Achievement of American Diabetes Association Clinical Practice Recommendations Among U.S. Adults With Diabetes, 1999–2002

The National Health and Nutrition Examination Survey

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OBJECTIVE — To estimate the proportion of U.S. adults with diabetes who meet American Diabetes Association (ADA) clinical practice recommendations.

RESEARCH DESIGN AND METHODS — Using data from the 1999–2002 National Health and Nutrition Examination Survey, 998 adults aged ≥18 years with self-reported diabetes were identified. The proportion of adults with diabetes meeting ADA recommendations for HbA_{1c} (A1C), HDL cholesterol, LDL cholesterol, triglycerides, blood pressure, renal function, nutrient intake, smoking, pneumococcal vaccination, and physical activity was estimated.

RESULTS — Among U.S. adults with diabetes in 1999–2002, 49.8% had A1C <7%; 27.4, 36.0, and 65.0% were classified as low risk for HDL cholesterol, LDL cholesterol, and triglycerides, respectively. Nearly 40% met blood pressure recommendations, 66% had normal renal function, and daily nutrient recommendations for protein, saturated fat, unsaturated fat, and fiber were met by 64.0, 48.3, 28.3, and 18.3%, respectively. Although >81% of the sample reported not smoking at the time of the exam, only 38.2% reported ever having had a pneumococcal immunization, and 28.2% reported getting the recommended level of physical activity. Race, age, duration of diabetes, and education affected achievement of ADA recommendations.

CONCLUSIONS — Achievement of ADA clinical practice recommendations is far from adequate in U.S. adults with diabetes.

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Control of blood glucose, obesity, and hypertension has beneficial health effects for diabetic individuals and those at high risk for diabetes (1–4). Behavioral factors such as healthy eating, avoidance of smoking, physical activity, and weight control also have beneficial health effects for people with diabetes and those at high risk (4–8). However, some of these risk factors are poorly controlled in diabetic individuals (9).

Each year, the American Diabetes Association (ADA) publishes updated clinical practice recommendations. These are available in the public domain (10). For public health planning purposes and to more effectively allocate health care resources, it is of interest to understand to what degree diabetic individuals meet specific clinical practice recommendations (1) and what clinical and demographic characteristics are associated with reduced achievement of these recommendations (2). The purpose of this report is to define the proportion of U.S. adults with diabetes who meet selected ADA clinical practice recommendations. A secondary goal is to examine the association between demographic and clinical characteristics and achievement of ADA recommendations.

RESEARCH DESIGN AND METHODS

— Data on ADA clinical practice recommendations are available in the National Health and Nutrition Examination Survey (NHANES) 1999–2002.

Table 1 summarizes selected ADA clinical practice recommendations that were published in 2001 and the number of NHANES participants for whom relevant data were collected. We selected the 2001 recommendations because that year approximates the midpoint of the period of data collection for the NHANES data used in this report.

Data source

NHANES is an ongoing data collection initiative conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. NHANES 1999–2000 (11) and NHANES 2001–2002 (12) are nationally representative surveys of the noninstitutionalized civilian population in the U.S. and were designed to be concatenated and analyzed as a single NHANES 1999–2002 survey (13). The NHANES surveys are stratified multistage probability samples based on selection of counties, blocks, households, and the number of people within households. NHANES 1999–2002 was designed to oversample Mexican Americans, non-Hispanic blacks, and children and adolescents (13–15).

Laboratory determinations

NHANES examinations were conducted either in a morning or afternoon session. Participants in the morning session were

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Abbreviations: ADA, American Diabetes Association; NHANES, National Health and Nutrition Examination Survey.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Summary of ADA clinical practice recommendations that can be evaluated among diabetic individuals in NHANES 1999–2002*

Characteristic	Clinical practice recommendation	*n*	NHANES assessment
A1C	<7%	451	Lab portion of medical exam; available only for persons in NHANES 2001–2002
HDL cholesterol		829	Lab portion of medical exam
Males	>45 mg/dl		
Females	>55 mg/dl		
LDL cholesterol	<100 mg/dl	252	Lab portion of morning medical exam; reported for persons who fasted ≥8 h
Triglycerides	<200 mg/dl	275	Lab portion of morning medical exam; reported for persons who fasted ≥8 h
Blood pressure	Systolic <130 mmHg and diastolic <80 mmHg	870	Medical exam
Albumin-to-creatinine ratio	<30 μg/mg	861	Lab portion of medical exam
Daily caloric intake			
Protein	10–20% of daily caloric intake	912	Medical exam
Saturated fat	<10% of daily caloric intake	869	Medical exam
Unsaturated fat	<10% of daily caloric intake	869	Medical exam
Daily fiber intake	20–35 g daily	871	Medical exam
Smoking	Smoking abstinence and cessation among current smokers	990	Household interview
Pneumococcal immunization	One-time vaccination for individuals <65 and one-time revaccination for those ≥65 years if first vaccination was administered >5 years ago	951	Household interview
Physical activity	≥30 min of moderate exercise on most days of the week	648	Assessed in household interview using MET scores from physical activity questionnaire; five or more moderate to vigorous activities or three or more vigorous activities lasting for at least 30 min per week defined as sufficient physical activity

asked to fast for 9 h before the exam, while participants in the afternoon session were asked to fast for 6 h. Fasting status was defined as self-reported fasting of ≥8 h before the blood draw, whether it occurred in the morning or afternoon session. Relevant laboratory determinations include glucose, HbA_{1c} (A1C), total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, and urinary albumin and creatinine. Data on glucose and total cholesterol are reported for fasting participants regardless of session, data on LDL cholesterol and triglycerides are reported for fasting participants in the morning session only, and HDL cholesterol and A1C data are presented for all diabetic participants. A1C was measured only in the 2001–2002 NHANES sample. Urine specimens collected during the exam were used to calculate albumin-to-creatinine ratio.

Medical examination

Systolic blood pressure was measured on the right brachial artery with the participant supine. Height, weight, and waist circumference were collected according to standardized methods. A detailed dietary assessment based on a 24-h food recall was administered. NHANES dietary methodologies are designed to translate foods into daily nutrient intake (16–18).

Household interview

Self-reported diabetes was assessed with the question "Have you ever been told by a doctor or health professional that you had diabetes or sugar diabetes?"

Current smoking was assessed with the question "Do you now smoke cigarettes?" Participants who reported smoking every day or some days were defined as current smokers. Cardiovascular conditions, including hypertension, congestive heart failure, angina, myocardial infarction, and stroke, were assessed with similar questions, i.e., "Has a doctor or other health professional ever told you that you had congestive heart failure?"

The NHANES question related to pneumococcal vaccination is phrased, "Have you ever had a pneumonia vaccination? This shot is usually given only once in a person's lifetime and is different from a flu shot."

The ADA recommends that diabetic individuals follow the Surgeon General's report on physical activity and obtain 30 min of moderate physical activity on most days of the week (19,20). In NHANES, a questionnaire assessed specific activities performed on a voluntary basis, as well as how often and for what duration these activities were performed. Each activity was assigned a MET (metabolic equivalent) score (21), which was used to classify each activity into light, moderate, and vigorous categories of physical activity. Five or more moderate to vigorous activities or three or more vigorous activities lasting for at least 30 min per week was defined as recommended physical activity (22).

Because of the relationship between diabetes and disability (23–25), we report recommended physical activity among diabetic individuals who can exercise voluntarily. As a proxy for ability to exercise, we used data on self-reported disability, which are available for participants aged

Table 2—*Characteristics of adults aged ≥18 years with self-reported diabetes, NHANES 1999–2002*

Characteristic	*n*	Mean or proportion ± SE
Age (mean years) (%)	998	59.1 ± 0.7
18–39		10.4 ± 1.5
40–59		37.9 ± 1.9
60–74		35.0 ± 1.6
≥75		16.8 ± 1.7
Sex (% female)	998	50.9 ± 2.1
Race (%)	998	
White		61.7 ± 3.3
Black		16.5 ± 2.5
Mexican American		7.0 ± 1.3
Other*		14.7 ± 3.6
BMI (kg/m^2)	841	31.8 ± 0.4
Waist circumference (cm)	844	
Male	419	109.2 ± 1.5
Female	425	105.8 ± 1.0
Fasting total cholesterol (mg/dl)	386	203.6 ± 3.1
Fasting glucose (mg/dl)	329	150.2 ± 4.0
Taking insulin (%)	996	27.4 ± 2.6
Taking oral hypoglycemic medications (%)	993	65.3 ± 2.4
Taking oral hypoglycemic medication or insulin (%)	998	82.2 ± 2.1
Taking insulin and orals (%)	991	10.4 ± 1.8
Duration of diabetes (years)	922	
0–1		15.1 ± 2.0
2–5		28.3 ± 1.8
6–9		15.0 ± 1.7
10–14		14.1 ± 1.4
≥15		27.5 ± 1.7
Self-reported cardiovascular disease (%)		
Congestive heart failure	894	8.8 ± 1.2
Angina	886	11.3 ± 1.6
Myocardial infarction	899	11.8 ± 1.9
Stroke	904	7.6 ± 1.1
Any cardiovascular disease	905	23.9 ± 2.1
Insurance coverage (% with any)	975	89.8 ± 1.3
Education	994	
Less than high school		37.1 ± 2.2
High school equivalent, no college		25.4 ± 2.2
At least some college		37.5 ± 2.3
Marital status (% married)	949	58.9 ± 2.8
Household income (in thousands)	848	
<20		33.8 ± 2.7
20–34		24.2 ± 1.8
35–54		19.9 ± 1.9
≥55		22.1 ± 2.5

*Includes other Hispanics and other race including multiracial. Some categories do not add to 100.0 due to rounding.

≥20 years. Disability was defined as reported difficulty walking one-quarter mile or walking up 10 steps without resting.

Statistical analysis

Means ± SEs are reported for continuous variables. Proportions and SEs are reported for categorical variables. Analyses focus on proportions of diabetic adults meeting specific ADA recommendations. We also present data according to race, duration of diabetes, income, education, and insurance status. The online appendix (available at http://care.diabetesjournals.org) contains detailed information on data available for each of these subgroups. For race, the χ^2 test was used with whites as the reference group. For duration of diabetes, household income, and education, tests for trend were conducted using logistic regression. The χ^2 test was used to examine insurance status in relation to ADA recommendations.

Data are weighted to the civilian noninstitutionalized population of the U.S. Analyses include sample weights to adjust for unequal probabilities of selection, oversampling, and nonresponse. Analyses were performed using SAS and SUDAAN software. The complex sampling design of NHANES produces means and proportions that are potentially more sensitive to sample size than conventional random sampling designs. Design effects, which measure the extent to which an estimate is influenced by the complex sample design, were calculated for all means and proportions reported here (26). The statistical reliability of reported estimates was evaluated based on the design effects and sample size according to NHANES guidelines (13–15). Estimates that may be statistically unstable are noted with an asterisk in the figure. These estimates should be interpreted with the same caution with which a mean produced from a simple random sample of $n < 30$ would be interpreted.

RESULTS — The 1999–2002 NHANES examination included 11,441 individuals aged ≥18 years. Of these, 998 (482 in the 1999–2000 survey and 516 in the 2001–2002 survey) reported having diabetes. These individuals represent 6.3% (95% CI 5.7–6.9) of U.S. noninstitutionalized adults aged ≥18 years. Although the mean age of the diabetic sample was 59 years, 10.4% of these individuals were under the age of 40. Approximately half of diagnosed cases were among women, and nearly two-thirds of cases were among whites. As expected, mean BMI (31.8 kg/m^2) and waist circumference (109.2 cm for men and 105.8 cm for women) were high.

More than half of adults with diabetes reported hypertension, and cardiovascular disease was reported by 24% of these individuals. Although 90% had insurance coverage, approximately one-third reported annual income of <$20,000 per year. Twenty-seven percent of diabetic adults reported taking insulin, and 65% reported taking oral hypoglycemic medications. Notably, 82% of diabetic adults reported taking either insulin or oral medication and 10.4% reported being on combination therapy. Mean fasting glucose was high (150 mg/dl) (Table 2).

Table 3—*Proportion of U.S. diabetic adults aged ≥18 years achieving selected 2001 ADA clinical practice recommendations, NHANES 1999–2002*

Characteristic	*n*	Proportion meeting recommendation ± SE
A1C*	451	
<7%		49.8 ± 3.6
7–<8%		20.5 ± 1.1
≥8%		29.7 ± 3.4
HDL cholesterol	829	
Low risk (>45 mg/dl for men, >55 mg/dl for women)		27.4 ± 2.0
Borderline risk (35–45 mg/dl in men, 45–55 mg/dl in women)		35.3 ± 2.5
High risk (<35 mg/dl for men, <45 mg/dl for women)		37.3 ± 2.3
LDL cholesterol†	252	
Low risk (<100 mg/dl)		36.0 ± 4.0
Borderline risk (100–130 mg/dl)		30.8 ± 4.0
High risk (≥130 mg/dl)		33.2 ± 2.6
Triglycerides†	386	
Low risk (<200 mg/dl)		65.0 ± 3.8
Borderline risk (200–399 mg/dl)		28.8 ± 3.4
High risk (≥400 mg/dl)		6.3 ± 1.7
Blood pressure (<130 mmHg systolic and <80 mmHg diastolic)	870	39.6 ± 2.7
Albumin-to-creatinine ratio	861	
Normal (<30 mg/g)		65.8 ± 1.5
Microalbuminuria (30–299 mg/g)		24.0 ± 1.6
Macroalbuminuria (≥300 mg/g)		10.1 ± 1.2
Daily caloric intake		
Protein (10–20%)	912	64.0 ± 2.8
Saturated fat (<10%)	869	48.3 ± 2.6
Unsaturated fat (<10%)	869	28.3 ± 1.9
Daily fiber intake (20–35g)	871	18.3 ± 2.2
Nonsmokers (%)	990	81.2 ± 1.4
Pneumococcal immunization (% ever)	951	38.2 ± 3.2
Recommended physical activity‡	648	28.2 ± 2.5

*NHANES 2001–2002 sample only. †Data reported from fasting participants only. ‡Among diabetic adults age ≥20 years who did not report difficulty walking quarter mile or walking up 10 steps without resting. Some categories do not add to 100.0 due to rounding.

Table 3 summarizes NHANES data relevant to selected ADA clinical practice recommendations. Although 50% met the A1C target of <7%, nearly 30% had A1C >8%. Similarly, only 27.4 and 36.0% of participants were in the low-risk categories for HDL cholesterol and LDL cholesterol, respectively. Findings were more favorable for triglycerides: 65.0% of the sample was in the low-risk category. Clinical albuminuria was present in 10% of the sample, and 24% had microalbuminuria. Forty percent of diabetic adults met recommendations for blood pressure.

Findings for dietary recommendations were mixed: while nearly 65% reported recommended levels of protein, only 18.3% reported getting the recommended amount of fiber. Eighty-one percent of the sample reported being nonsmokers at the time of the interview. Although <40% of the sample reported ever having a pneumococcal immunization, coverage differed substantially by age: 12.4, 25.5, 46.7, and 65.5% of diabetic adults in the 18–39, 40–59, 60–74, and 75+ age groups, respectively, reported pneumococcal vaccination. Only 28% of nondisabled diabetic adults reported getting recommended physical activity.

HDL targets appeared to be met more frequently among blacks than whites and Hispanics, but renal function and A1C targets were met less frequently among both blacks and Hispanics (Fig. 1). Longer duration of diabetes was associated with poorer renal function, and people who were newly diagnosed with diabetes were much more likely to meet the A1C recommendation than those with longer duration. An unexpected pattern of more frequent achievement of HDL recommendations was observed with increasing duration of diabetes. For blood pressure and albumin-to-creatinine ratio, higher income and higher educational achievement tended to be associated with more frequent achievement of recommendations. There was a suggestion that having insurance improved achievement of practice recommendations for several factors, but none of these relationships was statistically significant.

CONCLUSIONS — These nationally representative data demonstrate heterogeneity in achievement of selected ADA clinical practice recommendations among U.S. adults with diabetes and raise important questions about how to most effectively allocate public health resources toward improved achievement of these recommendations.

Only 49.8% of diabetic adults aged ≥18 years met the recommendation of A1C <7%, a finding similar to a report from NHANES III showing that the ADA recommendation of <7% was met by 44.6% of diabetic adults aged ≥20 years in 1988–1994 (27). Our findings from NHANES 1999–2002 echo a recent report using NHANES 1999–2000 that made the important observation that glycemic control has not materially improved in U.S. adults with diabetes over the last 10 years (9).

An NHANES III study highlighted ethnic differences in glycemic control, with black women and Mexican-American men having worse control relative to other groups (27). Our data show that black and Mexican-American diabetic individuals met A1C recommendations less frequently than whites. Supplemental analyses of A1C data revealed that white women met recommendations for glycemic control most frequently (59.5%), and Mexican-American women met them least frequently (39.6%). Other race-sex groups were intermediate in their achievement of glycemic control. Thus, with the exception of white women, glycemic control recommendations are currently met by less than half of all major U.S. race-sex groups with diabetes.

Only 27.4% of diabetic adults met recommendations for HDL cholesterol. We observed a curious trend in HDL cholesterol, with an apparent trend toward greater achievement of target with increasing duration of diabetes. In inter-

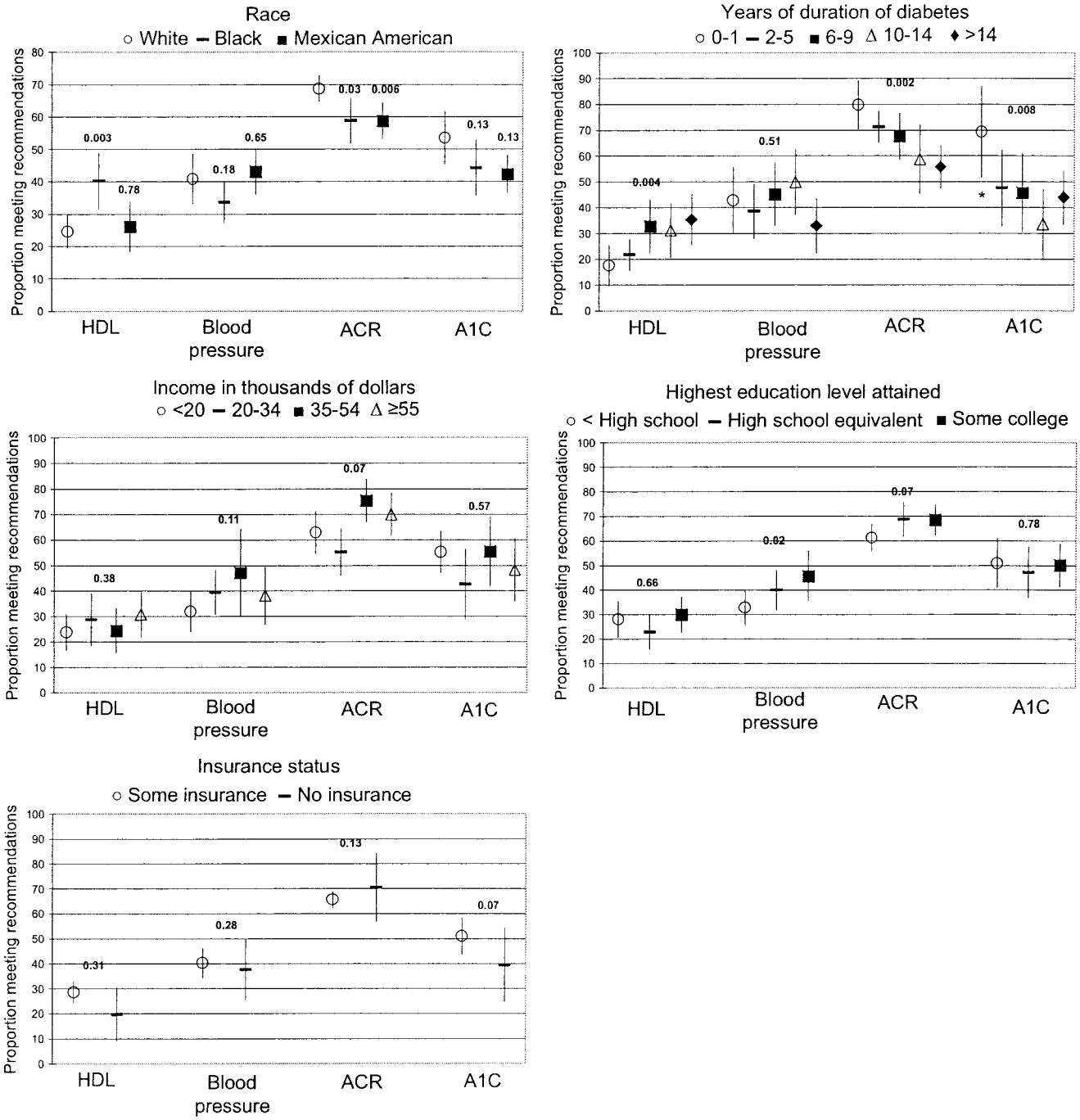

Figure 1—*Prevalence and 95% CIs for achievement of selected ADA clinical practice recommendations (HDL cholesterol of >45 mg/dl for men and >55 mg/dl for women, blood pressure <120/80 mmHg, albumin-to-creatinine ratio [ACR] <30 μg/g, A1C <7%) among U.S. adults with diabetes by race, duration of diabetes, income, education, and insurance status. The numbers on the figures represent* P *values. For race,* P *values are comparisons between black or Mexican-American participants and whites. All other* P *values are derived from tests for trend. *Statistically unreliable estimate due to small sample size.*

preting this observation, it is useful to point out that fibrates (gemfibrizil and fenofibrate) and niacin are the primary drugs for treating triglycerides and raising HDL cholesterol. However, niacin is relatively contraindicated in diabetes and the fibrates are underused because of the lack of consensus on treatment of triglycerides. This lack of consensus is due in part to the discrepancy between ADA and National Cholesterol Education Program recommendations for treatment of triglycerides (28).

Although 65% of the sample met recommendations for triglyceride levels, the remaining 35% had triglycerides >200 mg/dl. A potential explanation for this observation is that the only studies investigating triglyceride intervention at this time were the Helsinki Heart Study and the Veterans Affairs HDL Intervention Trial (29,30). Neither was specific to diabetes, and the impact of triglyceride control on reduction of cardiovascular

disease was modest. No public effort to lower triglycerides was ever undertaken and might explain the relatively poor control of this risk factor in diabetic adults. Notably, our data showed that more U.S. blacks with diabetes met recommendations for triglycerides, with whites and Mexican Americans meeting it less often. This observation may represent differential representation of individual components of the metabolic syndrome by ethnic group, a notion confirmed by a seminal report that showed less frequent hypertriglyceridemia and more hypertension among blacks compared with whites and Mexican Americans (31).

Ten percent of the sample had clinical albuminuria. The relatively well-preserved renal function is likely due to the short mean duration of diabetes (11.5 years). The striking inverse relationship between prevalence of normal renal function and duration of diabetes supports this concept. Our data show that favorable renal function was present more frequently in whites compared with blacks and Hispanics among persons with at least a high school education compared with those who did not finish high school and among those with higher incomes. These findings are consistent with previous reports suggesting that diabetes complications occur more frequently among minorities and that socioeconomic indicators are inversely associated with rates of diabetes complications (32–34).

Only 19% of diabetic adults reported being current smokers, a finding consistent with an earlier report using data from NHANES 1999–2000, which showed that 17% of diabetic individuals were current smokers (35). We postulated that the relatively low prevalence of current smoking among diabetic persons might be due in part to a larger proportion of diabetic individuals having quit smoking, possibly due to recommendations for smoking cessation among persons with diabetes. Accordingly, we examined the proportion of former smokers among both diabetic and nondiabetic adults aged ≥18 years in the NHANES 1999–2002 sample. Indeed, among diabetic nonsmokers, 32.3% reported being former smokers, compared with 24.5% former smoking in nondiabetic adults. Our findings are generally consistent with data suggesting dramatic decreases in the proportion of diabetic individuals who smoke (35).

Although the low prevalence of current smoking and the higher prevalence of quitting among ever-smokers is encouraging, there is much room for improvement given that nearly one-fifth of people with diabetes are still current smokers. Perhaps more serious was our post hoc observation that among U.S. adults aged 18–39 years, there is actually more smoking among diabetic (37.0%) than nondiabetic (30.4%) individuals. Thus, programs to enhance smoking cessation among diabetic individuals are needed, especially among younger adults with diabetes.

Less than 40% of diabetic adults reported ever having a pneumococcal vaccination, a finding consistent with a Centers for Disease Control and Prevention report (36) showing that pneumococcal coverage among U.S. adults with diabetes was 37.1%. The latter study demonstrated that coverage was higher for older diabetic adults compared with younger ones, an observation we confirmed in age-stratified analyses with our data. This pattern likely reflects successful public health education aimed at the elderly, which also captures some older diabetic individuals. It appears that additional efforts are needed to increase vaccination coverage among younger persons with diabetes.

Finally, only 28.2% of nondisabled adults with diabetes reported getting recommended levels of physical activity. Identifying ways to increase physical activity levels in diabetic adults is an obvious target for further study.

Achievement of ADA clinical practice recommendations is far from optimal in the U.S. Achievement of recommendations differs by age, race, duration of diabetes, and education. Public health resources should be focused on enhancing empowerment of people with diabetes to improve their diabetes self-management skills and on identifying ways to improve the efficacy of patient-physician partnerships aimed at achieving practice recommendations.

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