In 1961, spurred by emerging medical and epidemiologic research, the AHA issued dietary recommendations to “reduce the intake of total fat, saturated fat, and cholesterol” [8]. In 1977, the US Senate Select Committee on Nutrition and Human Needs issued Dietary Goals for the United States, which recommended that fat consumption be reduced to 30% of energy intake, and that carbohydrate consumption be increased to account for 55% to 60% of energy intake [1].

Following this report, Dietary Guidelines for Americans, issued by the USDA and the US Department of Health, Education and Welfare (now the Department of Health and Human Services; DHHS) in 1980, recommended a reduction in the consumption of the share of total macronutrients attributable to fat and saturated fat, and a reduction in the absolute consumption of cholesterol. To compensate, the guidelines recommended increasing consumption of carbohydrate as a share of total calories because “carbohydrates contain less than half the number of calories per ounce than fats” [9]. During the 1980s, the federal government continued to issue reports and recommendations encouraging Americans to limit fat consumption. In 1982, the Committee on Diet, Nutrition, and Cancer of the National Research Council issued Interim Dietary Guidelines that recommended fat intake be lowered from 40% to 30% of total calories in the diet, officially endorsing the AHA’s recommendations from 1961 and the Senate committee’s recommendations from 1977 [10]. The USDA and DHHS recommendations have remained largely unchanged since 1980. In 1992, the Food Guide Pyramid was released, urging Americans to use fats, oils,

and sweets “sparingly,” and to consume between 6 and 11 servings of bread, cereal, rice, and pasta [11]. The 30% dietary fat recommendations were issued as part of the guidelines in 1990, 1995, and 2000. In the 2005 and 2010 guidelines, fat consumption was capped at 35% of calories. A new set of dietary guidelines is expected in 2015.

It is notable that maintaining or achieving a desirable body weight is not addressed at all in the Senate’s initial Dietary Goals report. Although the recommendation “to avoid overweight” was added to the second edition of the report and the subsequent guidelines, it was not until 2005 and 2010 that guidance regarding estimated caloric requirements was included in the guidelines [12]. Instead, recommendations focused on altering the share of total calories attributable to fat, saturated fat, and carbohydrate as a way of achieving caloric balance.

NHANES data and research methods

To examine the long-term dietary consumption of the US population, we compiled detailed individual-level consumption from NHANES since the 1970s. Under the auspice of the NCHS, a division within the CDC (and ultimately, the DHHS), the NHANES has been conducted periodically since 1971 to assess the health and nutritional status of the US population by means of standardized interviews and physical examinations. The data collected include individual-level caloric consumption and body weight statistics, as well as detailed demographic information. These individual survey responses can be located on USDA’s website. The caloric consumption data we relied on are called “nutrient composition” in the first two surveys, “total nutrient intake” for surveys between 1988 and 2002, and “total nutrient intakes—day 1” from 2003 onward. Starting in 2003, total nutrient intake data have been collected over two separate dates, but for consistency with earlier years, we only relied on data collected from the first date. All of the data analysis was conducted using STATA version 13.

To date, 10 NHANES surveys have been conducted. The first three surveys: 1971–1974, 1976–1980, and 1988–1994, occurred irregularly and over uneven survey periods. Starting in 1999, NHANES was regularly conducted over each consecutive 2-y period. They include 1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, 2009–2010, and 2011–2012. The latest survey results (2011–2012) were released in September 2014. Of the earlier surveys, NHANES III was conducted in two phases,

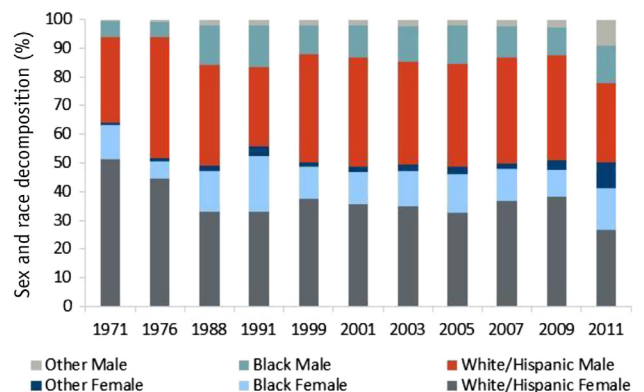


Fig. 1. Sex and race decomposition represented by NHANES surveys. Source: Authors’ analysis of the NHANES data. Horizontal axis indicates the start year of each survey.

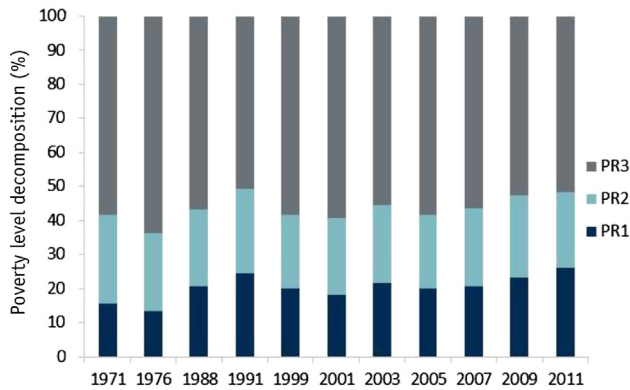


Fig. 2. Poverty level decomposition represented by NHANES surveys. Source: Authors' analysis of the NHANES data. Horizontal axis indicates the start year of each survey. PR1, below poverty line (poverty ratio <1); PR2, poverty ratio between 1 and 2; PR3, poverty ratio >2; PR, poverty ratio.

1988–1990 and 1991–1994. In the following analyses, we divided the NHANES III survey results into two subperiods in order to be more in line with the average survey periods and sample sizes in other NHANES surveys. We also referenced each survey by the starting year. For example, survey 1999 stands for the survey conducted between 1999 and 2000.

In addition to the NHANES data, we also included some data points from a 1965 USDA Household Food Consumption Survey [6]. Unlike the subsequent NHANES data releases, the 1965 individual survey data are unavailable, with only summary tables released. As a result, we did not conduct a detailed analysis of the underlying data, nor follow our complete resampling methodology discussed here to normalize the demographic composition of the surveys over time. However, to the extent possible, we incorporated the 1965 summary data in our long-term trend analyses.

Without statistical adjustments, the NHANES data have two biases for longitudinal analyses. First, the demographic composition of the US population, by race, age, and residence, changed over the 40-y time span. To the extent that different groups have different consumption and BMI characteristics, inconsistent shares of each group will tend to bias the aggregated data. Second and more importantly, NHANES was

designed to sample larger numbers of certain subgroups of particular public health interest, with the planned oversampling varying by year [13]. For example, in the late 1960s and early 1970s, there was concern that very-low-income populations and women of childbearing age were at greater risk for malnutrition than the general population. Therefore, these subgroups were oversampled in NHANES I between 1971 and 1974. In the three surveys between 1999 and 2004, the oversampled subgroups included blacks, Mexican-Americans, low-income white Americans (beginning in 2000), adolescents aged 12 to 19 y, and individuals aged ≥60 y.

To correct for this potential demographic bias, we divided observations from each NHANES survey into 18 different demographic groups organized by two sexes (male, female), three races (white/Hispanic, black, other) and three poverty levels (poverty ratio <1, poverty ratio between 1 and 2, poverty ratio >2). Figure 1 (six sex/race groups) and Figure 2 (three poverty-level groups) show the nonuniform decomposition of survey responses for survey participants aged 18 to 64 y.

In this study, we focused on the consumption patterns of Americans aged 18 to 64 y. Given the demographic changes in the country over the past 40 y and intentional over- and undersampling of the demographics in surveys, we calculated the diet and BMI statistics for each of the 18 cohort groups, and then resampled the survey data to provide a more consistent diet and BMI comparison of “an average American” over time. For each of the years, we applied the 1999–2011 average sample weights to each cohort group, as the sample weights were relatively stable during those years. This produced comparable demographic groups for all survey years to the overall sample between 1999 and 2011. Additionally, pregnant women were excluded from our reported statistics, both to adjust for the oversampling in the NHANES during the early 1970s and to avoid consumption bias not representative of nonpregnant women.

The reported statistics for 1965 consumption and BMI patterns in that follow are only resampled for sex. In other words, the 1965 summary statistics for men and women have been resampled to an average 1999–2011 sex weight. However, because race and poverty-level sample compositions were not reported with the requisite consumption and body

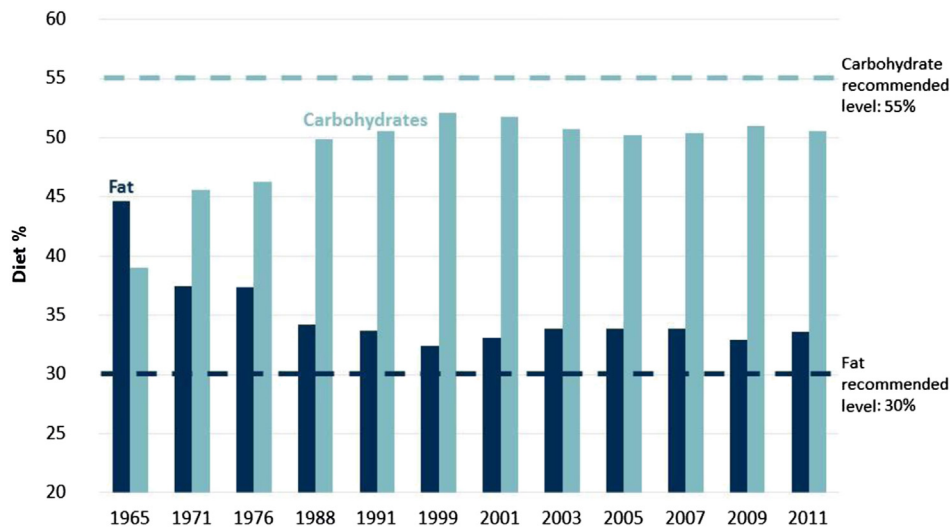


Fig. 3. Average adult fat and carbohydrate caloric consumption. Source: Authors' analysis of the NHANES data. Horizontal axis indicates the start year of each survey.

measurements, the 1965 data for an average American do not control for sampling changes with regard to race and poverty.

Results

Americans' caloric intake, 1965–2011

Trends in American caloric intake on average reflect the USDA/DHHS's recommendations regarding the consumption of fat and carbohydrate as a share of total calories. According to the 1965 USDA survey, fat consumption comprised 44.7% of adult Americans' diets, compared with 39% for carbohydrate. Even by 1971, those numbers had changed significantly, with fat down to 37.5% and carbohydrate up to 45.6%. By 1999, fat consumption reached a trough of 32.4%, whereas carbohydrate consumption hit its peak of 52.1%. The latest data from 2011 shows these trends slightly ebbing, but fat consumption is still down by 10.4% since 1971, and 24.9% since 1965, with fat comprising 33.6% of total caloric consumption for the average American adult. The pattern for carbohydrate consumption is the mirror opposite. Since 1971, carbohydrate consumption increased 10.9%, and 29.7% since 1965. In 2011, on average, 50.5% of total calories were derived from carbohydrate. The trend shown in Figure 3, which presents fat and carbohydrate consumption as a share of total consumption over time, is consistent with the USDA/DHHS's recommended shift in share of consumption from fat to carbohydrate, although ultimately never reaching the 55% goal for carbohydrate consumption, or the 30% ceiling for fat consumption. Protein consumption remained relatively constant throughout the period, ranging only from 15% to 17% of total caloric consumption.

The Senate's Dietary Goals report also included the objectives of lowering saturated fat consumption to "about 10 percent of total energy intake" and reducing total cholesterol consumption to "about 300 mg per day" [1]. Americans' consumption patterns followed these guidelines. In 1971, saturated fat comprised 13.5% of total calories. By 2011, Americans were eating 10.7% of their calories as saturated fat, a 20.5% reduction since 1971 (Fig. 4).

Likewise, as shown in Figure 5, Americans' consumption patterns followed the guidelines on cholesterol consumption. Per capita consumption was down <300 mg/d, from >400 mg/d in 1971.

These patterns and changes in consumption are consistent with the hypothesis that Americans on average adhered to the government dietary recommendations regarding fat, saturated fat, cholesterol, and carbohydrate. However, without specific

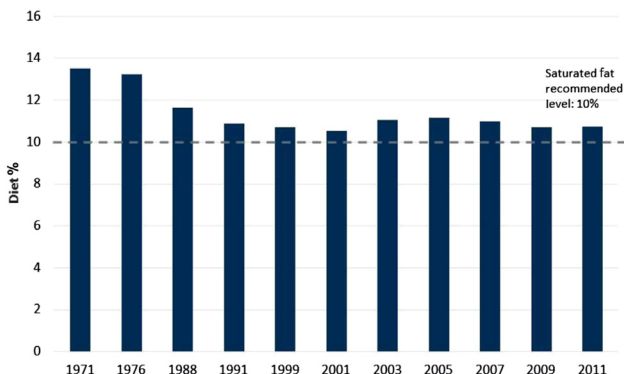


Fig. 4. Saturated fat consumed by adults as a portion of diet. Source: Authors' analysis of the NHANES data. Horizontal axis indicates the start year of each survey. Saturated fat consumption data not available for 1965.

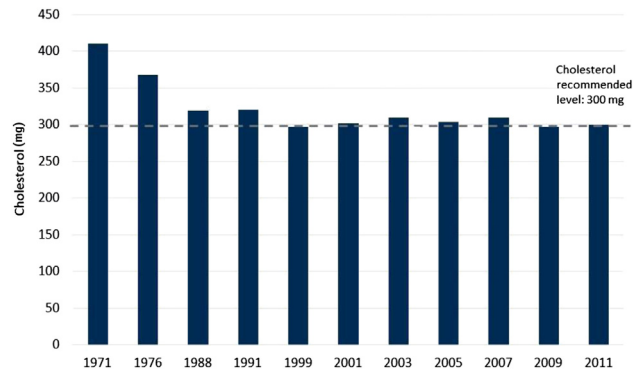


Fig. 5. Average mg/d cholesterol consumed by adults. Source: Authors' analysis of the NHANES data. Horizontal axis indicates the start year of each survey. Cholesterol consumption data not available for 1965.

recommendations from the AHA or the USDA/DHHS on total caloric intake on an absolute basis, the shift in the share of fat and carbohydrate is primarily due to an almost 65 g, or about a 260 kcal, daily increase in Americans' intake of carbohydrate from 1965 to 2011. For fat, Americans' consumption on an absolute basis fell between 1965 and 1971 by >25 g, but has since remained largely flat. As shown in Figure 6, the average adult American consumed about 109 g/d of fat and 213 g/d of carbohydrate in 1965. Daily fat consumption fell to 83 g in 1971, and remained at approximately the same level through 2011. In contrast, carbohydrate consumption, although basically flat from 1965 to 1971 in terms of total calories, has risen to 278 g/d since 1965, an increase of 30.6%.

Americans' BMI, 1965–2011

The main policy objective for recommending lower fat, saturated fat, and cholesterol consumption was to reduce heart disease. A number of recent studies showed that although the incidence of mortality has declined, the goal of reducing risk for heart disease and its effect on the health care system has not been achieved on an absolute or per-capita basis [14]. A review of guidance from advisory committees, including the one for the USDA/DHHS Dietary Guidelines, found conclusions about the relationship between saturated fat and heart disease reported by these committees do not reflect available science [15], a disconnect that may explain these outcomes. At the same time, our analyses of the NHANES data indicate a correlation between dietary shift and significant increases in rates of obesity, which is associated with increased risk for heart disease. For example,

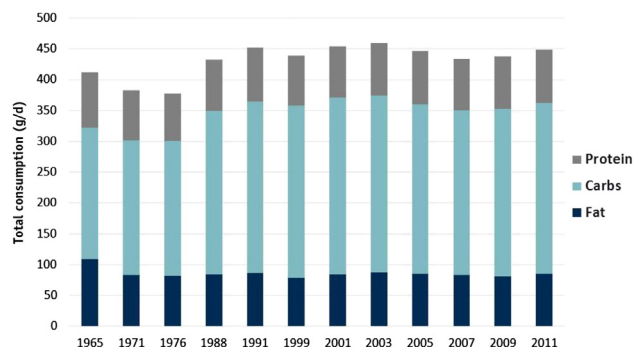


Fig. 6. Total daily consumption by adults. Source: Authors' analysis of the NHANES data. Horizontal axis indicates the start year of each survey.

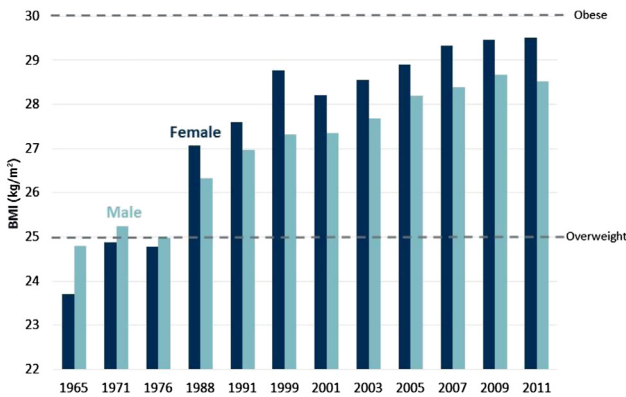


Fig. 7. Average adult male and female BMI. Source: Authors' analysis of the NHANES Data. Horizontal axis indicates the start year of each survey. Overweight: BMI >25 kg/m²; obese: BMI >30 kg/m². BMI, body mass index.

evidence from the Framingham Heart Study shows that obesity is a “significant independent predictor of cardiovascular disease” [16,17].

Our analysis of the NHANES shows that the distribution of BMI has shifted. BMI is a well-accepted proxy for weight compared with height, with BMI >25 kg/m² representing overweight, >30 kg/m² representing obese, and >40 kg/m² representing severely obese. Figure 7 shows the significant increase from 1965 in average adult BMI for both men and women. Average BMI increased from about 24 kg/m² in 1965 to about 29 kg/m² in 2011. There is a strong relationship between the increase in carbohydrate share of total intake and obesity. This is reflected by the high correlation at the individual level between caloric share from carbohydrate and adult BMI: 85.3% for men and 91.2% for women.

The large uptick in average BMI is reflected in the large increases in the American population who are overweight (BMI >25 kg/m²), obese (BMI >30 kg/m²) and severely obese (BMI >40 kg/m²). Figure 8 shows that the BMI distribution was much tighter around the median BMI 24.1 kg/m² in 1971, with only a slight rightward skew in the higher BMI end of the tail. By 2011, the median BMI had risen steeply to 27.4 kg/m², with the distribution skewing much more toward the severely obese.

As indicated in Figure 8, in 1971, 42.3% of adult Americans were overweight, 14.7% were obese, and 1.6% severely obese. Over the past 4 decades, the percent overweight increased by 56.3% to 66.1%, the percent obese more than doubled to 35.2%, and the percent severely obese increased >4 -fold to 7.2%.

To explore whether this shift in BMI distribution toward obesity, as well as its correlation with the change in dietary composition, can be explained by an increase in overall caloric intake, we conducted the same tests over two subsamples of survey participants who consumed similar calories over time. First, we examined whether the pattern held true in a subsample of men and women who consumed around the average caloric levels between 1971 and 2011, namely men who consumed between 2400 and 2500 kcal/d and women who consumed between 1700 and 1800 kcal/d in each survey. (This group comprised 1.5% and 1.6% of the total sample of men in 1971 and 2011, respectively, and 3.6% and 2.5% of the total sample of women in those same years, respectively.) Our results and general conclusions of this study for the whole sample held true for this subsample, demonstrating that the change in the BMI distribution was not caused by total caloric intake for this subgroup.

Second, we examined the BMI change and dietary pattern for men and women who consumed significantly higher total calories per day. For men, we looked at the group consuming between 3400 and 3600 kcal/d, whereas for women we looked at the group consuming 2400 to 2600 kcal/d. The patterns for this subsample are consistent with the full sample: Macronutrient shares start at different levels but trend consistently with the full sample, and BMI also rises in concert with the full sample. Total fat calories fell for both groups by 3 to 4 percentage points in 2011, from 40% in 1971. BMI for men was just under 25 kg/m² in 1971, but grew to just under 29 kg/m² in 2011. This represented a similar starting point in 1971, with a slight growth from 28 kg/m² for the full sample, to 29 kg/m² for the high-calorie group. For women, BMI started off at 23 kg/m² in 1971, significantly lower than the full sample's starting BMI of about 25 kg/m². However, both groups of women grew to BMIs just under 29 kg/m² in 2011.

Taken together, the similar trends in BMI for both the full sample and two subsamples with relatively constant caloric intakes indicated that the increase in total caloric consumption

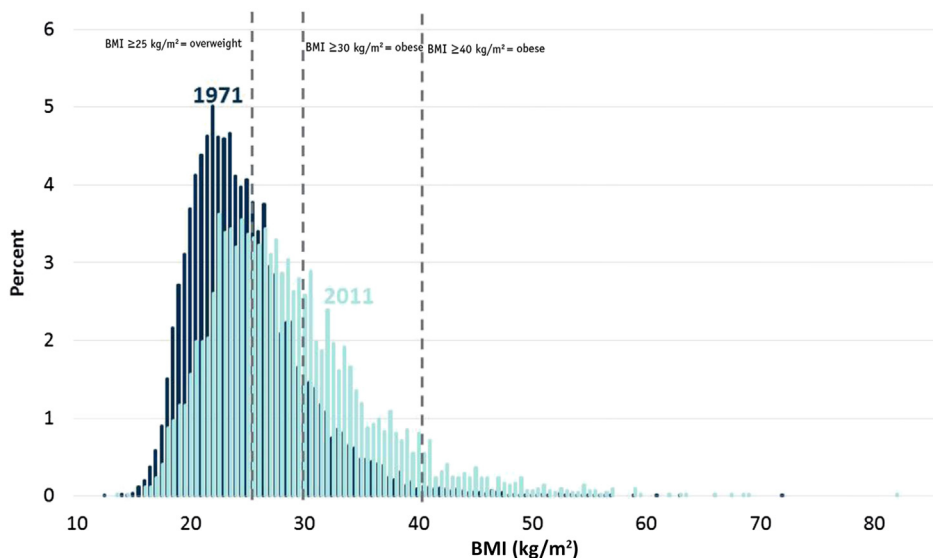


Fig. 8. Adult BMI distribution for 1971 and 2011. Source: Authors' analysis of the NHANES data. BMI, body mass index.

since 1971 was not likely to offer any significant explanation for the increase in BMI over the past 4 decades.

Conclusion

In the first comprehensive statistical analysis using all available NHANES surveys, this study demonstrated that general adherence to government dietary recommendations to decrease fat share of total dietary intake has been accompanied by a rapid increase in obesity rates. The results from this study compel a full analysis of the potential causal relationship between Americans seeming adherence to the government's nutrition recommendations and obesity.

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References

- [1] Select Committee on Nutrition and Human Needs of the United States Senate. Dietary goals for the United States [Internet]. 2nd ed. Washington, DC: U.S. Government Printing Office; 1977. Available at: <http://catalog.hathitrust.org/Record/000325810>. Accessed January 14, 2015.
- [2] Hite AH, Feinman RD, Guzman GE, Satin M, Schoenfeld PA, Wood RJ. In the face of contradictory evidence: report of the Dietary Guidelines for Americans Committee. *Nutr Burbank Los Angel City Calif* 2010;26:915–24.
- [3] Zinn AR. Unconventional wisdom about the obesity epidemic. *Am J Med Sci* 2010;340:481–91.
- [4] U.S. Department of Agriculture, U.S. Department of Health and Human Services. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. Washington DC: U.S. Department of Agriculture; 2010.
- [5] Marantz PR, Bird ED, Alderman MH. A call for higher standards of evidence for dietary guidelines. *Am J Prev Med* 2008;34:234–40.
- [6] U.S. Department of Agriculture. Food and nutrient intake of individuals in the United States, Report No. 11. Available at: http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/6566/hfcs6566_rep_11.pdf. Accessed January 14, 2015.
- [7] Heini AF, Weinsier RL. Divergent trends in obesity and fat intake patterns: the American paradox. *Am J Med* 1997;102:259–64.
- [8] Kritchevsky D. History of recommendations to the public about dietary fat. *J Nutr* 1998;128:449S–52S.
- [9] U.S. Department of Agriculture and U.S. Department of Health and Human Services. Nutrition and your health: dietary guidelines for Americans. 1st ed. Washington, DC: U.S. Government Printing Office; 1980. Available at: <http://www.cnpp.usda.gov/Publications/DietaryGuidelines/1980/DG1980pub.pdf>. Accessed January 14, 2015.
- [10] National Research Council. Diet nutrition and cancer. Washington DC: National Academy Press; 1982. Available at: <http://archive.org/details/dietnutritionand019332mbp>. Accessed January 14, 2015.
- [11] Davis C, Saltos E. Dietary recommendations and how they have changed over time. America's eating habits: changes and consequences. Washington DC: U.S. Department of Agriculture, Economic Research Service; 1999.
- [12] U.S. Department of Health and Human Services and U.S. Department of Agriculture. Dietary guidelines for Americans. 6th ed. Washington DC: U.S. Government Printing Office; 2005.
- [13] Centers for Disease Control and Prevention. Key concepts about NHANES survey design. Available at: <http://www.cdc.gov/nchs/tutorials/nhanes/SurveyDesign/SampleDesign/Info1.htm>. Accessed February 27, 2015.
- [14] Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics—2013 update a report from the American Heart Association. *Circulation* 2013;127:e6–245.
- [15] Hoenselaar R. Saturated fat and cardiovascular disease: the discrepancy between the scientific literature and dietary advice. *Nutr Burbank Los Angel Cty Calif* 2012;28:118–23.
- [16] Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation* 1983;67:968–77.
- [17] Eckel RH, Krauss RM. American Heart Association call to action: obesity as a major risk factor for coronary heart disease. *Circulation* 1998;97:2099–100.