MILLIMAN REPORT

Racial disparities in preventive services for Medicare FFS beneficiaries with type 2 diabetes

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Executive Summary

Racial disparities in healthcare exist due to systemic inequalities such as differences in health insurance coverage, access to care, household income, education level, provider bias, and personal distrust in the quality of healthcare services, among other reasons (1) (2) (3) (4). Racial disparities are observed across the entire healthcare spectrum, from primary and preventive care to specialized procedures and mental health services (2) (3) (5) (6) (7).

Over 30 million Americans have type 2 diabetes mellitus (T2DM), with an additional 88 million estimated to have prediabetes. Regular preventive care can lower the risk of developing common diabetes complications, such as heart attacks, strokes, amputation, nephropathy, and retinopathy, and can lower the risk of developing certain comorbidities associated with T2DM, such as ischemic heart failure (8). T2DM disproportionately affects people of color, who also have worse outcomes with respect to diabetes management, treatment, and complications.

This study examines utilization of three preventive services for Medicare fee-for-service (FFS) beneficiaries with T2DM (a sample size of over 430,000 beneficiaries): hemoglobin A1C (HbA1c) testing, eye exams, and nephropathy care, by race, in five metropolitan areas in the United States. We measured racial disparities between Black and white Medicare beneficiaries receiving these three preventive services using the 2016-2018 Centers for Medicare and Medicaid Services (CMS) 100% Research Identifiable Files, after controlling for geography, age, sex, and low-income status. This study focuses only on racial disparities between Black and white beneficiaries, due to changes in race coding conventions over time in our source data for groups other than Black and white.

RACIAL DISPARITIES IN DIABETES CARE

This study showed that Black beneficiaries with T2DM were less likely than white beneficiaries, with statistical significance ($P<0.01$), to have received Medicare-paid preventive services, specifically HbA1c testing, eye exams, and nephrology care. This study controlled for individuals' geography, age, sex, and low-income status. We also found that:

- The prevalence of T2DM was higher in Black populations in each of the five metropolitan areas
  - Across the five metropolitan areas, the prevalence of T2DM was 35% for the Black population and 24% for the white population
- For white low-income beneficiaries, T2DM prevalence was 14% higher than for white non-low-income beneficiaries. However, for Black beneficiaries, low-income and non-low-income beneficiaries had almost the same T2DM prevalence
- More Black beneficiaries with T2DM were low-income (65%) compared to white beneficiaries with T2DM (41%) across the five metro areas
- Black females had the highest prevalence of T2DM (37%) whereas white females had the lowest (22%)
- Black beneficiaries with diabetes were on average five years younger than white beneficiaries with diabetes

Language used to describe race

Consistent with the Associated Press (AP) style guide, we capitalize Black when used in a racial, ethnic, or cultural sense throughout this paper, while leaving white in lowercase in the same context (9). When citing data from external references, we use the terms/race categories used in those sources for consistency. For example, our data source and external references use the term "Hispanic," which may include those of Latin American and/or European-Spanish descent (10). We use "Latinx/Hispanic" when referencing these sources. Additionally, some sources used the term "Asian," which may include those of South Asian or Filipino descent.

Background

RACIAL DISPARITIES IN THE U.S. HEALTHCARE SYSTEM

Many inter-related factors contribute to disparities in healthcare, including health insurance coverage, household income, education level, affordability and access to care and personal distrust in the healthcare system itself. In the past 20 years, there has been an increasing focus on race as a contributing factor to healthcare disparities. Collectively, these factors contribute to healthcare disparities across racial groups, and the consequences of these disparities accumulate over time. The result is a lasting burden of increased morbidity and mortality for those experiencing these disparities, persisting across generations. In this paper, we study the differences between Black and white beneficiaries with type 2 diabetes (T2DM) in their utilization of hemoglobin A1C (HbA1c) testing, eye exams, and nephropathy care in the Medicare fee-for-service (FFS) population.

Many of the factors contributing to healthcare disparities are rooted in systems that perpetuate these racial inequalities. It has been shown that Black and Latinx/Hispanic people, on average, have lower income and education levels, greater dependence on government-subsidized programs, and are more likely to be uninsured or under-insured, all of which are barriers to accessing health care (3). The U.S. Census reports that the 2019 median income for Black Americans was 63% that of white Americans (11), and, in 2019, more Black Americans lived in poverty (18.7%) than other race/ethnic groups (Latinx/Hispanic Americans, 15.7%; Asian Americans, 7.3%; white Americans, 7.3%) (4). Income differences can exacerbate healthcare disparities, as they may make patient cost-sharing less affordable and/or impede patients' healthcare services due to needing time off work, having a lack of transportation, or other similar barriers.

Provider bias, both conscious and unconscious, can have significant impact on patient health status, and has also been identified as a factor contributing to racial disparities in healthcare. Perceptions of racial discrimination in healthcare are more common among Black and Native American people than among white people, and, while white people perceive increasingly privileged treatment based on higher income and education levels, Black people report less privilege and more discrimination at higher income and education levels (1). According to one study, among all racial groups, those who reported cost prohibiting them from accessing medical care had a higher risk of perceived racial discrimination (1). Another study showed that people of color (excluding Asians and Pacific Islanders) were more likely than white people to report that their personal health status was fair or poor, that they had obesity, and that cost prohibited them from seeing a provider in the prior year (2).

Even within groups that have comparable income or health insurance coverage, there are reported disparities in how racial groups use and access healthcare. People of color have reported being less likely than non-Latinx/Hispanic white people to have a personal health care provider (2). After controlling for frequency and number of primary care visits, racial disparities persist in the utilization of many preventive care procedures (5). These discrepancies are present even among those with comparable private insurance coverage: a 2019 study found that privately-insured Black and Latinx/Hispanic members who reported poor or fair health had approximately five fewer office-based or hospital outpatient visits in a year than white members who reported similar health statuses (6). Black and Latinx/Hispanic members who reported excellent health also showed a disparity of approximately two fewer annual visits compared to white members who reported similar health status (6). Another study showed that, among those with similar access to care, diagnosis, and illness severity, Black and Latinx/Hispanic adults used services requiring provider authorization, such as invasive and operative procedures, at lower rates than their white counterparts (3). This pattern persists in mental healthcare as well: Black individuals are less likely to receive appropriate mental health care regardless of insurance and income (7).

In addition to a lower quantity of healthcare services provided to people of color, significant national economic losses are associated with racial health disparities each year (12). Racial disparities are associated with roughly $35 billion in additional healthcare costs due to poorer health outcomes, another $10 billion in lost productivity due to sickness, and almost $200 billion due to lost economic contributions from avoidable deaths (12). Although the 2010 Patient Protection and Affordable Care Act (ACA) led to improvements in access to healthcare services, these improvements did not manifest equally across racial groups (13). While non-Latinx/Hispanic white people had the greatest gains in healthcare access and utilization, data suggests that healthcare access for Black people, particularly Black women, did not improve significantly in the initial years of the ACA (13).

Some racial disparities in healthcare have become more prominent in recent years, such as the variability in the use of some preventive screenings and vaccinations (5). The COVID-19 pandemic has shed light on these healthcare inequalities; emerging data indicates that Black and Latinx/Hispanic Americans have higher cases per 100,000 and higher mortality per 100,000 compared to white Americans (14). As of May 2020, Black residents in New York City had an age-adjusted mortality rate due to COVID-19 that was nearly twice that of white residents (184 per 100,000 versus 93 per 100,000) (14).

As these statistics illustrate, the existence of racial disparities in healthcare is indisputable.

DIABETES: ONE OF AMERICA'S MOST PREVALENT CONDITIONS

There are two primary types of diabetes: type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). People with T1DM do not produce insulin, an essential hormone that regulates the amount of sugar in the blood, whereas people with T2DM produce insulin, but it is not used properly in the body (15). Roughly 34.2 million Americans have diabetes, about 90% to 95% of whom have T2DM (16). An additional 88 million adults are estimated to have prediabetes and are at increased risk of developing T2DM and other serious health problems (16). Over one quarter (26.8%) of Americans aged 65 and older are living with diabetes (16).

Regular preventive care can lower the risk of developing common diabetes complications, such as heart attacks, strokes, wounds, and ulcers that can progress to amputations, nephropathy, and retinopathy, and can lower the risk of developing certain comorbidities associated with T2DM, such as ischemic heart failure (8). The American Diabetes Association (ADA) recommends that people with diabetes receive regular preventive services, including regular hemoglobin A1C (HbA1C) monitoring and eye examinations (17).

RACIAL DISPARITIES IN THE POPULATION WITH DIABETES

Diabetes disproportionately affects people of color (18). According to the Centers for Disease Control and Prevention (CDC), recent data suggests that new diabetes cases in adults are higher among non-Latinx/Hispanic Black people (8.2 per 1,000), people of Latinx/Hispanic origin (9.7 per 1,000), and non-Latinx/Hispanic Asian people (7.4 per 1,000) compared to non-Latinx/Hispanic white people (5.0 per 1,000) (16). The number of new cases of T2DM among children aged 10 to 19 significantly increased from the 2002-2010 period, with the number increasing at a higher rate for non-Latinx/Hispanic Black people, people of Latinx/Hispanic origin, and non-Latinx/Hispanic Asian people and Pacific Islanders compared to non-Latinx/Hispanic white people (16).

Race is correlated with diabetes management, treatment, and complications. Black Americans with diabetes have a higher burden of mortality and illness than their white counterparts and have been shown to be less likely to receive HbA1c screening and eye exams, or to achieve adequate HbA1c control (19). The ADA reports that Black Americans are roughly 50% more likely than white Americans to develop diabetic retinopathy (20). CMS indicates that among people over the age of 65 with diabetes, fewer Black people report having their blood sugar under control all of the time (19.7%) compared to white people in the same group (29.9%) (18). People of color with diabetes also have poorer outcomes, including increased risk of developing end-stage renal disease (ESRD) and of requiring amputations (21). Studies have also shown that people of color, particularly Latinx/Hispanic and Black adults, are more likely to suffer severe complications and related emergency department (ED) visits due to their diabetes (22).

Although there are many published studies (as discussed above) on racial disparities in the US healthcare system, they are largely focused on the commercial population and therefore do not include most of the aged population, a cohort at the highest risk for diabetes complications. Many of these studies suffer from credibility issues such as self-reported metrics and small sample sizes or are outdated. There is a dearth of claims-based, quantitative research regarding racial inequalities of care among Medicare beneficiaries with T2DM.

- This study examines utilization of HbA1c testing, eye exams, and nephropathy care by race, among beneficiaries with T2DM in the Medicare FFS population in five metropolitan cities across the United States.

Findings

After accounting for differences in geography, age, sex, and low-income status, we found that among those with T2DM, Black beneficiaries were less likely than white beneficiaries to have received preventive care across all three preventive care measures (HbA1c testing, eye exams, and nephropathy care). The table in Figure 1 summarizes the regression coefficients, and the approximate effect of race on the measure outcome. The findings in Figure 1 were statistically significant for race (*P*<0.01).

We found Black beneficiaries with type 2 diabetes were approximately 8.8% less likely than white beneficiaries with type 2 diabetes to receive HbA1c testing, approximately 4.9% less likely to receive eye exams, and approximately 2.5% less likely to receive nephropathy care.

FIGURE 1. DISPARITIES IN PREVENTIVE SERVICES BETWEEN BLACK AND WHITE MEDICARE BENEFICIAIRES WITH DIABETES

Measure	Regression coefficients for Black beneficiaries with diabetes (white beneficiaries as control group)	Approximation of relative difference in likelihood of testing between Black and white beneficiaries with diabetes*
HbA1c testing	-0.3523 (*P*<0.01)	-8.8%
Eye Exam	-0.1968 (*P*<0.01)	-4.9%
Nephropathy Care	-0.0990 (*P*<0.01)	-2.5%

*Difference of Black from control (white), using Gelman's "divide by 4 rule" applied to regression coefficients (23)

There are also disparities across income statuses. The table in Figure 2 applies our logistic regression results to an illustrative male with diabetes between the ages of 80 and 84 living in Los Angeles. We include scenarios of Black compared to white and low-income compared to non-low-income and show the probability that he receives each preventive service. In this example, the low-income person, regardless of race, was less likely to receive these preventive services, though this difference was higher in the Black cohort. This table also illustrates the consistency of racial disparities, showing a lower likelihood of receiving preventive care for the Black cohort across both low-income and non-low-income groups.

FIGURE 2. ILLUSTRATION: HOW PROBABILITY OF RECEIVING A PREVENTIVE SERVICE VARIES BY RACE AND INCOME: A MALE WITH T2DM AGED 80-84 IN LOS ANGELES

Male with T2DM, 80-84, Los Angeles									
	HbA1c Testing			Eye Exams			Nephropathy Care		
	Non-LI*	LI*	Difference (LI - Non-LI)	Non-LI*	LI*	Difference (LI - Non-LI)	Non-LI*	LI*	Difference (LI - Non-LI)
White	86.1%	80.9%	-5.2%	70.9%	63.8%	-7.1%	93.6%	92.6%	-1.0%
Black	81.3%	74.9%	-6.4%	66.7%	59.2%	-7.5%	93.0%	91.9%	-1.1%
Difference (Black - White)	-4.8%	-6.0%		-4.2%	-4.7%		-0.6%	-0.7%	

*LI = Low-income

STUDY POPULATION DEMOGRAPHICS

Black beneficiaries with T2DM were younger than white beneficiaries with T2DM: the average age for beneficiaries with diabetes was 70.1 years for Black beneficiaries and 75.0 years for white beneficiaries. Consistent with prior research cited above, we found that T2DM disproportionately affects the Black Medicare FFS population. The prevalence of T2DM was higher in the black population in each of the five metropolitan areas. In total, the prevalence of T2DM was 35% for the Black population and 24% for the white population. T2DM prevalence among low-income white beneficiaries was 14% higher than T2DM prevalence among non-low-income white beneficiaries; low-income status made virtually no difference in the T2DM prevalence among the Black population. For more demographic detail of the study population, refer to the Appendix.

FIGURE 3: DEMOGRAPHICS SUMMARY

	Black	White
Average Age (Years)	**70.1**	**75.0**
Population Prevalence		
Overall	35.1%	24.1%
Income Status		
Low-Income	34.7%	34.3%
Non-Low-Income	36.0%	20.1%
Metro Area		
Atlanta	33.8%	20.6%
Chicago	35.2%	23.3%
Houston	38.3%	24.1%
Los Angeles	32.4%	25.5%
New York	36.2%	25.2%

Discussion

This study reinforces and expands on prior published findings (2) (5) that describe significant racial disparities in access to preventive diabetes care (i.e., HbA1c testing, eye exams, and nephropathy care). Regular preventive care can lower the risk of developing diabetes complications and can lower the risk of developing certain comorbidities associated with T2DM. Our results confirm that even after controlling for other factors including age, sex, race, low-income status, and geography, race persists as a statistically significant predictor of receiving studied diabetes care measures. Black beneficiaries with T2DM were 8.8% less likely to receive annual HbA1c screening, 4.9% less likely to receive appropriate diabetic retinopathy screening, and 2.5% less likely to receive recommended nephropathy care compared to white beneficiaries with T2DM. We interpret this to mean that being Black had a measurable, negative correlation with the likelihood of someone receiving recommended diabetic preventive care. This suggests that observed racial disparities in long-term outcomes, such as mortality, are likely connected to fundamental disparities in preventive care that have had far-reaching consequences. While the scope of this study is not to determine differences by metropolitan area, future research can be done to identify and quantify regional variation.

These results also support prior research that has demonstrated the negative impact of low-income status on health care access and quality (24). Our modeling calculated that among beneficiaries with T2DM, low-income beneficiaries overall were 9.5% less likely to receive appropriate HbA1c screening than non-low-income beneficiaries, 8.1% less likely to receive recommended diabetic eye exams, and 3.9% less likely to receive appropriate diabetic nephropathy screening. This is particularly troubling, as the data showed that Black beneficiaries were uniformly more likely to be low-income, thus suggesting that low-income Black beneficiaries are at a compounded risk of preventive care lapses as compared to other non-Latinx/Hispanic white or non-low-income groups. We did not account for possible compounding between variables such as income status and race, but our results suggest that disparities could be exacerbated between low-income Black beneficiaries and non-low-income white beneficiaries in a way that cannot be explained by race and income alone. It should be noted that Black beneficiaries had a lower likelihood than white beneficiaries of receiving preventive care services across both low-income and non-low-income groups, suggesting that income status does not protect against racial disparities.

It is worth noting that the average age of Black beneficiaries with diabetes was significantly lower than the average age of white beneficiaries with diabetes in the study population. Similar trends have been seen in other data sources (25). It is unclear whether this is due to differing trends in the onset of diabetes, such that Black beneficiaries are more likely to be diagnosed with diabetes at a younger age, or due to racial disparities in mortality that could have reduced the share of Black beneficiaries with advanced age in the sample. Nevertheless, it is concerning that Black beneficiaries, who were younger overall, demonstrated less frequent preventive care utilization than white beneficiaries, as these preventive measures result in better outcomes in the long term.

Taken together, these findings suggest systemic racial disparities in the health care system for people with diabetes. This is supported by existing research, both for people with diabetes and the population at large. There are many domains (biological, sociocultural, etc.) and levels of influence (individual, community, etc.) that can impact health outcomes and racial disparities (26).

Possible systemic factors include:

- Systemic racism in healthcare delivery and access
  - Conscious and unconscious provider bias that can affect provider behavior and treatment choice, such as recommending different treatment options based on assumptions about people's ability to adhere to a specific regimen (27)
  - A history of structural and medical racism toward people of color within the healthcare system, resulting in patient distrust and avoidance of care (28)
  - Poorer quality of care at facilities most frequently utilized by Black and low-income people (29)
  - Unequal access to consistent, high quality health insurance – people of color are less likely to have coverage through an employer, and more likely to have uninsured periods or to be on Medicaid
  - Limited access to adequate medical information and health education, resulting in low health literacy (30)
- Other systemic racism factors
  - Higher income is not entirely protective; there is a strong correlation between lower income and healthcare access, and Black people are disproportionately low-income
  - Race is also correlated with level of education, access to safe housing, and food security, all of which people of color have less access to and which impact access to healthcare services (3)
  - People with lower socioeconomic status, who are disproportionately people of color, are less likely to have the flexibility and resources to access care (e.g., transportation to and from appointments, aftercare)

In order to parse the effects of the many factors that could be contributing to these racial disparities, additional research is required on overall healthcare interaction and utilization rates, quality of care outcomes, and long-term clinical outcomes, by geographic area. A longitudinal cohort study using administrative claims data would allow for the ongoing examination of the effects of racial disparities in preventive care on continuing treatment, morbidity, and mortality. While there are other studies on racial disparities in diabetes that report similar findings, none of them use the complete national CMS-adjudicated claims datasets, representing 100% of all Medicare FFS paid claims across all lines of service. Other nationally representative CMS datasets lack reliable information on race and/or do not contain claims for all beneficiaries and all service categories. We believe this study underlines the need for further research to highlight racial disparities among people with diabetes and in the healthcare system overall, and to identify measurable interventions to reduce these disparities. Claims analyses provide real-world evidence of current and past healthcare patterns that can be used to support future systematic healthcare and policy reform. There is clear evidence that racial disparities in healthcare exist, leaving in their wake a burden of costs and diminished health outcomes for people of color and the healthcare system that persist across generations.

Limitations

We note the following limitations with this study:

1. The race variable contained in the CMS 100% Innovator Research (IR) dataset is the Beneficiary Race Code. It contains the values in the table in Figure 4.

FIGURE 4: BENEFICIARY RACE CODE VALUES

Code	Code value
0	Unknown
1	White (non-Latinx/Hispanic)
2	Black (non-Latinx/Hispanic)
3	Other
4	Asian, Asian American, or Pacific Islander
5	Latinx/Hispanic
6	North American Native

   This code uses data from the Social Security Administration (SSA's) master beneficiary record (MBR), which includes several definitions of race depending on the year in which a beneficiary was born (31). For those born between 1935 and 1980, the SSA only had three classifications of race: white, Black, and other (unknown was used for those who did not report race on the Social Security application form) (31). In 1980, the SSA expanded the race categories to the options shown in Figure 4 (31), but these definitions were not retroactively applied to all beneficiaries. Therefore, race data is not precise for races other than Black and white for the population studied. Additionally, each beneficiary has only one distinct value for this field, so we are unable to identify beneficiaries with more than one race.

2. The population used in this study consists of a sample of Medicare fee-for-service (FFS) beneficiaries who meet specific enrollment criteria described in the 'Data Sources and Methodology' section below. This represents only a portion of the total population with diabetes. Further research is needed on Medicare Advantage, commercial and Medicaid populations in order to examine whether these racial disparities persist in other insured or uninsured populations.

3. The results presented here are based on a population identified with T2DM using administrative claims data. The algorithm used to identify beneficiaries with T2DM looks for the presence of diabetes diagnosis codes over three years of data. It may not identify beneficiaries with T2DM who did not interact with a healthcare provider, or who were not appropriately coded for T2DM. However, we note that the overall T2DM prevalence rate (26%) and prevalence rates by race (35% among Black beneficiaries and 24% for white beneficiaries) determined in this study are consistent with other claims data studies on the Medicare FFS population (28% overall, 38% for Black beneficiaries, and 25% for white beneficiaries) (32). These rates are slightly lower than other sources that use survey data or health records to estimate the T2DM population, and others that quantify the entire population with diabetes (including T1DM) (16).

4. The algorithms described in the 'Data Sources and Methodology' section below look for the evidence of preventive services in claims data. We are unable to account for care that is not captured in the Medicare FFS claims data. For example, if a Medicare beneficiary received a preventive service that was paid for by coverage other than Medicare FFS (like the Veteran's Health Administration) or provided through public health services.

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Data Sources and Methodology

DATA SOURCES

CMS 100% Innovator Research Data Set

The CMS 100% Innovator Research (IR) dataset contains a Medicare eligibility file and all Medicare Parts A, B, and D paid claims for all Medicare FFS beneficiaries. We used 2016-2018 data years for this analysis.

METHODOLOGY

Using 2016 – 2018 Medicare FFS 100% sample data, we examined differences in use of preventive services between Black and white populations with T2DM in five metropolitan areas in the United States. We restricted the population to five metropolitan areas in an effort to have a comparable number of Black and white beneficiaries. We further limited the population to city limits within each metropolitan area to minimize the impact of differences in access to care between Black and white beneficiaries. We leveraged effectiveness of care measures defined by the National Committee for Quality Assurance (NCQA) (33) Healthcare Effectiveness Data and Information Set (HEDIS) to identify:

1. Testing for hemoglobin A1C (HbA1c)
2. Eye exams
3. Evidence of nephropathy care

LOGISTIC REGRESSION

We performed multivariable logistic regression analyses to determine the effect of race on use of the three preventive care services for Medicare FFS beneficiaries with T2DM.

Denominator identification

Beneficiaries for the HbA1c and nephropathy studies were required to be enrolled in Medicare Parts A, B, and D Medicare fee-for-service continuously for all months of the measurement year, from January 1, 2018 to December 31, 2018. Beneficiaries under the age of 18 and beneficiaries who died in 2018 were excluded. Beneficiaries were required to have a ZIP Code within the city limits of one of the following metro areas: Atlanta, Georgia; Chicago, Illinois; Houston, Texas; Los Angeles, California; or New York City, New York (see Figure 5 in the Appendix for definitions of city limits). Beneficiaries who had a Beneficiary Race Code other than 2 (Black) or 1 (white) were excluded.

Beneficiaries for the eye exam study included the same criteria as described above, but also required continuous enrollment in Medicare Parts A, B, and D from January 1, 2017 to December 31, 2017. The effectiveness of care measures for eye exams defined by the NCQA span a two-year period whereas for HbA1c and nephropathy care the effectiveness of care measures span a one-year period.

T2DM identification

Across the five metropolitan areas (Atlanta, Chicago, Houston, Los Angeles, and New York) we identified approximately 233,000 white and 92,000 Black Medicare FFS beneficiaries with T2DM.

We identified beneficiaries with T2DM by applying the following algorithm:

- **First**, identify beneficiaries with either type 1 or type 2 diabetes. Beneficiaries with diabetes could be identified in any of the following ways:
  - At least two outpatient, observation, emergency department (ED), or nonacute inpatient encounters (see Qualified Claims codes in the Supplemental Appendix) on different dates of service with a diagnosis of diabetes (see T1DM, T2DM, and Other Diabetes codes in the Supplemental Appendix)

  - At least one acute inpatient encounter (see Qualified Claims codes in the Supplemental Appendix) with a diagnosis of diabetes (see T1DM, T2DM, and Other Diabetes codes in the Supplemental Appendix)
  - Being dispensed hypoglycemic/antihyperglycemics/insulin (see Diabetes ID Drugs codes in the Supplemental Appendix) *and* have at least one outpatient, observation, ED, or nonacute inpatient encounter (see Qualified Claims codes in the Supplemental Appendix) with a diagnosis of diabetes (see T1DM, T2DM, and Other Diabetes codes in the Supplemental Appendix).
- **Second**, remove beneficiaries identified as having type 1 diabetes via any of the following:
  - At least one claim with a diagnosis code for T1DM (see T1DM codes in the Supplemental Appendix) and no diagnosis codes for T2DM (see T2DM codes in the Supplemental Appendix)
  - Have claims coded with diagnosis codes for both T1DM and T2DM (see T1DM and T2DM codes in the Supplemental Appendix) and the majority of diabetes codes are T1DM
- Any beneficiaries dispensed hypoglycemics/antihyperglycemics were automatically assigned to the type 2 diabetes population. Any beneficiaries initially identified as having type 1 diabetes who were not dispensed insulin were moved to the type 2 diabetes population.

The beneficiary's diabetes initial diagnosis date is the date of the first qualified claim used in identifying the adult with diabetes. Beneficiaries were required to have an initial diagnosis date in 2016 or 2017 to be included in the HbA1c/nephropathy study population and were required to have an initial diagnosis date in 2016 to be included in the eye exam study population. The most recent annual data available was for 2018, so that was used as our study year. Refer to the Measures Identification section below for more information on the years of data required for each measure.

The descriptive statistics used for the Study Population Demographics discussion in the Findings section above reflect beneficiaries with type 2 diabetes and an index date in 2016 or 2017.

STATISTICAL ANALYSIS

From the beneficiaries with T2DM identified within the denominator population we performed logistic regression analyses using SAS version 9.4 to examine the effect of race on three preventive measures, when adjusting for covariates (characteristics) of beneficiaries receiving preventive services. The examined outcomes were treatment for HbA1c testing, eye exams, and evidence of nephropathy care.

The following five covariates were included in each logistic regression to compare beneficiaries with T2DM who received preventive treatment and those who did not: age, sex, race, metro area, and low-income status. Reference categories in the logistic regression were assigned to white, New York metro area, age group 65 to 69, male, and non-low-income status. We used Andrew Gelman's "rule of 4" to approximate the effect of being Black on each outcome (23). Gelman's rule estimates the slope of the logistic curve at its maximum point to be the regression coefficient without the intercept divided by 4 (23).

Beneficiaries who reported missing values for one or more of the following covariates were excluded from this study: race, age, sex, and rural/urban.

Each of these covariates is described below.

Covariate descriptions

Covariates included in the regression models were defined as follows:

- Age distribution by five-year age band between 65 and 84. We aggregated ages 18 to 64 and those older than 85 in two additional age bands.
  - Age was assigned based on age as of December 31, 2018
- Sex is defined as male or female. Beneficiaries identified with unknown sex were excluded.
- Race is defined as Black or white. Medicare beneficiaries not identified as Black or white were excluded.
- Metro area included the following major cities and surrounding areas:
  - Atlanta, Georgia, which included Sandy Springs and Alpharetta, Georgia
  - Chicago, Illinois, which included Naperville and Evanston, Illinois

  - Houston, Texas, which included The Woodlands and Sugar Land, Texas
  - Los Angeles, California, which included Long Beach and Glendale, California
  - New York City, New York, which included Jersey City, New Jersey, and White Plains, New York
- Low-income is defined as those qualifying for the low-income subsidy (LIS) Medicare prescription drug (Part D) program for at least one month in 2018.

MEASURES IDENTIFICATION

We used effectiveness of care measures defined by the 2018 National Committee for Quality Assurance (NCQA) Healthcare Effectiveness Data and Information Set (HEDIS) (33). Specifically, we utilized three components of the HEDIS Comprehensive Diabetes Care measure, which look for annual hemoglobin A1c (HbA1c) testing, regular eye exams, and medical attention for nephropathy among people with diabetes.

For the HbA1c measure, individuals were considered compliant if they showed evidence of an HbA1c test during the measurement year.

For the eye exam measure, individuals were considered compliant if they had evidence of a retinal or dilated eye exam in the measurement year or in the year prior. This includes beneficiaries who had one of the following:

- A retinal or dilated eye exam by an eye care professional (optometrist or ophthalmologist) in the measurement year.
- A *negative* retinal or dilated eye exam (negative for retinopathy) by an eye care professional in the year prior to the measurement year.
- Bilateral eye enucleation anytime during the beneficiary’s history through December 31 of the measurement year.

Beneficiaries were considered to have received medical attention for nephropathy if they had evidence of a nephropathy screening or monitoring test or evidence of nephropathy in the measurement year. This includes beneficiaries who had one of the following:

- Treatment for nephropathy, including angiotensin converting enzyme (ACE) inhibitors and angiotensin II therapy
- End-stage renal disease (ESRD)
- Kidney transplant
- A claim for a visit with a nephrologist

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Appendix

FIGURE 5: METRO AREA DEFINITIONS

COUNTIES INCLUDED IN EACH METRO AREA

Atlanta	New York	Chicago	Los Angeles	Houston
Metropolitan Statistical Areas (MSA)				
Atlanta-Sandy Springs-Alpharetta, GA	New York-Jersey City-White Plains, NY-NJ	Chicago-Naperville-Evanston, IL	Los Angeles-Long Beach-Glendale, CA	Houston-The Woodlands-Sugar Land, TX
Counties				
Cherokee	Bronx	Cook	Los Angeles	Harris
Clayton	Kings			
Cobb	New York			
Dekalb	Queens			
Douglas	Richmond			
Fayette				
Fulton				
Gwinnett				
Henry				
Rockdale				

FIGURE 6: DESCRIPTIVE STATISTICS OF DENOMINATOR AND T2DM POPULATIONS

Preventive Care Measure	Denominator Population [N=1,545,399]	T2DM Population [N=437,626]
Age (years), N (%)		
Mean	**72.3**	**73.6**
<65	226,983 (14.7%)	61,072 (14.0%)
65-69	322,055 (20.8%)	76,810 (17.6%)
70-74	339,256 (22.0%)	94,637 (21.6%)
75-79	257,783 (16.7%)	79,754 (18.2%)
80-84	186,825 (12.1%)	61,716 (14.1%)
85+	212,497 (13.8%)	63,637 (14.5%)
Race, N (%)		
White, non-Latinx/Hispanic	967,669 (62.6%)	233,512 (53.4%)
Black, non-Latinx/Hispanic	262,566 (17.0%)	92,274 (21.1%)
Asian	114,034 (7.4%)	43,077 (9.8%)
Latinx/Hispanic	100,828 (6.5%)	37,725 (8.6%)
North American Native	1,563 (0.1%)	624 (0.1%)
Other	57,550 (3.7%)	20,463 (4.7%)
Unknown/Missing	41,189 (2.7%)	9,951 (2.3%)
Birth Sex, N (%)		
Male	636,735 (41.2%)	190,668 (43.6%)
Female	908,663 (58.8%)	246,958 (56.4%)
Low-income Status, N (%)		
Yes	675,970 (43.7%)	241,524 (55.2%)
No	869,429 (56.3%)	196,102 (44.8%)
Region, N (%)		
Atlanta-Sandy Springs-Alpharetta, GA	178,968 (11.6%)	43,834 (10.0%)
Chicago-Naperville-Evanston, IL	350,191 (22.7%)	95,502 (21.8%)
Houston-The Woodlands-Sugar Land, TX	145,075 (9.4%)	41,184 (9.4%)
Los Angeles-Long Beach-Glendale, CA	449,338 (29.1%)	133,534 (30.5%)
New York-Jersey City-White Plains, NY-NJ	421,827 (27.3%)	123,572 (28.2%)

FIGURE 7: DESCRIPTIVE STATISTICS OF OUTCOMES FOR EACH COVARIATE AND PREVENTIVE CARE MEASURE

Preventive Care Measure	HbA1C Test [N=325,786] Yes [N=276,196]	HbA1C Test [N=325,786] No [N=49,590]	Eye Exam [N=266,946] Yes [N=169,862]	Eye Exam [N=266,946] No [N=97,084]	Nephropathy Care [N=325,786] Yes [N=296,076]	Nephropathy Care [N=325,786] No [N=29,710]
Age (years), N (%)						
Mean	**73.7**	**73.3**	**75.1**	**72.7**	**73.7**	**72.2**
<65	35,932 (13.0%)	9,307 (18.8%)	16,877 (9.9%)	18,046 (18.6%)	39,472 (13.3%)	5,767 (19.4%)
65-69	47,875 (17.3%)	8,120 (16.4%)	22,675 (13.3%)	15,268 (15.7%)	50,437 (17.0%)	5,558 (18.7%)
70-74	63,093 (22.8%)	8,722 (17.6%)	40,557 (23.9%)	20,428 (21.0%)	65,988 (22.3%)	5,827 (19.6%)
75-79	52,676 (19.1%)	7,781 (15.7%)	36,209 (21.3%)	16,418 (16.9%)	55,894 (18.9%)	4,563 (15.4%)
80-84	39,664 (14.4%)	6,515 (13.1%)	27,854 (16.4%)	12,617 (13.0%)	42,715 (14.4%)	3,464 (11.7%)
85+	36,956 (13.4%)	9,145 (18.4%)	25,690 (15.1%)	14,307 (14.7%)	41,570 (14.0%)	4,531 (15.3%)
Race, N (%)						
White, non-Latinx/Hispanic	201,598 (73.0%)	31,914 (64.4%)	127,010 (74.8%)	65,648 (67.6%)	213,460 (72.1%)	20,052 (67.5%)
Black, non-Latinx/Hispanic	74,598 (27.0%)	17,676 (35.6%)	42,852 (25.2%)	31,436 (32.4%)	82,616 (27.9%)	9,658 (32.5%)
Birth Sex, N (%)						
Male	120,397 (43.6%)	21,616 (43.6%)	71,919 (42.3%)	42,806 (44.1%)	129,451 (43.7%)	12,562 (42.3%)
Female	155,799 (56.4%)	27,974 (56.4%)	97,943 (57.7%)	54,278 (55.9%)	166,625 (56.3%)	17,148 (57.7%)
Low-income Status, N (%)						
Yes	126,093 (45.7%)	28,901 (58.3%)	74,153 (43.7%)	53,010 (54.6%)	138,892 (46.9%)	16,102 (54.2%)
No	150,103 (54.3%)	20,689 (41.7%)	95,709 (56.3%)	44,074 (45.4%)	157,184 (53.1%)	13,608 (45.8%)
Region, N (%)						
Atlanta, GA	34,793 (12.6%)	5,351 (10.8%)	20,573 (12.1%)	12,775 (13.2%)	36,965 (12.5%)	3,179 (10.7%)
Chicago, IL	68,482 (24.8%)	12,421 (25.0%)	43,790 (25.8%)	23,592 (24.3%)	73,372 (24.8%)	7,531 (25.3%)
Houston, TX	27,729 (10.0%)	5,260 (10.6%)	15,536 (9.1%)	11,300 (11.6%)	30,113 (10.2%)	2,876 (9.7%)
Los Angeles, CA	64,818 (23.5%)	14,173 (28.6%)	39,965 (23.5%)	23,753 (24.5%)	72,088 (24.3%)	6,903 (23.2%)
New York, NY	80,374 (29.1%)	12,385 (25.0%)	49,998 (29.4%)	25,664 (26.4%)	83,538 (28.2%)	9,221 (31.0%)

FIGURE 8: T2DM PREVALENCE

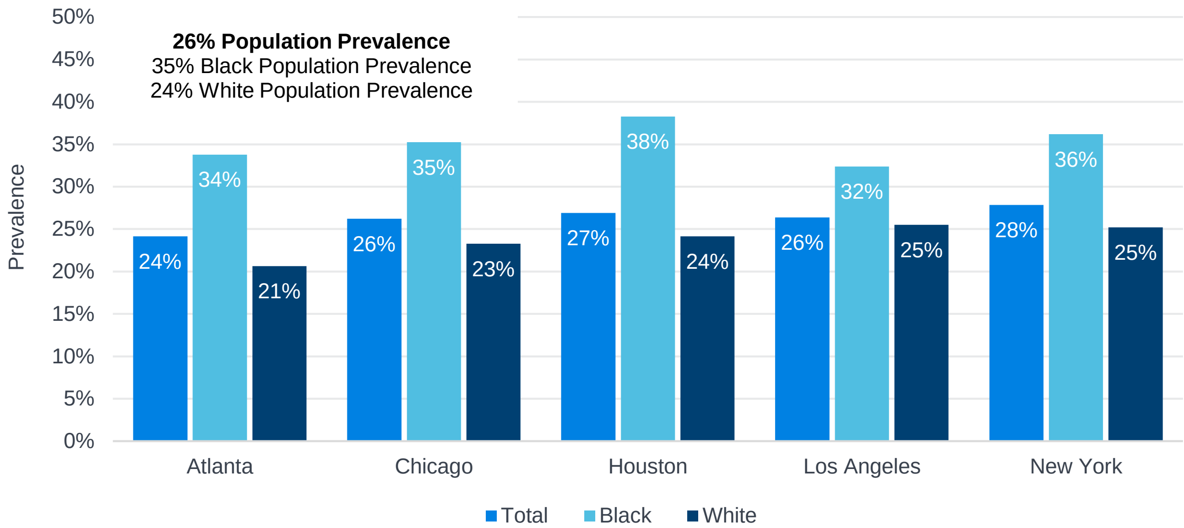


FIGURE 9: T2DM PREVALENCE BY SEX

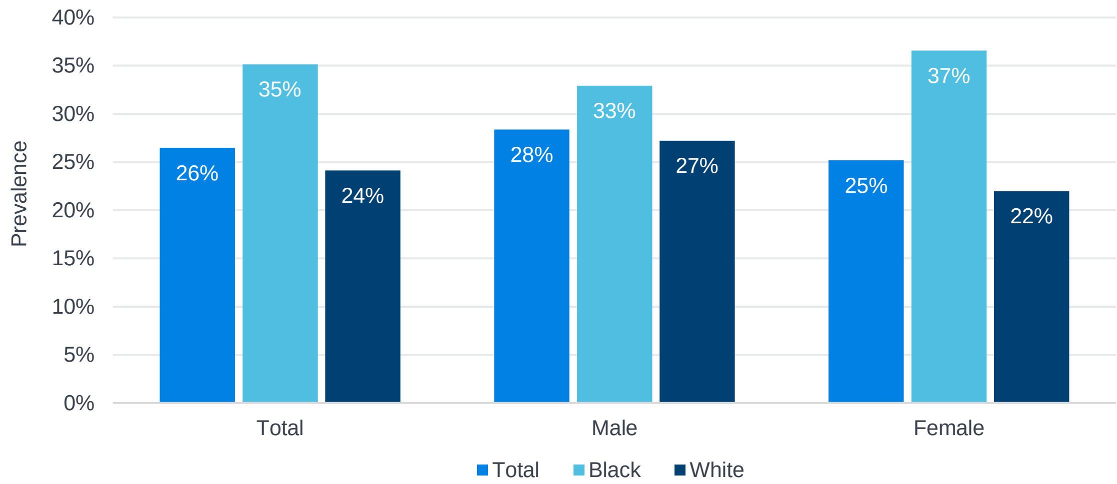
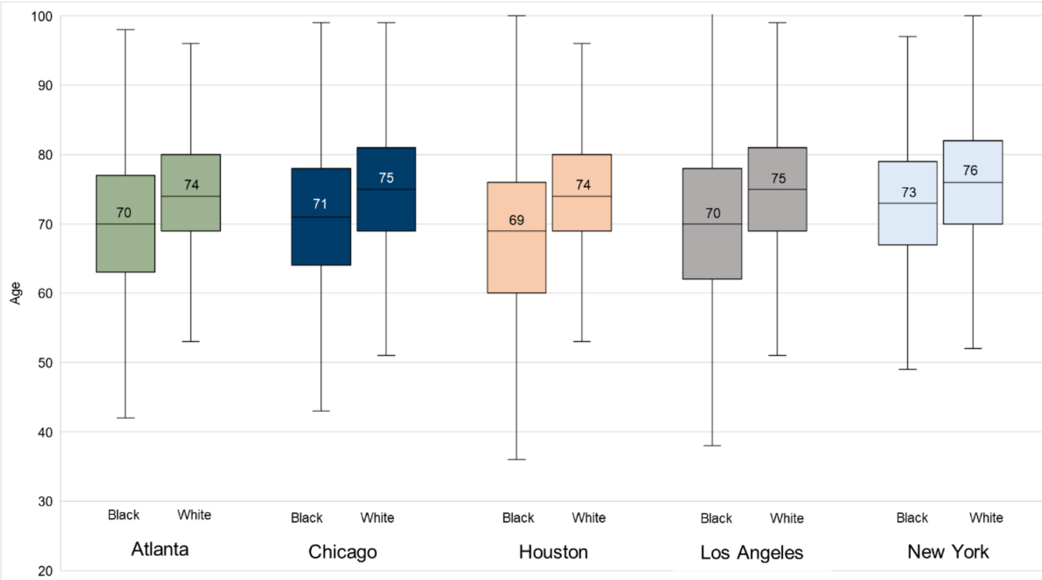
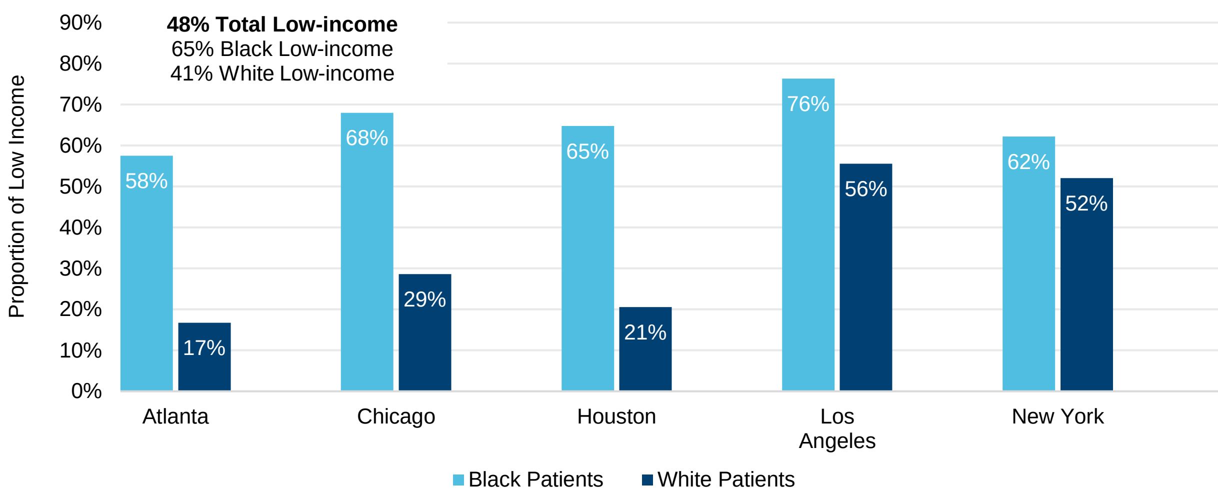


FIGURE 10: AGE DISTRIBUTION BY METRO AREA



Note: The lower and upper bounds of the box represent the 25th and 75th percentiles, respectively; the lower and upper bounds of the whiskers represent the 5th and 95th percentiles, respectively

FIGURE 11: LOW-INCOME STATUS BY METRO AREA



Please see the Supplemental Appendix for full ICD-10-CM and National Drug Code (NDC) code lists.