Published in final edited form as:
Ethn Health. 2009 October ; 14(5): 439–457. doi:10.1080/13557850802699155.

Changes in Racial/Ethnic Disparities in the Prevalence of Type 2 Diabetes by Obesity Level among U.S. Adults

Qi Zhang[a,*], **Youfa Wang**[b], and **Elbert S. Huang**[c]

[a] School of Community and Environmental Health, Old Dominion University, Norfolk, VA, USA

[b] Center for Human Nutrition, Department of International Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA

[c] Section of General Internal Medicine, Pritzker School of Medicine, University of Chicago, Chicago, IL, USA

Abstract

Objective—Ethnic minority status and obesity are two independent risk factors for type 2 diabetes (T2D). There is no clear understanding of how they may have interacted and influenced disparities in T2D prevalence over time. This study examined the trends in racial/ethnic disparities in the prevalence of T2D by weight status among US adults.

Methods—We used nationally representative data from the National Health and Nutrition Examination Surveys (NHANES) I (1971–1975), II (1976–80), and III (1988–1994), and 1999–2004 among 49,574 adults aged 20–74 years. The prevalence of diagnosed and undiagnosed T2D were estimated by race/ethnicity groups (non-Hispanic white, non-Hispanic black, and Mexican American) and body mass index (BMI) groups (normal, 18.5–24.9; overweight, 25–29.9; obese, 30–34.9; severely obese, >=35). We used logistic regression controlling for age, gender, and education to estimate the odd ratio of T2D across race/ethnicity and BMI groups.

Results—Trends in racial/ethnic disparities in prevalence of diagnosed T2D varied by BMI. Normal weight group saw increasing racial disparities. In the overweight group, ethnic disparities worsened as diabetes prevalence increased 33.3% in whites, compared to 60.0% in blacks and 227.3% in Mexican Americans. Minimal racial/ethnic disparities were observed in obese and severely obese groups over time. In contrast to diagnosed diabetes, overall racial/ethnic disparities in undiagnosed T2D declined in all BMI groups.

Conclusions—Racial/ethnic disparities in diabetes prevalence have become most pronounced among normal and overweight groups. Eliminating racial/ethnic disparities in diabetes will require prevention efforts not only in obese minority individuals, but also in normal and overweight minority individuals.

Keywords

Diabetes; Obesity; Racial/Ethnic Disparities; Trends

Introduction

Reducing racial/ethnic disparities in diabetes prevalence and other obesity-related chronic conditions is a high priority of U.S. public health policy (US DHHS, 2000). Racial disparities

*Corresponding author. School of Community and Environmental Health, Old Dominion University, Norfolk, VA 23529, USA. Tel: 1-757-683-6870; Fax: 1-757-683-6333; Email: qzhang@odu.edu.

in diabetes have their origins in common risk factors for the disease (e.g., obesity) but are not entirely explained by racial/ethnic differences in the prevalence of these risk factors (Resnik *et al.*, 1998). For example, studies have found that minority group status remains an independent risk factor for diabetes, even after controlling for body mass index (BMI) and socioeconomic status (Davidson, 2001; Robbins *et al.*, 2001).

The past three decades have seen remarkable changes in both the racial/ethnic composition and the weight distribution in the U.S. The major change in racial/ethnic composition has been an influx of larger numbers of relatively young Hispanic immigrants (Larsen, 2004). This change has been accompanied by a steady increase in the prevalence of obesity across all racial/ethnic groups (Wang and Beydoun, 2007). Both secular changes may have altered the state of racial/ethnic disparities in diabetes prevalence.

Several previous studies have examined the secular changes on disparities in diabetes prevalence by race/ethnicity or BMI (Cowie et al., 2006; Gregg *et al.*, 2004; Harris *et al.*, 1999; Li *et al.*, 2006). However, few studies have specifically examined whether the racial/ethnic disparities in prevalence of diabetes within each body weight group have changed over time based on more recent data. In 1979–1982, Stern and Mitchell (1995) found that the disparity in type 2 diabetes (T2D) between Hispanic American and whites was more severe in obese groups than in lean groups in 1979–1982. However, it is unknown whether this finding still holds after steady immigration of Hispanic populations over the past two decades. Gregg et al. (2004) found that trends in diabetes prevalence including all racial/ethnic groups have varied dramatically by BMI groups. However, we do not know whether trends in racial disparity in diabetes prevalence varied by BMI. The current study aims to examine changes in racial/ethnic disparities in the prevalence of diabetes, stratified by body weight status over the last three decades. Our results will help design effective prevention programs to eliminate racial/ethnic disparity in diabetes.

Methods

Data

We used the four waves of National Health and Nutrition Examination Surveys (NHANES) data collected between 1971 and 2004. The NHANES is a series of cross-sectional surveys that provide nationally representative information on the nutrition and health status of the U.S. civilian population. The first, second, and third NHANES surveys (NHANES I, II, and III) were collected in 1971–1975, 1976–1980, and 1988–1994, respectively. Since 1999, NHANES has been a continuous survey. The data were recently made available for the first six years of that period (1999–2004). All rounds of NHANES surveys have used a stratified, multistage probability cluster sampling design. In each survey, standardized protocols have been used for all interviews and examinations. Detailed descriptions of the surveys have been published elsewhere (NCHS, 1973; McDowell *et al.*, 1981; CDC, 1996; CDC, 2008).

To make a comparable analysis across the four waves, we limited the study population to non-pregnant individuals aged 20 to 74 years old, who had weight and height information through direct physical examination and a diabetes history assessed during the interview. There were 12,990, 11,655, 14,661, and 10,268 respondents included respectively in NHANES I, II, III, and 1999–2004.

Measurements

Race/ethnicity—In NHANES I and II, race/ethnicity was classified as white, black, and ‘other’ based on interviewer observation. In NHANES III and in 1999–2004, subjects were classified as non-Hispanic white, non-Hispanic black, Mexican American, and other ethnic

groups, based on self-reported race and ethnicity. To account for these differences, we recoded race/ethnicity in NHANES I & II into non-Hispanic white, non-Hispanic black, Mexican American, and other ethnic groups by using the information provided from "national origin or ancestry". An alternative data source would have been the Hispanic Health and Nutrition Examination Survey (HHANES) (1982–84). However HHANES was not a national representative sample and, on its own, cannot be used to study racial/ethnic disparities in diabetes (Maurer, 1985).

Body weight status—BMI (weight [kg]/height [m^2]) was calculated for each individual based on measured weight and height. We classified the individuals into five BMI groups (underweight: <18.5; normal weight 18.5–24.9; overweight: 25–29.9; obesity: 30–34.9; severe obesity: 35+). These weight groups were suggested by National Heart Lung and Blood Institute (NHLBI, 1998).

Diagnosis of T2D—We studied the prevalence of diagnosed and undiagnosed T2D, based on results of fasting glucose.

Diagnosed diabetes was defined as a positive answer to the question "Have you ever been told that you have diabetes by a doctor?" In the latest two waves of NHANES, "other than during pregnancy" was specified in this question regarding the presence of diabetes. NHANES I & II did not have such designation for pregnancy so we were unable to ensure that gestational diabetes was not included among our cases of diabetes in these two waves. However, since we excluded pregnant adults from the baseline study population and since the prevalence of gestational diabetes is only 2%–5% among pregnancies (Coustan, 1995), we presumed that the prevalence of gestational diabetes in the first two waves was negligible. We excluded individuals with presumed type 1 diabetes (T1D). T1D accounts for less than 10% of all diabetes cases and studies suggest white Americans have an excessive risk of T1D, compared with minority group (LaPorte *et al.*, 1995). T1D was identified by the presence of diagnosed diabetes and use of insulin prior to age 40. We could not make this exclusion in NHANES I since information on insulin use was not available.

Undiagnosed diabetes was identified among the individuals who were randomly assigned to a morning fasting session but did not report having diabetes. Fasting glucose levels were collected in NHANES II, III, and 1999–2004. Standardized procedures were employed to collect and examine the blood sample (NCHS, 1973; McDowell *et al.*, 1981; CDC, 1996; CDC, 2008). Glucose levels were not collected in NHANES I, so we did not estimate undiagnosed diabetes for this survey. We did not use the Oral Glucose Tolerance Test (OGTT, with 2-hour glucose levels) to determine undiagnosed diabetes because of its inconsistent use over different waves of the surveys (Olefsky and Reaven, 1974; Kosaka *et al.*, 1966; Mooy *et al.*, 1996; Ko, 1998) For the fasting glucose levels, we applied the American Diabetes Association (ADA)'s criteria for this test (fasting time >=9 hours and fasting blood glucose level >= 126 mg/dl) (ADA, 2004). The denominators for undiagnosed diabetes groups were 3,761, 6,168, and 4,328 respectively for NHANES II, III, and 1999–2004.

The prevalence of total T2D was calculated as the sum of the prevalence of diagnosed and undiagnosed T2D. This definition of total T2D assumes that participants in the morning examination sessions were representative of the general NHANES population, since morning examinations, were performed on a random basis. Our approach to establishing the prevalence of total T2D mirrors that of previous studies (Gregg *et al.*, 2005; Gregg *et al.*, 2004; Kanjilal *et al.*, 2006). It is worth noting that the diagnostic criteria for diabetes have changed over time. The WHO's 1980 diagnostic criteria classified diabetic patients as having fasting glucose greater than or equal to 140 mg/dl or 2-h plasma glucose greater than or equal to 200 mg/dl. In a sensitivity analysis, we compared the use of the ADA definition and WHO definition with

NHANES II and III. The WHO definition gave a higher prevalence of undiagnosed diabetes, which is consistent with prior research (Wahl et al., 1998; Gabir et al., 2000; Resnick et al., 2000). However, the prevalences of undiagnosed diabetes were similar across racial/ethnic groups for different waves of NHANES, irrespective of the specific diagnostic criteria that were used. These results suggest that, while diagnostic criteria may have changed over time they are unlikely to have been differentially adopted across ethnic groups..

Socioeconomic status (SES)—We used education as a proxy of SES. We coded the education level as: low education (less than high school diploma, meaning 11^{th} grade or less), medium education (high school diploma, meaning 12^{th} grades), and high education (college or higher). We selected education level as the measure of SES, because: a) many researchers have suggested that education is the most stable and robust indicator of SES (Liberatos, et al., 1988; Williams et al., 1995); b) low educational attainment is a more significant predictor of incident type 2 diabetes than income and occupation (Maty et al. 2005); c) education is less likely to be affected by a subject's body weight status; d) education is more comparable across time than income or occupation; and e) education had fewer missing data in NHANES than income.

Statistical analysis

Our analyses took into account the complex survey design and unequal probabilities of sample selection in NHANES by using the 'svy' commands in Stata (Version 9, Stata Press, College Station, TX) (Stata, 2006). We first examined the trends in prevalence of total diabetes by race/ethnicity and BMI groups. Sample sizes for each racial/ethnic and BMI subgroups are provided in Appendix 1. The denominator for diagnosed diabetes was the number of respondents who answered the survey and completed the examination at the mobile examination center. This denominator included respondents who made up the denominator for undiagnosed diabetes. The denominator for undiagnosed diabetes was restricted to the number of respondents who participated in the blood sample drawing in the morning session. Due to the different denominators, we separated the analyses of diagnosed diabetes from analyses of undiagnosed diabetes.

Prevalence of diagnosed and undiagnosed diabetes was adjusted by age and gender using the same approach adopted by Gregg *et al.* (2005), i.e., the adjusted prevalence was equal to the predicted values from multiple logistic regressions controlling age and gender. Two measures were adopted to measure the racial/ethnic disparity: a) the ratio of the prevalence of diabetes between two racial/ethnic groups; and b) the Odds Ratio (OR) of minority status for diabetes in logistic regression analyses, controlling for age, gender, and education attainment. Mantel-Haenszel tests were applied to examine the statistical significance of interactive effects of race/ethnicity and body weight groups on diabetes within waves of NHANES.

Results

Socio-demographic characteristics and anthropometric measures

The proportions of white Americans dropped from 86.8% in NHANES I (1971–75) to 71.9% in 1999–2004, while the proportions of minority subjects increased (Table 1). The proportion of Mexican American adults rose from 2.3% to 7.5%. The proportions of severely obese subjects increased 340.9% in men and 280.7% in women during the same period. Minority women had higher increase in BMI than white women. But the racial/ethnic disparity in BMI was very limited among men, which was consistent with previous research (Flegal *et al.*, 2002).

Trends in prevalence of T2D by race/ethnicity and by BMI groups

The prevalence of total diabetes (both diagnosed and undiagnosed) increased in all racial/ethnic groups (Figure 1). Mexican Americans had the largest percent increase of 288.2%, followed by blacks (206.7%), and whites (169.0%).

Diagnosed T2D—Trends in the prevalence of diagnosed diabetes varied across race/ethnicity and BMI groups (Table 2). The largest percent increase in diagnosed diabetes was observed among Mexican Americans, with a percent increase of 223.5%, followed by blacks (144.4%), and whites (89.7%). Comparing BMI groups, the largest percent increase in prevalence was observed in the severely obese group (147.1%). The normal weight, overweight, and obese groups had a percent increase of 44.0%, 74.1%, and 76.6% respectively.

Undiagnosed T2D—Trends in the prevalence of undiagnosed diabetes varied across race/ethnicity and BMI groups (Table 3). Whites had a 35.3% increase in prevalence of overall undiagnosed diabetes, but minority groups experienced reductions: 37.8% in blacks and 15.4% in Mexican Americans. In obese and severely obese groups, 31.0 and 54.7% reduction were observed, while 11.1% and 42.9% increases were observed in normal and overweight groups.

In our examination of the interactions of race, BMI group, and diabetes prevalence, we found that the -values of Mantel-Haenszel Chi-square statistics of diagnosed and undiagnosed T2D were less than 0.001 for different race/ethnicity and BMI groups. The results indicate that racial disparities in T2D prevalence across BMI groups were statistically significant in each of the four waves of NHANES.

Racial/ethnic disparities within BMI groups

Racial/ethnic disparities in the prevalence of total diabetes varied by BMI groups (Figure 2). In normal and overweight groups, minority groups had a greater increase in prevalence of diabetes than whites. For example, in normal weight group, the ratios of diabetes between blacks and whites increased from 1.4 in NHANES I to 1.9 in NHANES 1999–2004 (Figure 2). However, in obese and severely obese groups the racial/ethnic disparity became less pronounced. For example, in NHANES 1999–2004, the ratio of diabetes between severely obese Mexican Americans and whites was only 1.1.

Diagnosed T2D—Higher BMI groups had less racial/ethnic disparity in diagnosed diabetes, especially in the latest two surveys (Table 2). For example, in NHANES III, the ratios of diagnosed diabetes prevalence between blacks and whites were 2.4, 2.1, 1.6 and 0.9 for normal, overweight, obese, and severely obese groups respectively. In NHANES 1999–2004, the ratios between Mexican Americans and whites were 3.3, 3.0, 1.4, and 1.3 for four BMI groups respectively. Normal weight groups had the largest increase in the disparity between blacks and whites. For example, the ratio between blacks and whites increased by 71.4% in normal weight group compared with 22.7%, 33.3%, and 50.0% in overweight, obese, and severely obese groups, respectively.

The overall racial/ethnic disparities in diagnosed diabetes increased even after adjustment for age, gender, and education (Table 4). The ORs of Mexican Americans increased from 1.1 to 2.1 from NHANES I to 1999–2004, while the ORs of blacks increased from 1.4 to 2.0. But the trends varied by BMI groups. For example, the ORs of Mexican Americans increased from 1.5 to 4.0 and 1.5 to 3.4 in normal weight and overweight groups, respectively. However, we did not find increases in ORs for obese and severely obese groups.

Undiagnosed T2D—Table 3 showed the clear reduction of racial/ethnic disparity in undiagnosed diabetes in all BMI groups except in obese blacks. For example, in normal weight

group, the ratio between blacks and whites was reduced from 11.0 in NHANES II to 0.6 in NHANES 1999–2004. In obese groups, the same ratio was reduced from 1.1 to 0.9. The ratios of undiagnosed T2D prevalence were close to 1.0 in all BMI groups in NHANES 1999–2004, indicating virtually no racial disparities in undiagnosed diabetes.

After adjustment for age, gender, and education (Table 4), the ORs decreased for both minority groups. For example, in NHANES II, the ORs were 2.3 for blacks and 3.0 for Mexican Americans, while the ORs in NHANES 1999–2004 were 1.0 and 0.9, respectively. Before NHANES 1999–2004, the ORs in all BMI groups were greater than 1.0, but in NHANES 1999–2004, except for obese groups, the ORs were less than 1.0.

Discussion

Based on nationally representative data collected over the last three decades, we found that trends in racial/ethnic disparities in diabetes prevalence varied across BMI groups among U.S. adults. Overall the disparities were small among obese individuals (BMI>=30), but were more pronounced among normal and overweight groups. Trends in racial/ethnic disparities also varied between diagnosed and undiagnosed diabetes, which increased for diagnosed diabetes but decreased for undiagnosed diabetes over time. Overall, our study suggests that future public health efforts designed to reduce racial disparities in diabetes should intervene among minorities of all weight categories.

Our findings do not question the importance of addressing obesity in preventing diabetes. The results indicate that the rising prevalence of obesity has been a major contributor to the increase in T2D (Gregg *et al.*, 2004; Colditz *et al.*, 1995; Ford *et al.*, 1997). The disproportionate impact of diabetes on minorities in the U.S. is partially attributable to the higher prevalence of obesity, especially abdominal obesity in minority groups (Mokdad *et al.*, 2000; Hertz *et al.*, 2006; Resnick *et al.*, 1998; Davidson, 2001; Okosun et al., 2004; Li et al., 2007). Many diabetes prevention programs already recognize this relationship and set goals to reduce diabetes risk by promoting weight loss among obese populations (Burnet *et al.*, 2006; Liburd and Vinicor, 2003). However, our study suggests that additional efforts should be placed on preventing diabetes among minorities in non-overweight groups.

Our study also suggests that the increasing disparity in diabetes between Mexican Americans and whites is larger than that between blacks and whites. This finding is consistent with a previous study that found Latinos experienced the greatest increase in T2D among all race/ethnicity groups (McBean *et al.*, 2004). Previous studies have suggested that acculturation and chronic stress can contribute to visceral adiposity accumulation and therefore insulin resistance (Bjorntorp, 2001; Tull *et al.*, 2003). Since Latinos are a young, rapidly growing group in the U.S.(Guzman and Bureau, 2001), we suspect that the disparity in diabetes between Mexican Americans and whites will worsen over time if no effective interventions are implemented. There is more disparity in diabetes prevalence between normal and overweight Mexican Americans and whites now than what was described one decade ago (Stern and Mitchell, 1995). Because of the unique health beliefs and culture of Latinos (Alcozer, 2000; Caban and Walker, 2006), culturally tailored programs are likely needed for effective diabetes prevention and treatment.

It is encouraging to find diminishing racial/ethnic disparities in undiagnosed diabetes. In obese and severely obese groups, the reduced disparity was largely due to the significant reduction in the prevalence of undiagnosed diabetes across all race/ethnicity groups. This result most likely reflects the increasing public awareness of the relationship between obesity and diabetes. Improved access and quality of health care may have also contributed to better screening of diabetes in minority populations (Engelgau et al., 2000; Porterfield et al., 2004; Trivedi et al.,

2005). However, among normal weight and overweight individuals, the reduction in disparities actually came about because whites had a slight increase in the prevalence of undiagnosed diabetes. More balanced efforts in screening and detection of diabetes should be adopted to reduce the undiagnosed diabetes across race/ethnicity.

Our study has several limitations. First, the clinical diagnosis of diabetes has changed considerably over time (ADA, 1997). Therefore, self-reported diabetes may be underestimated in earlier waves of NHANES. However, based on our sensitivity analyses, changing definitions across time had limited impact on racial/ethnic disparities in the prevalence of diabetes. Second, we could not account for all demographic or clinical changes in the population in our trend analysis. Future research should examine dietary intake, physical activity, and other intermediate factors that can explain the trends in the racial disparities in diabetes across obesity levels. Lack of insulin information in NHANES I and pregnancy status in NHANES I & II limited our analyses of undiagnosed diabetes and gestational diabetes in the first two waves of NHANES. Due to the cross-sectional design of NHANES, we were unable to test the statistical significance of secular changes in racial/ethnic disparities in diabetes prevalence across body weight groups. Although obesity is a risk factor of diabetes across ethnic groups, there are other factors contributing to the ethnic disparity in diabetes. For example, minorities have been found to be less insulin-sensitive even after controlling body weight status (Haffner et al, 1996; Torrens et al., 2004). Interactions between diet, life styles, and metabolism could also be different across ethnic groups that ultimately affect the risk of both obesity and diabetes (Shai et al., 2006).

In summary, this study reminds us that BMI is only one of many factors affecting the risk for T2D. More studies should study risk factors of diabetes other than BMI in the whole spectrum of minority populations. Effective interventions, in particular lifestyle changes should certainly be promoted among high-risk groups such as the obese population, but apparently low-risk groups may benefit from such lifestyle changes as well (Tuomilehto *et al.*, 2001; Diabetes Prevention Program Research, 2002). More resources and effective interventions are needed to target normal and overweight minorities to prevent further widening of racial/ethnic disparities in diabetes and to achieve the national goals of eliminating health disparity outlined in Healthy People 2010.

Acknowledgments

Funding

The present study is supported in part by the following research grants: National Institute of Child Health and Human Development (R03 HD056073 to Q. Z. and Y.W.); USDA/Southern Rural Development Center RIDGE Grant (Q. Z.); National Institute on Aging (K23 AG021963 to E.S.H.); National Institute of Diabetes and Digestive and Kidney Diseases (P60 DK20595 to E.S.H.); US Department of Agriculture (2044-05322 to Y. W.); National Institute of Diabetes and Digestive and Kidney Diseases (R01 DK63383 to Y. W.).

References

Alcozer F. Secondary analysis of perceptions and meanings of type 2 diabetes among Mexican American women. The Diabetes Educator 2000;26:785–795. [PubMed: 11221581]

American Diabetes Association (ADA). Report of the expert committee on the diagnosis and classifcation of diabetes mellitus. Diabetes Care 1997;20:1183–1197. [PubMed: 9203460]

American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2004;27 (Suppl 1):S5–s10. [PubMed: 14693921]

Bjorntorp P. Do stress reactions cause abdominal obesity and comorbidities? Obesity Reviews 2001;2:73–86. [PubMed: 12119665]

Burnet DL, Elliott LD, Quinn MT, Plaut AJ, Schwartz MA, Chin MH. Preventing Diabetes in the Clinical Setting. Journal of General Internal Medicine 2006;21:84–93. [PubMed: 16423130]

Caban A, Walker EA. A systematic review of research on culturally relevant issues for Hispanics with diabetes. The Diabetes Educator 2006;32:584–595. [PubMed: 16873596]

Centers for Disease Control and Prevention (CDC). The third national health and nutrition examination survey (NHANES III 1988–1994) reference manuals and reports (CD-ROM). Bethesda, MD: 1996.

Centers for Disease Control and Prevention (CDC). 2008 [accessed on July 11,2008]. NHANES 1999–2004 data files: data, docs, codebooks, sas code (http://www.cdc.gov/nchs/about/major/nhanes/datalink.htm

Colditz GA, Willett WC, Rotnitzky A, Manson JE. Weight gain as a risk factor for clinical diabetes mellitus in women. Annals of Internal Medicine 1995;122:481–486. [PubMed: 7872581]

Coustan, DR. Gestational Diabetes, Diabetes In America. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; Bethesda, Md: 1995. p. 703

Cowie CC, Rust KF, Byrd-Holt DD, Eberhardt MS, Flegal KM, Engelgau MM, Saydah SH, Williams DE, Geiss LS, Gregg EW. Prevalence of diabetes and impaired fasting glucose in adults in the U.S. population: National Health and Nutrition Examination Survey 1999–2002. Diabetes Care 2006;29:1263–1268. [PubMed: 16732006]

Davidson MB. The disproportionate burden of diabetes in African-American and Hispanic populations. Ethnicity & Disease 2001;11:148–151. [PubMed: 11289236]

Diabetes Prevention Program Research G. Reduction in the incidence of type 2 diabetes with Lifestyle Intervention or Metformin. New England Journal of Medicine 2002;346:393–403. [PubMed: 11832527]

Engelgau MM, Narayan KMV, Herman WH. Screening for type 2 diabetes. Diabetes Care 2000;23:1563–1580. [PubMed: 11023153]

Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and Trends in Obesity among US Adults, 1999–2000. JAMA 2002;288:1723–1727. [PubMed: 12365955]

Ford ES, Williamson DF, Liu S. Weight change and diabetes incidence: findings from a national cohort of US adults. American Journal of Epidemiology 1997;146:214–222. [PubMed: 9247005]

Gabir MM, Hanson RL, Dabelea D, Imperatore G, Roumain J, Bennett PH, Knowler WC. The 1997 American Diabetes Associaiton and 1999 World Health Organization criteria for hyperglycemia in the diagnosis and prediction of diabetes. Diabetes Care 2000;23:1108–1112. [PubMed: 10937506]

Gregg EW, Cadwell BL, Cheng YJ, Cowie CC, Williams DE, Geiss L, Engelgau MM, Vinicor F. Trends in the prevalence and ratio of diagnosed to undiagnosed diabetes according to obesity levels in the U.S. Diabetes Care 2004;27:2806–2812. [PubMed: 15562189]

Gregg EW, Cheng YJ, Cadwell BL, Imperatore G, Williams DE, Flegal KM, Narayan KMV, Williamson DF. Secular trends in cardiovascular disease risk factors according to body mass index in US adults. JAMA 2005;293:1868–1874. [PubMed: 15840861]

Guzman, B.; Bureau, USC. The Hispanic population, 2000. U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau; Washington, D.C.: 2001.

Haffner SM, D'Agostino R, Saad MF, Rewers M, Mykkanen L, Selby J, Howard G, Savage PJ, Hammer RF, Waganknecht LE. Increased insulin resistance and insulin secretion in nondiabetic African-Americans and Hispanics compared with non-Hispanic whites: the Insulin Resistance Atherosclerosis Study. Diabetes 1996;45:742–748. [PubMed: 8635647]

Harris MI, Eastman RC, Cowie CC, Flegal KM, Eberhardt MS. Racial and ethnic differences in glycemic control of adults with type 2 diabetes. Diabetes Care 1999;22:403–408. [PubMed: 10097918]

Hertz RP, Unger AN, Ferrario CM. Diabetes, hypertension, and dyslipidemia in Mexican Americans and non-Hispanic Whites. American Journal of Preventive Medicine 2006;30:103–110. [PubMed: 16459207]

Kanjilal S, Gregg EW, Cheng YJ, Zhang P, Nelson DE, Mensah G, Beckles GLA. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US adults, 1971–2002. Archives of Internal Medicine 2006;166:2348–2355. [PubMed: 17130388]

Ko G, Chan JC, Woo J, Lau E, Yeung VT, Chow CC, Cockram CS. The reproducibility and usefulness of the oral glucose tolerance test in screening for diabetes and other cardiovascular risk factors. Annals of Clinical Biochemistry 1998;35:62–67. [PubMed: 9463740]

Kosaka K, Mizuno Y, Kuzuya T. Reproducibility of the oral glucose tolerance test and the rice-meal test in mild diabetics. Diabetes 1966;15:901–904. [PubMed: 5957481]

LaPorte, R.; Matsushima, M.; Chang, YF. Prevalence and incidence of insulin-dependent diabetes. In: Harris, MI., editor. Diabetes in America. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; Bethesda, Md: 1995. p. 42-44.NIH publication, no. 95-1468

Larsen, L. Current Population Reports. Washington, DC: 2004. The foreign-born population in the United States: 2003; p. 20-551.

Liberatos P, Link BG, Kelsey JL. The measurement of social class in epidemiology. Epidemiology Review 1988;10:87–121.

Li C, Ford ES, McGuire LC, Mokdad AH. Increasing trends in waist circumference and abdominal obesity among U.S. adults. Obesity 2007;15:216–223. [PubMed: 17228050]

Li C, Ford ES, McGuire LC, Mokdad AH, Little RR, Reaven GM. Trends in hyperinsulinemia among nondiabetic adults in the U.S. Diabetes Care 2006;29:2396–2402. [PubMed: 17065674]

Liburd LC, Vinicor F. Rethinking diabetes prevention and control in racial and ethnic communities. Journal of Public Health Management Practice 2003 November;:S74–S79.

Maty SC, Everson-Rose SA, Haan MN, Raghunathan TE, Kaplan GA. Education, income, occupation, and the 34-year incidence (1965–99) of type 2 diabetes in the Alameda county study. International Journal of Epidemiology 2005;34:1274–1281. [PubMed: 16120636]

Maurer K. Plan and operation of the hispanic health and nutrition examination survey, 1982–84. Vital Health Statistics 1985;1:1–37.

McBean AM, Li S, Gilbertson DT, Collins AJ. Differences in diabetes prevalence, incidence, and mortality among the elderly of four racial/ethnic groups: whites, blacks, Hispanics, and Asians. Diabetes Care 2004;27:2317–2324. [PubMed: 15451894]

McDowell A, Engel A, Massey JT, Maurer K. Plan and operation of the Second National Health and Nutrition Examination Survey, 1976–1980. Vital And Health Statistics. Ser. 1, Programs and Collection Procedures 1981:1–144.

Mokdad AH, Bowman BA, Ford ES, Vinicor F, Marks JS, Koplan JP. The continuing epidemics of obesity and diabetes in the United States. JAMA 2001;286:1195–1200. [PubMed: 11559264]

Mokdad AH, Ford ES, Bowman BA, Nelson DE, Engelgau MM, Vinicor F, Marks JS. Diabetes trends in the U.S.: 1990–1998. Diabetes Care 2000;23:1278–1283. [PubMed: 10977060]

Mooy JM, Grootenhuis PA, Vries H, Kostense PJ, Popp-Snijders C, Bouter LM, Heine RJ. Intra-individual variation of glucose, specific insulin and proinsulin concentrations measured by two oral glucose tolerance tests in a general Caucasian population: the Hoorn Study. Diabetologia 1996;39:298–305. [PubMed: 8721775]

NHLBI. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults--the evidence report. National Institutes of Health. Obesity Research 1998;6(Suppl 2):51S–209s. [PubMed: 9813653]

Okosun IS, Chandra KMD, Boev A, Boltri JM, Choi ST, Parish DC, Dever GEA. Abdominal adiposity in U.S. adults: prevalence and trends, 1960–2000. Preventive Medicine 2004;39:197–206. [PubMed: 15208003]

Olefsky JM, Reaven GM. Insulin and glucose responses to identical oral glucose tolerance tests performed forty-eight hours apart. Diabetes 1974;23:449–453. [PubMed: 4830180]

Porterfield DS, Din R, Burroughs A, Burrus B, Petteway R, Treiber L, Lamb B, Engelgau M. Journal the National Medical Association 2004;96:1325–1331.

Resnick HE, Valsania P, Halter JB, Lin X. Differential effects of BMI on diabetes risk among black and white Americans. Diabetes Care 1998;21:1828–1835. [PubMed: 9802729]

Resnick HE, Harris MI, Brock DB, Harris TR. American Diabetes Association Diabetes diagnostic criteria, advancing age, and cardiovascular disease risk profiles: results from the third National Health and Nutrition Examination Survey. Diabetes Care 2000;23:176–180. [PubMed: 10868827]

Robbins JM, Vaccarino V, Zhang H, Kasl SV. Socioeconomic status and type 2 diabetes in African American and non-Hispanic white women and men: evidence from the Third National Health and Nutrition Examination Survey. American Journal of Public Health 2001;91:76–83. [PubMed: 11189829]

Shai I, Jiang R, Manson JE, Stampfer MJ, Willett WC, Colditz GA, Hu FB. Ethnicity, obesity, and risk of type 2 diabetes in women: a 20-year follow-up study. Diabetes Care 2006;29:1585–1590. [PubMed: 16801583]

Stata 2006. Base Reference Manual. Stata Press; College Station, TX: National Center for Health Statistics (NCHS). Vital Health Statistics. Vol. 1. 1973. Plan and operation of the health and nutrition examination survey, United States 1971–1973.

Stern, MP.; Mitchell, BD. Diabetes in Hispanic American. In: Harris, MI., editor. Diabetes in America. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; Bethesda, Md: 1995. p. 631-660.

Torrens JI, Skumick J, Davidow AL, Korenman SG, Santoro N, Soto-Greene M, Lasser N, Weiss G. Ethnic differences in insulin sensitivity and β-cell function in premenopausal or early perimenopausal woemn without diabetes: the Study of Women's Health Aacross the Nation (SWAN). Diabetes Care 2004;27:354–361. [PubMed: 14747213]

Trivedi AN, Zaslavsky AM, Schneider EC, Ayanian JZ. Trends in the quality of care and racial disparities in Medicare managed care. New England Journal of Medicine 2005;353:692–700. [PubMed: 16107622]

Tull ES, Thurland A, LaPorte RE, Chambers EC. Acculturation and psychosocial stress show differential relationships to insulin resistance (HOMA) and body fat distribution in two groups of blacks living in the US Virgin Islands. JAMA 2003;95:560–569.

Tuomilehto J, Lindstrom J, Eriksson JG, Valle TT, Hamalainen H, Ilanne-Parikka P, Keinanen-Kiukaanniemi S, Laakso M, Louheranta A, Rastas M, Salminen V, Uusitupa M, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. New England Journal of Medicine 2001;344:1343–1350. [PubMed: 11333990]

Wahl PW, Savage PJ, Psaty BM, Orchard TJJ, Robbins JA, Tracy RP. Diabetes in older adults: comparison of 1997 American Diabetes Association classification of diabetes mellitus with 1985 WHO classification. Lancet 1998;352:1012–1015. [PubMed: 9759743]

Wang Y, Beydoun M. The obesity epidemic in the United States--gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. Epidemiologic Reviews 2007;29:6–28. [PubMed: 17510091]

Williams DR, Collins C. U.S. socioeconomic and racial differences in health: Patterns and Explanations. Annual Review of Sociology 1995;21:349–386.

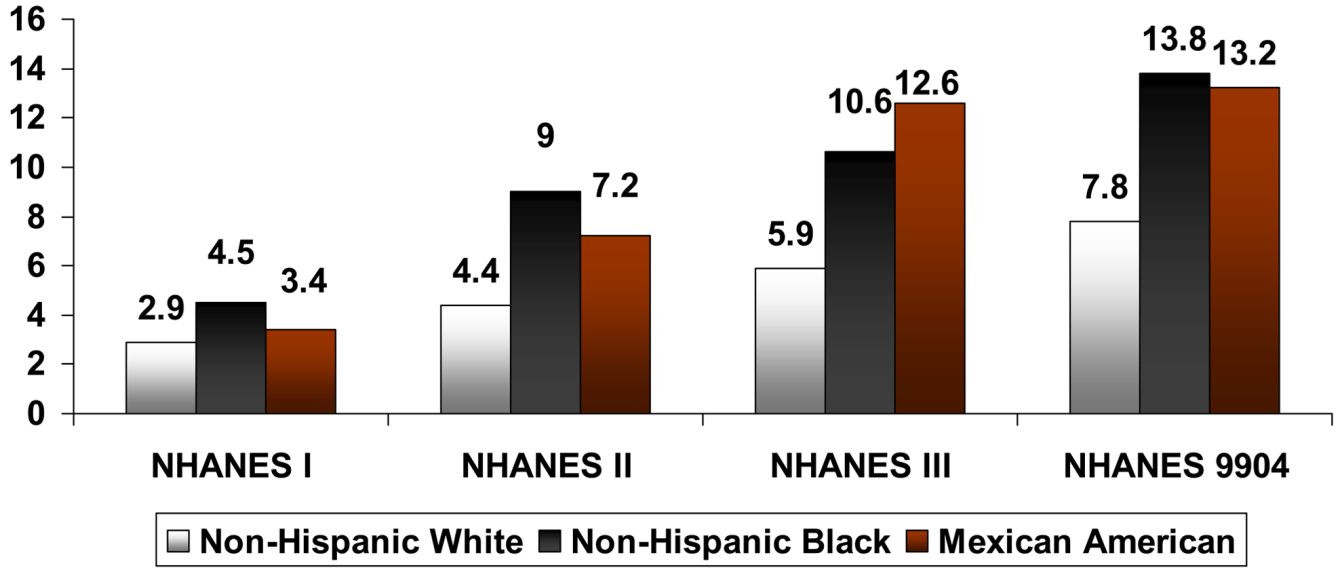

Figure 1.
Age- and gender- adjusted prevalence (%) of total diabetes among U.S. Adults by racial/ethnic groups in NHANES 1971 to 2004

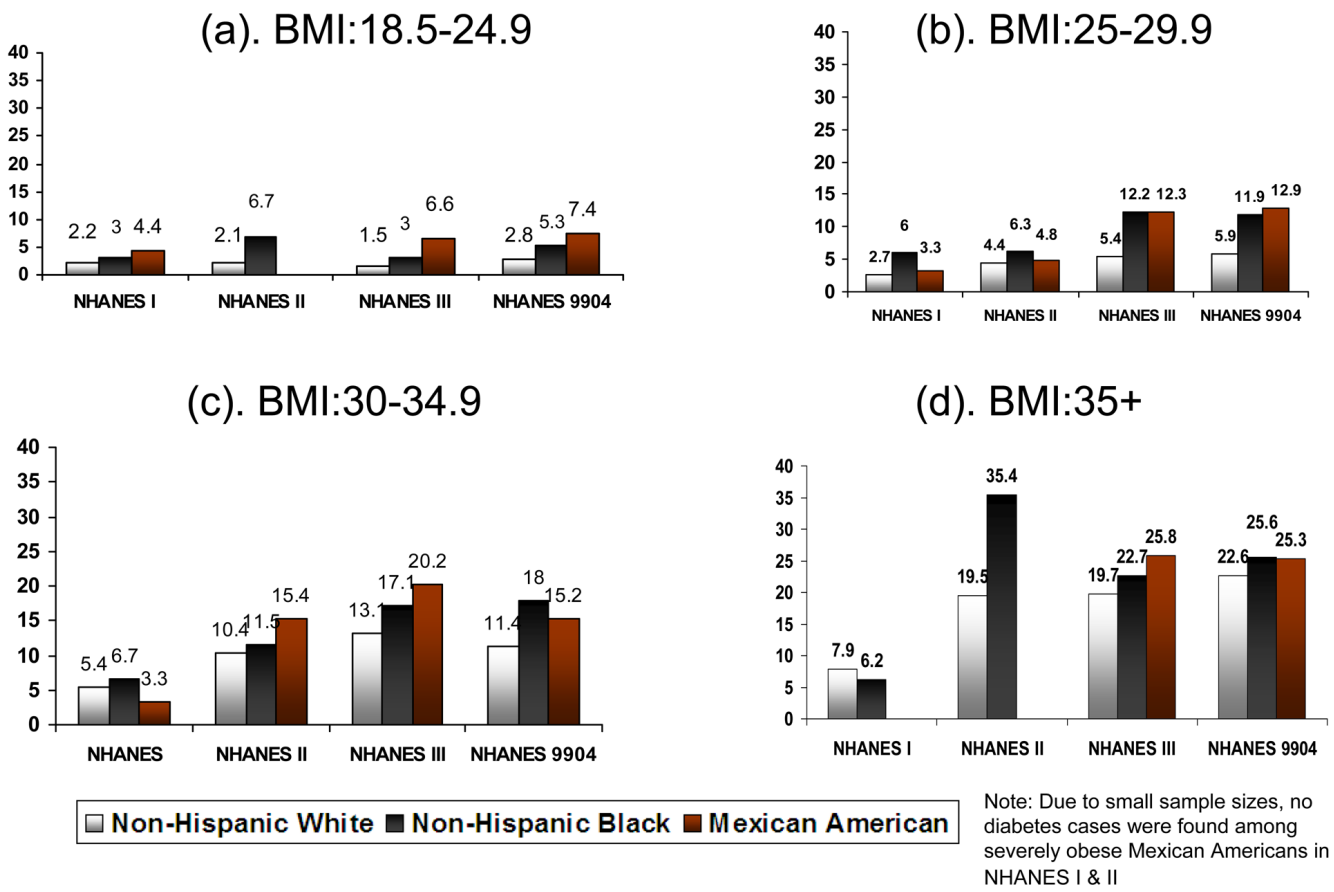

Figure 2.

Age- and gender-adjusted prevalence (%) of total diabetes among U.S. adults by race/ethnicity and BMI groups in NHANES 1971 to 2004

Table 1

Sociodemographic characteristics and anthropometric measures [mean (SE) or %] of US adults aged 20–74 years in NHANES 1971 to 2004

	NHANES I (1971–75)	NHANES II (1976–80)	NHANES III (1988–94)	NHANES 1999–2004
n	12,990	11,655	14,661	10,268
Age (years) (SE)	42.8 (0.3)	42.5 (0.3)	42.2 (0.4)	43.5 (0.3)
Men (%) (SE)	47.2 (0.5)	48.1 (0.5)	48.4 (0.4)	49.9 (0.5)
Non-Hispanic White (%) (SE)	86.8 (0.8)	82.8 (1.4)	75.6 (1.3)	71.9 (1.7)
Non-Hispanic Black (%) (SE)	9.9 (0.7)	10.0 (1.3)	11.1 (0.6)	11.0 (1.0)
Mexican American (%) (SE)	2.3 (0.6)	2.5 (0.6)	5.3 (0.4)	7.5 (0.9)
Below poverty line (%) (SE)	11.5 (0.7)	11.3 (0.4)	12.4 (0.8)	13.8 (0.7)
Less than high school diploma (%) (SE)	34.5 (1.1)	29.0 (1.0)	23.0 (1.0)	18.8 (0.7)
Men's BMI (kg/m2) (SE)	25.5 (0.1)	25.5 (0.1)	26.6 (0.1)	28.0 (0.1)
White Men (SE)	25.6 (0.1)	25.5 (0.1)	26.7 (0.1)	28.2 (0.1)
Black Men (SE)	25.6 (0.3)	25.4 (0.2)	26.6 (0.1)	27.9 (0.2)
Mexican American Men (SE)	26.2 (0.5)	26.4 (0.5)	26.9 (0.2)	28.0 (0.2)
Women's BMI (kg/m2) (SE)	25.0 (0.1)	25.2 (0.1)	26.5 (0.2)	28.3 (0.2)
White Women(SE)	24.8 (0.1)	24.8 (0.1)	26.1 (0.2)	27.8 (0.2)
Black Women(SE)	27.3 (0.3)	27.4 (0.3)	28.8 (0.2)	31.5 (0.2)
Mexican American Women (SE)	25.6 (0.4)	26.2 (0.6)	28.1 (0.2)	29.3 (0.3)
Men: BMI<18.5 (Underweight) (%) (SE)	2.5 (0.3)	1.71 (0.2)	1.1 (0.2)	1.0 (0.1)
Men: BMI:18.5–24.9 (Normal Weight) (%) (SE)	44.6 (1.1)	47.3 (0.9)	39.2 (1.1)	29.5 (0.8)
Men: BMI:25–29.9 (Overweight) (%) (SE)	41.2 (1.1)	39.0 (0.8)	39.8 (0.9)	40.5 (0.9)
Men: BMI: 30–34.9 (Obesity) (%) (SE)	9.5 (0.5)	9.7 (0.5)	14.5 (0.6)	19.2 (0.6)
Men: BMI>35 (Severe obesity) (%) (SE)	2.2 (0.3)	2.3 (0.2)	5.4 (0.6)	9.7 (0.6)
Women: BMI<18.5 (Underweight) (%) (SE)	5.0 (0.3)	4.7 (0.3)	3.6 (0.4)	2.5 (0.3)
Women: BMI:18.5–24.9 (Normal Weight) (%) (SE)	54.4 (0.8)	54.0 (1.0)	45.8 (1.1)	35.8 (1.1)
Women: BMI:25–29.9 (Overweight) (%) (SE)	24.1 (0.7)	24.6 (0.8)	25.5 (0.7)	27.8 (1.0)
Women: BMI: 30–34.9 (Obesity) (%) (SE)	10.8 (0.5)	10.3 (0.4)	14.4 (0.6)	17.9 (0.8)

	NHANES I (1971–75)	NHANES II (1976–80)	NHANES III (1988–94)	NHANES 1999–2004
Women: BMI>35 (Severe obesity) (%) (SE)	5.7 (0.4)	6.4 (0.3)	10.7 (0.8)	16.0 (0.7)

Table 2

Age-,gender-adjusted prevalence of diagnosed diabetes (%, SE) by race/ethnicity and body weight groups

	NHANES I 1971–1975	NHANES II 1976–80	NHANES III 1988–94	NHANES 1999–2004	Δ (I & II) (%)*	Δ (I & III) (%)*	Δ (I & 1999–2004) (%)*
Total Diagnosed Diabetes	3.0 (0.2)	3.0 (0.2)	4.1 (0.2)	6.8 (0.3)	0.0%	36.7%	126.7%
Race							
Non-Hispanic White	2.9 (0.2)	2.7 (0.2)	3.7 (0.3)	5.5 (0.4)	−6.9%	27.6%	89.7%
Non-Hispanic Black	4.5 (0.6)	4.5 (0.3)	6.7 (0.4)	11.0 (0.6)	0.0%	48.9%	144.4%
Mexican American	3.4 (0.9)	4.6 (1.2)	7.8 (0.3)	11 (0.5)	35.3%	129.4%	223.5%
Ratio: Black/White	1.6	1.7	1.8	2.0	6.2%	12.5%	25.0%
Ratio: Mexican/White	1.2	1.7	2.1	2.0	41.7%	75.0%	66.7%
Level of Obesity							
BMI<18.5 (Underweight)	3.0 (1.2)	2.5 (0.8)	3.4 (1.5)	1.1 (0.6)	−16.7%	13.3%	−63.3%
18.5–24.9 (Normal Weight)	2.5 (0.3)	2.2 (1.2)	1.5 (0.2)	3.6 (0.4)	−12.0%	−40.0%	44.0%
BMI:25–29.9 (Overweight)	2.7 (0.3)	2.7 (0.3)	3.9 (0.4)	4.7 (0.4)	0.0%	44.4%	74.1%
BMI: 30–34.9 (Obesity)	4.7 (0.9)	4.9 (0.7)	6.1 (0.7)	8.3 (0.7)	4.3%	29.8%	76.6%
BMI>=35 (Severe obesity)	6.8 (1.4)	7.1 (1.3)	12.0 (1.3)	16.8 (1.1)	4.4%	76.5%	147.1%
With BMI:18.5–24.9							
Non-Hispanic White	2.2 (0.3)	1.7 (0.1)	1.0 (0.2)	2.0 (0.4)	−22.7%	−54.5%	−9.1%
Non-Hispanic Black	3.0 (0.9)	2.3 (0.5)	2.4 (0.4)	4.8 (0.8)	−23.3%	−20.0%	60.0%
Mexican American	4.4 (1.9)	5.5 (2.3)	4.5 (0.5)	6.6 (0.5)	20.0%	2.3%	50.0%
Ratio: Black/White	1.4	1.4	2.4	2.4	71.4%	71.4%	71.4%
Ratio: Mexican/White	2.0	3.2	4.5	3.3	45.5%	125.0%	65.0%
With BMI: 25–29.9							
Non-Hispanic White	2.7 (0.3)	2.9 (0.3)	3.8 (0.5)	3.6 (0.5)	7.4%	40.7%	33.3%
Non-Hispanic Black	6.0 (0.8)	4.3 (0.9)	8.0 (0.6)	9.6 (1.0)	−28.3%	33.3%	60.0%
Mexican American	3.3 (0.5)	3.2 (1.0)	8.0 (0.5)	10.8 (7.6)	−3.0%	142.4%	227.3%
Ratio: Black/White	2.2	1.5	2.1	2.7	−31.8%	−4.5%	22.7%
Ratio: Mexican/White	1.2	1.1	2.1	3.0	−8.3%	75.0%	150.0%
With BMI: 30–34.9							
Non-Hispanic White	5.4 (1.1)	5.5 (0.9)	6.9 (1.0)	8.4 (0.8)	1.9%	27.8%	55.6%
Non-Hispanic Black	6.7 (2.0)	7.6 (1.4)	11.1 (0.9)	13.8 (1.3)	13.4%	65.7%	106.0%

	NHANES I 1971–1975	NHANES II 1976–80	NHANES III 1988–94	NHANES 1999–2004	Δ (I & II) (%)*	Δ (I & III) (%)*	Δ (I & 1999–2004) (%)*
Mexican American	3.3 (2.1)	8.6 (3.7)	11.1 (0.8)	11.5 (0.9)	160.6%	236.4%	248.5%
Ratio: Black/White	1.2	1.4	1.6	1.6	16.7%	33.3%	33.3%
Ratio: Mexican/White	0.6	1.6	1.6	1.4	166.7%	166.7%	133.3%
With BMI: 35+							
Non-Hispanic White	7.9 (1.7)	7.3 (1.5)	12.5 (1.6)	16.7 (1.4)	−7.6%	58.2%	111.4%
Non-Hispanic Black	6.2 (1.7)	12.0 (3.3)	11.5 (1.3)	20.0 (2.0)	93.5%	85.5%	222.6%
Mexican American	†	†	14.8 (3.0)	22.0 (2.0)	†	†	†
Ratio: Black/White	0.8	1.6	0.9	1.2	100.0%	12.5%	50.0%
Ratio: Mexican/White	†	†	1.2	1.3	†	†	†

*(% of NHANES II/III/1999–2004 - % of NHANES I)/(% of NHANES I)

†No diabetes case due to small sample size

Table 3

Age-, Gender-adjusted Prevalence of undiagnosed diabetes (%, SE) by race/ethnicity and body weight groups

	NHANES II 1976–80	NHANES III 1988–94	NHANES 1999–2004	Δ (II & III) (%)*	Δ (II & 1999–2004) (%)*
Total Undiagnosed Diabetes % (SE)	2.0 (0.3)	2.5 (0.2)	2.3 (0.3)	25.0%	15.0%
Race					
Non-Hispanic White	1.7 (0.3)	2.2 (0.3)	2.3 (0.3)	29.4%	35.3%
Non-Hispanic Black	4.5 (1.2)	3.9 (0.4)	2.8 (0.5)	−13.3%	−37.8%
Mexican American	2.6 (1.0)	4.8 (0.4)	2.2 (0.3)	84.6%	−15.4%
Ratio: Black/White	2.6	1.8	1.2	−30.8%	−53.8%
Ratio: Mexican/White	1.5	2.2	1.0	46.7%	−33.3%
Level of Obesity					
BMI<18.5 (Underweight)	1.8 (1.0)	‡	0.9 (0.5)	‡	−50.0%
BMI:18.5–24.9 (Normal Weight)	0.9 (0.3)	0.9 (0.2)	1.0 (0.3)	0.0%	11.1%
BMI:25–29.9 (Overweight)	1.4 (0.4)	1.7 (0.3)	2.0 (0.4)	21.4%	42.9%
BMI: 30–34.9 (Obesity)	4.2 (1.3)	5.4 (0.8)	2.9 (0.7)	28.6%	−31.0%
BMI>=35 (Severe obesity)	13.6 (2.9)	8.1 (1.8)	5.8 (1.1)	−40.4%	−57.4%
With BMI:18.5–24.9					
Non-Hispanic White	0.4 (0.2)	0.5 (0.2)	0.8 (0.3)	25.0%	100.0%
Non-Hispanic Black	4.4 (1.8)	0.6 (0.3)	0.5 (0.4)	−86.4%	−88.6%
Mexican American	‡	2.1 (0.3)	0.8 (0.3)	‡	‡
Ratio: Black/White	11.0	1.2	0.6	−89.1%	−94.5%
Ratio: Mexican/White	‡	4.2	1.0	‡	‡
With BMI: 25–29.9					
Non-Hispanic White	1.5 (0.4)	1.6 (0.4)	2.3 (0.5)	6.7%	53.3%
Non-Hispanic Black	2.0 (0.9)	4.2 (0.6)	2.3 (0.9)	110.0%	15.0%
Mexican American	1.6 (1.0)	4.3 (0.6)	2.1 (0.5)	168.8%	25.0%
Ratio: Black/White	1.3	2.6	1.0	100.0%	−23.1%
Ratio: Mexican/White	1.1	2.7	0.9	145.5%	−18.2%
With BMI: 30–34.9					
Non-Hispanic White	4.9 (1.6)	6.3 (1.1)	3.0 (0.9)	28.6%	−38.8%
Non-Hispanic Black	3.9 (2.3)	6.2 (1.1)	4.2 (1.0)	59.0%	7.7%
Mexican American	6.8 (3.8)	8.6 (1.9)	3.7 (0.7)	26.5%	−45.6%

	NHANES II 1976–80	NHANES III 1988–94	NHANES 1999–2004	Δ (II & III) (%)*	Δ (II & 1999–2004) (%)*
Ratio: Black/White	0.8	1.0	1.4	25.0%	75.0%
Ratio: Mexican/White	1.4	1.4	1.2	0.0%	−14.3%
With BMI: >=35					
Non-Hispanic White	12.2 (3.3)	7.2 (2.3)	5.9 (1.6)	−41.0%	−51.6%
Non-Hispanic Black	23.4 (11.8)	11.2 (2.3)	5.6 (1.8)	−52.1%	−76.1%
Mexican American	7.4 (5.2)	10.9 (2.2)	3.3 (0.9)	47.3%	−55.4%
Ratio: Black/White	1.9	1.6	0.9	−15.8%	−52.6%
Ratio: Mexican/White	0.6	1.5	0.6	150.0%	0.0%

*(% of NHANES III/1999–2004 - % of NHANES II)/(% of NHANES II)

†(% of NHANES 1999–2004 - % of NHANES II)/(% of NHANES II)

‡No diabetes cases due to small sample size

Table 4

Logistic regression models: association between race/ethnicity and diagnosed/undiagnosed diabetes (OR and 95% CI), by body weight groups in US adults aged 20–74 years in NHANES 1971 to 2004*

	NHANES I (1971–75)	NHANES II (1976–80)	NHANES III (1988–94)	NHANES 1999–2004
Diagnosed diabetes				
All groups				
Non-Hispanic Black	1.4 (1.1–1.8)†	1.6 (1.3–2.1)‡	1.7 (1.4–2.1)‡	2.0 (1.7–2.4)‡
Mexican American	1.1 (0.6–2.0)	1.6 (0.7–3.5)	1.8 (1.5–2.3)‡	2.1 (1.7–2.5)‡
With BMI:18.5–24.9				
Non-Hispanic Black	1.5 (1.0–2.2)§	1.3 (0.7–2.3)	2.3 (1.3–3.9)†	2.4 (1.4–4.1)‡
Mexican American	1.5 (0.5–4.1)	3.3 (0.8–13.6)	4.4 (2.7–7.0)‡	4.0 (2.5–6.6)‡
With BMI:25–29.9				
Non-Hispanic Black	1.5 (1.0–2.2)§	1.4 (0.8–2.4)	2.2 (1.5–3.1)‡	3.0 (2.1–4.3)‡
Mexican American	1.5 (0.7–3.6)	1.0 (0.4–2.3)	2.0 (1.3–3.0)‡	3.4 (2.4–4.8)‡
With BMI: 30–34.9				
Non-Hispanic Black	1.0 (0.6–1.7)	1.4 (0.7–2.7)	1.7 (1.2–2.3)†	1.5 (1.0–2.1)§
Mexican American	0.4 (0.1–3.2)	1.6 (0.4–7.1)	1.5 (1.0–2.3)§	1.3 (0.9–1.9)
With BMI: >=35				
Non-Hispanic Black	1.1 (0.6–2.0)	1.8 (0.8–4.2)	0.8 (0.5–1.2)	1.1 (0.8–1.6)
Mexican American	–‖	–‖	0.9 (0.5–1.7)	1.1 (0.8–1.7)
Undiagnosed diabetes				
All groups				
Non-Hispanic Black	¶	2.3 (1.3–4.1)†	1.6 (1.1–2.3)†	1.0 (0.6–1.6)
Mexican American	¶	3.0 (1.1–8.7)§	1.7 (1.2–2.5)†	0.9 (0.6–1.6)
With BMI:18.5–24.9				
Non-Hispanic Black	¶	9.5 (3.1–29.0)‡	1.0 (0.3–3.1)	0.4 (0.1–2.8)
Mexican American	¶	–	1.8 (0.7–4.6)	0.9 (0.2–4.6)
With BMI:25–29.9				
Non-Hispanic Black	¶	1.8 (0.7–4.9)	2.1 (1.1–3.9) §	0.5 (0.2–1.4)
Mexican American	¶	1.9 (0.2–16.5)	1.8 (0.9–3.4)	0.5 (0.2–1.2)
With BMI: 30–34.9				
Non-Hispanic Black	¶	1.5 (0.4–5.5)	1.1 (0.6–2.0)	1.9 (0.8–4.7)
Mexican American	¶	4.1 (0.8–21.3)	1.4 (0.7–2.6)	1.7 (0.7–4.0)
With BMI: >=35				
Non-Hispanic Black	¶	1.0 (0.3–3.6)	1.5 (0.7–3.0)	0.8 (0.3–2.3)
Mexican American	¶	1.5 (0.1–15.0)	1.3 (0.6–3.1)	0.7 (0.2–2.3)

*Models controlled age, gender and education

§<0.05;

†<0.01;

‡<0.001

||No available due to small sample size among Mexican Americans

¶No available information on glucose level in NHANES I (1971–75)

Appendix 1

Sample Size by Race/Ethnicity and Body Weight Groups

	NHANES I 1971–1975	NHANES II 1976–80	NHANES III 1988–94	NHANES 1999–2004
Race				
Non-Hispanic White	10267	9642	5443	4929
Non-Hispanic Black	2241	1283	4362	2139
Mexican American	342	280	4249	2430
Level of Obesity				
BMI<18.5 (Underweight)	551	366	292	150
BMI:18.5–24.9 (Normal Weight)	6377	5627	5405	3063
BMI:25–29.9 (Overweight)	4011	3818	5033	3608
BMI: 30–34.9 (Obesity)	1434	1286	2470	2025
BMI>=35 (Severe obesity)	617	558	1461	1422
With BMI:18.5–24.9				
Non-Hispanic White	5524	4754	2246	1623
Non-Hispanic Black	922	532	1516	554
Mexican American	143	105	1370	608
With BMI: 25–29.9				
Non-Hispanic White	3183	3158	1818	1672
Non-Hispanic Black	676	409	1385	678
Mexican American	122	107	1644	965
With BMI: 30–34.9				
Non-Hispanic White	1029	1006	807	933
Non-Hispanic Black	349	199	766	437
Mexican American	46	49	803	543
With BMI: >=35				
Non-Hispanic White	400	422	451	610
Non-Hispanic Black	196	106	594	439
Mexican American	20	14	378	302