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Racial Disparities in the Control Status of Cardiovascular Risk Factors in an Underinsured Population with Type 2 Diabetes

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Abstract

Aims—To investigate the race-specific trend in attainment of the American Diabetes Association (ADA) cardiovascular risk factors control goals of patients with type 2 diabetes (HbA1c <53 mmol/mol [7.0%], blood pressure <130/80 mmHg, and low-density lipoprotein [LDL] cholesterol <2.6 mmol/L).

Methods—The study sample included 14,946 African American and 12,758 White patients who were newly diagnosed with type 2 diabetes between 2001 and 2009 in the Louisiana State University Hospital System. The race-specific percentages of patients' attainment of ADA goals were calculated using the baseline and follow-up measurements of HbA1c, blood pressure, and LDL-cholesterol levels. Logistic regression was used to test the difference between African American and White patients.

Results—The percentage of patients who met all three ADA goals increased from 8.2% in 2001 to 10.2% in 2009 (increased by 24.4%) in this cohort. Compared with African American patients, White patients had better attainment of the following ADA goals: HbA1c goal (61.4 vs. 55.1%), blood pressure goal (25.8 vs. 20.4%), LDL-cholesterol goal (40.1 vs. 37.7%), and all three goals (7.3 vs. 5.1%). African American and White patients generally had improved CVD risk factors profile during follow-up when we assessed attainment of the ADA goals by using means of HbA1c, blood pressure and LDL cholesterol.

Conclusions—During 2001–2009, this low income cohort with type 2 diabetes generally experienced improved control of CVD risk factors. White patients had better attainment of the ADA cardiovascular risk factors control goals than their African American counterparts.

INTRODUCTION

Type 2 diabetes is considered "the epidemic of the 21st century", affecting approximately 24 million individuals in the US alone [1]. Compared with people without type 2 diabetes,

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those with type 2 diabetes have higher death rates [2], and are at elevated risk of cardiovascular disease (CVD) and other complications of diabetes, such as retinopathy, nephropathy, and neuropathy [3–5]. Diabetes and its complications remain major causes of morbidity and mortality in the US [6–10].

In order to prevent CVD and other complications, the American Diabetes Association (ADA) recommends that adults with diabetes maintain an HbA1c <53 mmol/mol (7.0%), blood pressure <130/80 mmHg, and low-density lipoprotein (LDL) cholesterol <2.6 mmol/L [10]. Recent analyses from the National Health and Nutrition Examination Survey (NHANES) showed that these goals are seldom met in the US: about 40–50% of patients with type 2 diabetes meet any one of ADA goals and only 5–12% of patients with type 2 diabetes meet all three goals [11, 12]. Although the control status of the three risk factors is available at the national level, they are less clear for population subgroups, especially those with low income. In addition, most studies only assessed a single measurement of HbA1c, blood pressure, or LDL cholesterol which may produce potential bias in understanding the management of risk factors of diabetes. Moreover, several studies have found racial disparities in the control of CVD risk factors among type 2 patients with diabetes: African American patients with type 2 diabetes are less likely to meet individual and combined ADA goals compared with white patients[11, 13].

It has been suggested that the detected racial disparities in the control of CVD risk factors were partly attributed to the different socioeconomic status of African American and white patients with diabetes.[14–16] Therefore, the investigation of racial disparities in a sample with similar socioeconomic status is of special interest. The present study aims to investigate the race-specific trend in attainment of the ADA CVD risk factor control goals of patients with type 2 diabetes (HbA1c <53 mmol/mol (7.0%), blood pressure <130/80 mmHg, and LDL cholesterol <2.6 mmol/L) from 2001–2009 and to evaluate racial disparities in the percentage at enrollment and the updated mean percentage of successful attainment of the ADA goals in the cohort with type 2 diabetes of the Louisiana State University Hospital-based Longitudinal Study (LSUHLS).

METHODS

Subjects

Louisiana State University Health Care Services Division (LSUHCSD) operates seven public hospitals and affiliated clinics in Louisiana, which provide quality medical care to the residents of Louisiana regardless of their income or insurance coverage [17–22]. Overall, LSUHCSD facilities have served about 1.6 million patients (35% of the Louisiana population) since 1997. Administrative, anthropometric, laboratory, and clinical diagnosis data collected at these facilities are available in electronic form since 1997 for both inpatients and outpatients. Using these data, we have established the LSUHLS. All patients' information on birth date, race, sex, address, types of insurance, family income, smoking habits, date of examination, measurements of height, weight and blood pressure for each clinical visit, diagnosis of various diseases and date of diagnosis, laboratory tests, and medication history was included in the LSUHLS database. Since 1997, LSUHCSD's internal diabetes management guidelines call for physician confirmation of diabetes

diagnoses by applying the ADA criteria: a fasting plasma glucose level ≥126 mg/dL; 2-hour glucose level ≥200 mg/dL after a 75-g 2-hour oral glucose tolerance test (OGTT); one or more classic symptoms plus a random plasma glucose level ≥200 mg/dL [23]. A cohort of patients with diabetes was identified through the LSUHLS database between January 1, 2001, and December 31, 2009 using the International Classification of Disease Code (ICD) 250 (ICD-9). The first record of diabetes diagnosis was used to establish the baseline for each patient in the present analyses due to the design of the cohort study. These newly diagnosed participants with diabetes had been served by LSUHCSD hospitals for 3.68 ± 4.35 years prior to the baseline. In this cohort, about 63.6% of patients qualify for free care (by virtue of being low income and uninsured – any individual or family unit whose income is at or below 200% of Federal Poverty Level), about 9.6% of patients are self-pay (uninsured, but incomes not low enough to qualify for free care), about 7.9% of patients are covered by Medicaid, about 14.1% of patients have Medicare, and about 4.8% of patients are covered by commercial insurance. After excluding patients with type 1 diabetes and patients with incomplete data on any required variables, the present analyses included 5,447 non-Hispanic white men, 7,311 non-Hispanic white women, 5,633 African American men and 9,313 African American women. Compared with patients excluded in the present study, patients with type 2 diabetes included in the present study were younger (52.6 vs. 55.4 years old), had fewer African Americans (54.0% vs. 57.3%), and fewer males (40.0% vs. 45.5%). Both inpatients and outpatients were included and the majority patients in the present study are primary care patients. The study and analysis plan were approved by the Pennington Biomedical Research Center and LSU Health Sciences Center Institutional Review Boards, LSU System. We did not obtain informed consent from participants involved in our study because we used anonymized data compiled from electronic medical records.

Baseline and follow-up measurements

Patient characteristics, including age, race/ethnicity, family income, smoking status, weight, body mass index (BMI), blood pressure, total cholesterol, high-density lipoprotein (HDL) cholesterol, LDL cholesterol, triglycerides, HbA1c, and medication (antihypertensive drug, cholesterol lowering drug and antidiabetic drug) within 0.5 year of the diabetes diagnosis were extracted from the computerized hospitalization records. At each clinical visit, nurses measured height, weight, and blood pressure. Height was measured without shoes and weight was measured with light clothing. BMI was calculated by dividing weight in kilograms by the square of height in meters. Blood pressure was measured from the right arm after five minutes of sitting using a mercury sphygmomanometer or automatic blood pressure monitor. Follow-up information was obtained from the LSUHLS database by using the unique identification number assigned to every patient who visits the LSUHCSD hospitals. The average number of clinic laboratory measurements during the follow-up period was 8.5 times for HbA1c, 20.0 times for blood pressure, and 6.5 times for LDL cholesterol. The overall mean of these measurements for each participant was calculated.

Statistical analyses

Differences in the baseline characteristics based on different races were tested. Linear regression was used for numerical variables and logistic regression was used for categorical variables with age as a covariate. The yearly race-specific percentages of patients'

attainment of ADA goals for CVD risk factors control were calculated by logistic regression adjusted for age, BMI, smoking status, income, type of insurance, use of antihypertensive drugs, use of diabetes medications, and use of cholesterol-lowering agents. The linear trend across time was tested using attainment of ADA goals as the outcome variable and year as a continuous variable in the model. The age, gender and type of insurance- standardized percentages of patients' attainment of ADA goals for CVD risk factors control at baseline and during follow-up was calculated by the direct method to the African American population of this cohort (age groups: 30–44, 45–59, 60–74, and ≥ 75 years; gender groups: male and female; and insurance types: insured and not insured). All statistical analyses were performed by using SAS for Windows, version 9.3 (SAS Institute, Cary, NC).

RESULTS

The present study included 27,704 patients with type 2 diabetes (26% white women, 34% African American women, 20% white men, and 20% African American men). General characteristics of the study population at baseline are presented by race and sex in Table 1. White patients were generally older and had higher BMI, total cholesterol, triglycerides, and percentage of cholesterol-lowering medication usage, when compared with African American patients. African American patients had higher blood pressure, HDL cholesterol, LDL cholesterol, and HbA1c. In this cohort, the average number of clinic visits during the follow-up period was 27 for white patients, and 26 for African American patients.

Table 2 shows the adjusted percentage of patients' attainment of ADA CVD risk factors control goals from 2001 to 2009. Percentages of patients who achieved the target levels of HbA1c, blood pressure, LDL-cholesterol, or all the three were higher among white patients with type 2 diabetes than among the African American patients with type 2 diabetes in each of the nine years (2001–2009) in the total sample. The percentage of patients who met all three ADA goals increased from 8.2% in 2001 to 10.2% in 2009 (increased by 24.4%) in the total sample.

In the total sample, after direct standardization, 55.1% of African American and 61.4% of White had HbA1c <7.0%, 20.4% of African American and 25.8% of White had blood pressure <130/80 mmHg, 37.7% of African American and 40.1% White had LDL cholesterol <100 mg/dL, and 5.1% of African American and 7.3% of White met all three ADA goals (P <0.001 for race difference) at the baseline examination (i.e. the diagnosis of type 2 diabetes). When we used the mean measurements during a mean follow-up of 5.5 years after the diagnosis of diabetes, 52.3% of African American and 58.3% of White had HbA1c <7.0%, 19.2% of African American and 28.0% of White had blood pressure <130/80 mmHg, 40.9% of African American and 44.2% White had LDL cholesterol <100 mg/dL, and 5.5% of African American and 8.9% of White met all three ADA goals (P <0.001 for race difference) (Table 3)

DISCUSSION

The present study is a large-scale investigation of the attainment of the ADA CVD risk factor control goals in a biracial population of low income individuals. Our study suggested

that, during 2001–2009, this low income cohort with type 2 diabetes generally experienced improved attainment of ADA goals. White patients had better attainment of ADA CVD risk factors control goals than their African American counterparts.

It has long been known that people with type 2 diabetes have a 2–4 times greater risk for future CVD compared to people without type 2 diabetes [3–5]. CVD is the leading cause of morbidity/mortality and accounts for more than 70% of total mortality among patients with type 2 diabetes [8–10]. In order to prevent CVD and other complications of diabetes, the ADA recommends that adults with diabetes maintain an HbA1c <53 mmol/mol (7.0%), blood pressure <130/80 mmHg, and LDL cholesterol <2.6 mmol/L. This ADA recommendation reflects recent evidence from epidemiological studies and randomized controlled trials that controlling any single risk factor of HbA1c, blood pressure, or LDL cholesterol can reduce the development and progression of complications in patients with diabetes [10, 24–26]. Data from NHANES have indicated that control of blood glucose, blood pressure, and total cholesterol has been substantially improved among individuals with diabetes over the last 20 years [11, 12]. However, these ADA goals are seldom met in the US – 50% of American people with diabetes had HbA1c 53 mmol/mol (7.0%), 46.5% had blood pressure <130/80 mmHg, 58.7% had total cholesterol <5.2 mmol/L (not LDL cholesterol <2.6 mmol/L due to few samples with available LDL cholesterol information), and only 13.5% met all three goals in the NHANES 1999–2008 [11]. In the Look AHEAD Study, 45.8% of the participants had HbA1c <53 mmol/mol (7.0%), 51.7% had blood pressure <130/80 mmHg, 37.2% had LDL cholesterol<2.6 mmol/L, and only 10.1% met all three goals upon enrollment (2001–2004). Compared with participants in the previous studies, patients with type 2 diabetes in the current analysis have similar HbA1c control and LDL cholesterol control, but poorer blood pressure control and combined goals control. The lower socioeconomic status may partly account for this difference.

In the current study, African American patients type 2 diabetes were less likely to meet individual and all ADA goals compared with white patients with type 2 diabetes, which confirms the findings of previous studies [11, 13]. It has been shown that subjects' socioeconomic status and health care access may contribute to the racial difference observed in CVD risk factors and their relations to CVD risk. Results from the National Vital Statistics System [14] and the National Health Interview Survey [15] have indicated that patients with diabetes as well as the general population with low socioeconomic status had higher age-standardized death rates from all causes, CVD and cancer compared with those with high socioeconomic status. The Translating Research Into Action for Diabetes Study suggested that even in an insured population with good access to health care, family income remained an important predictor of health [16]. Since study populations in most of the previous studies have significant differences in socioeconomic status and access to health care between Whites and African Americans, these studies cannot fully avoid the potential bias in assessing racial disparities in CVD risk factors among patients with diabetes, even though socioeconomic status and access to health care were statistically controlled in their studies. Thus, the current study, in which the participants have the same health care access and similar socioeconomic status, provides a unique opportunity to investigate racial disparities in CVD risk factors among patients with diabetes. Results from the current study indicate that, besides socioeconomic status and health care access, other factors (for example

behavioural and genetic factors) may also contribute to the observed higher percentages of African Americans who had HbA1c, blood pressure and LDL cholesterol levels over the ADA recommended limits.

Previous studies usually investigated the control status of CVD risk factors in cross-sectional studies. These analyses were based on a single measurement of the CVD risk factors, which may produce potential bias. It has been shown that updated mean values of HbA1c, blood pressure, or LDL cholesterol during follow-up are more important predictors of CVD risk than a single baseline measurement [25, 27]. Therefore, in the current study, besides reporting the baseline control status of HbA1c, blood pressure, and LDL cholesterol, we also calculated the mean percentage of participants' attainment of the three ADA goals based on the updated mean values of HbA1c, blood pressure, or LDL cholesterol during follow-up. Our results suggest that both African American and White patients with type 2 diabetes had improved attainment of all three goals during follow-up.

There are several strengths of the present study, including the large sample size, high proportion of African Americans, long follow-up time, and the use of administrative databases to avoid the problem of differential recall bias. In addition, participants in this study use the same public health care system and have similar socioeconomic status, which minimizes the influence from the accessibility of health care, particularly in comparing African Americans and Whites. Moreover, mean values of HbA1c, blood pressure, or LDL cholesterol during follow-up were used to calculate the mean percentage of participants' attainment of ADA goals in this analysis, which can avoid potential bias from a single baseline measurement. One limitation of our study is that our analysis was not performed on a representative sample of the state of Louisiana's population which limits the generalizability of this study; however, LSUHCSD hospitals are public hospitals and cover over 1.6 million patients, most of which were low income persons in Louisiana. Nevertheless, the present study employed a cohort study design and reported both the baseline and mean percentages of attainment of the ADA goal in participants who received medical care from Louisiana public hospitals, which provides important information for understanding the scope of CVD risks in Louisiana, especially among those of low income. In addition, we cannot completely exclude the effects of residual confounding due to some unmeasured factors, such as occupations and education levels for each race.

In conclusion, the current study suggests that, although CVD risk factor control improved during the past decade, it remains suboptimal; thus, further efforts are required to improve outcomes among low income patients with diabetes. This study would drive further improvement in care because earlier recognition of the risk could provide an earlier opportunity to intervene, thereby delaying or preventing the progression to CVD, which can improve clinical outcomes and also achieve significant lifetime cost savings from reduced medication and healthcare utilization. In addition, despite equal access to care and the similar socioeconomic status, racial disparities still exist in the control state of the ADA CVD risk factors in this underinsured population with type 2 diabetes, which calls for further exploration of the possible reasons.

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Novelty Statement

The present study is the first large prospective study to assess the race-specific trend in attainment of the ADA cardiovascular risk factors control goals of patients with type 2 diabetes in low income population.

The present study showed that although cardiovascular risk factor control improved during the past decade, it remains suboptimal. Moreover, White patients had better attainment of the ADA cardiovascular risk factors control goals than their African American counterparts.

The results of the present study suggest that further efforts are required to improve outcomes and to reduce racial disparities among low income patients with type 2 diabetes.

Table 1

Baseline characteristics of African American and White men and women with type 2 diabetes in the Louisiana State University Hospital-based Longitudinal Study

Characteristics	Men		P value	Women		P value
	African American	White		African American	White	
No. of participants	5,633	5,447		9,313	7,311	
Age, mean (SD), y	50.8 (10.4)	54.4 (10.5)	<0.001	51.6 (10.3)	54.0 (10.7)	<0.001
Income, mean (SD), $/family	13,839 (14,776)	14,882 (14,289)	<0.001	11,484 (9,733)	13,276 (11,946)	<0.001
Body mass index, mean (SD), kg/m^2	31.6 (7.7)	33.3 (7.9)	<0.001	35.3 (8.7)	35.7 (9.1)	<0.001
Blood pressure, mean (SD), mm Hg						
Systolic	144 (25)	140 (22)	<0.001	146 (25)	141 (23)	<0.001
Diastolic	84 (14)	80 (13)	<0.001	82 (14)	77 (13)	<0.001
Total cholesterol, mean (SD), mmol/L	4.7 (1.4)	4.7 (1.4)	0.002	4.9 (1.2)	5.1 (1.3)	<0.001
High-density lipoprotein cholesterol, mean (SD), mmol/L	1.1 (0.4)	1.0 (0.3)	<0.001	1.2 (0.4)	1.1 (0.3)	<0.001
Low-density lipoprotein cholesterol, mean (SD), mmol/L	2.8 (1.1)	2.7 (1.0)	<0.001	3.1 (1.0)	3.0 (1.0)	<0.001
Triglycerides, mean (SD), mmol/L	1.6 (1.0)	1.9 (1.1)	<0.001	1.4 (0.8)	2.0 (1.0)	<0.001
HbA_{1c}, mean (SD), mmol/mol	67 (33)	57 (24)	<0.001	60 (27)	53 (22)	<0.001
HbA_{1c}, mean (SD), %	8.3 (3.0)	7.4 (2.2)	<0.001	7.6 (2.5)	7.0 (2.0)	<0.001
Current smoker (%)	44.0	43.0	0.040	28.6	35.6	<0.001
Types of health insurance (%)			<0.001			<0.001
Free of charge	72.3	68.8		81.6	78.8	
Self-pay	10.5	5.4		4.6	3.5	
Medicare	5.7	3.8		5.9	4.4	
Medicaid	9.3	17.4		6.2	10.3	
Commercial	2.2	4.6		1.8	3.2	
Medication use, %						
Blood pressure	90.8	92.0	0.862	94.5	91.9	<0.001
Diabetes	82.8	82.2	0.318	79.2	79.7	0.038
Cholesterol	67.8	77.3	<0.001	70.5	78.7	<0.001

Analyses were based on subjects with the target information. Values are adjusted for age.

Table 2

Percentage of patients with type 2 diabetes attaining ADA goals of cardiovascular risk factor control (HbA1c <53 mmol/mol [7.0%], blood pressure <130/80 mmHg, and LDL cholesterol <2.6 mmol/L) in the Louisiana State University Hospital-based Longitudinal Study from 2001 to 2009

	Year									P value
	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Number of participants										
African American	1,423	1,533	1,710	1,420	1,573	1,661	1,711	1,831	2,084	
White	936	1,043	1,340	1,327	1,424	1,591	1,655	1,593	1,849	
Total	2,359	2,576	3,050	2,747	2,997	3,252	3,366	3,424	3,933	
HbA1c										
African American	64.3	65.8	64.3	68.2	68.8	69.4	67.6	68.0	66.0	0.037
White	72.0	74.9	74.8	79.5	76.5	75.9	75.6	75.1	74.9	0.512
Total	68.1	70.2	68.5	74.1	72.9	72.8	71.9	71.7	70.6	0.019
Blood pressure										
African American	21.0	22.4	23.4	23.2	22.4	25.5	22.9	27.6	27.0	<0.001
White	30.8	31.4	29.9	33.0	31.7	30.2	30.8	32.3	35.4	0.043
Total	24.7	25.9	26.1	27.5	26.5	27.4	26.4	29.4	30.7	<0.001
LDL cholesterol										
African American	42.9	40.9	40.9	41.5	40.7	41.2	37.0	43.0	39.5	0.126
White	51.3	52.7	48.6	47.4	49.5	45.6	46.0	48.8	48.6	0.024
Total	46.5	45.8	44.4	44.3	44.8	43.1	41.1	45.4	43.5	0.008
All three										
African American	6.9	7.4	6.4	6.3	6.3	7.3	6.1	9.0	8.0	0.089
White	9.8	11.2	9.2	10.6	9.5	8.2	9.4	10.0	12.3	0.351
Total	8.2	9.1	7.8	8.6	8.0	7.8	7.8	9.5	10.2	0.046

HbA1c: glycosylated hemoglobin; LDL cholesterol: low-density lipoprotein cholesterol

Values are adjusted for age, BMI, smoking status, income, type of insurance, use of antihypertensive drugs, use of diabetes medications, and use of cholesterol-lowering agents.

Table 3

The baseline percentage and the mean percentage of patients with type 2 diabetes attaining ADA goals of cardiovascular risk factor control (HbA1c <53 mmol/mol [7.0%], blood pressure <130/80 mmHg, and LDL cholesterol <2.6 mmol/L) in the Louisiana State University Hospital-based Longitudinal Study.

	Men		Women		Total	
	African American	White	African American	White	African American	White
Total Sample						
Number of participants	5,633	5,447	9,313	7,311	14,946	12,758
Baseline						
None	23.6	19.9	23.0	17.9	23.3	18.6
HbA1c only	21.6	21.7	30.8	30.1	27.4	26.9
BP only	5.4	5.5	5.0	4.7	5.2	5.0
LDL cholesterol only	17.0	14.4	11.0	9.1	13.3	11.1
HbA1c + BP	5.3	7.4	7.6	10.7	6.7	9.5
HbA1c + LDL cholesterol	16.8	18.7	15.3	17.0	15.9	17.7
BP + LDL cholesterol	4.8	5.0	2.5	3.4	3.4	4.0
All three	5.5	7.5	4.8	7.1	5.1	7.3
P value	<0.001		<0.001		<0.001	
Follow-up						
None	25.4	19.2	24.7	18.5	25.0	18.8
HbA1c only	18.6	17.5	27.6	26.0	24.3	22.8
BP only	4.4	5.1	4.3	5.1	4.3	5.1
LDL cholesterol only	19.1	16.8	12.3	10.3	14.9	12.7
HbA1c + BP	4.3	6.9	6.6	10.3	5.7	9.0
HbA1c + LDL cholesterol	17.5	18.6	16.3	17.0	16.8	17.6
BP + LDL cholesterol	4.8	6.1	3.0	4.3	3.7	5.0
All three	5.9	9.7	5.2	8.5	5.5	8.9
P value	<0.001		<0.001		<0.001	

BP: blood pressure; HbA1c: glycosylated hemoglobin; LDL cholesterol: low-density lipoprotein cholesterol

Values are age, gender and type of insurance- standardized by the direct method to the African American population of this cohort (age groups: 30–44, 45–59, 60–74, and ≥ 75 years; gender groups: male and female; and insurance types: insured and not insured).