CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES
OFFICE OF MINORITY HEALTH

DATA HIGHLIGHT
NO. 25 | SEPTEMBER 2021

# Disparities in Diabetes Care Among Medicare Fee-for-Service Beneficiaries

## Introduction

Diabetes disproportionately affects racial and ethnic minority populations in both prevalence and health outcomes.[1,2] Additionally, social determinants of health (SDOH), which Healthy People 2030 defines as "the conditions in the environments where people are born, live, learn, work, play, worship, and age,"[3] impact the prevalence and management of chronic conditions, including diabetes.[4,5] Understanding the extent of disparities by race, ethnicity and SDOH is a critical step in advancing health equity among people with diabetes.

The prevalence of diabetes in the Medicare Fee-for-Service (FFS) population remained relatively steady from 2012–2018 (32.2% to 27.7%) but was almost triple the overall national prevalence of diabetes (10.5%). In 2018, the prevalence of diabetes was higher among American Indian/Alaska Native (AI/AN) (40%), Hispanic (38%), Black/African American (38%) and Asian/Pacific Islander (API) (37%) Medicare FFS beneficiaries than White (25%) beneficiaries.[6] These disparities in diabetes prevalence among the Medicare FFS population mirror overall national disparities reported by the American Diabetes Association.[2,7]

Disparities also exist in quality of diabetes care (e.g., receipt of recommended screenings, blood pressure or glycemic control) and diabetes-related health outcomes such as hospitalizations for complications of diabetes. Compared to non-Hispanic White individuals with diabetes, non-Hispanic Black individuals[i] in the general and Medicare populations have lower rates of meeting glycemic and blood pressure control targets.[1,8]

Additionally, individuals with diabetes who experience housing insecurity are at greater risk for diabetes-related hospitalization.[9,10] Other SDOH factors, such as access to food, income and education level, are also associated with diabetes prevalence and outcomes.[4] Studies have shown that individuals living in distressed neighborhoods (e.g., low income, low graduation rates) and in rural areas are more likely to develop diabetes and experience worse health outcomes than those living in better-resourced and more advantaged neighborhoods.[11–15]

This data highlight examines disparities in quality of diabetes care and preventable utilization of health care services (emergency department [ED] visits and hospitalizations) by race, ethnicity and SDOH factors in the Medicare FFS population. The results may help inform efforts to increase equity in diabetes care, including policies regarding value-based programs and incentives focused on eliminating disparities.

## Key Findings

Among Medicare FFS beneficiaries:

- Black and AI/AN beneficiaries were more likely to experience potentially preventable complications of diabetes requiring emergency department (ED) or hospital care than White beneficiaries
- Black beneficiaries were also less likely to receive recommended diabetes care than White beneficiaries
- Beneficiaries who were dually eligible for Medicare and Medicaid were less likely to have a retinal eye exam or adhere to statin therapy and more likely to have diabetes complications resulting in ED or hospital care, compared to beneficiaries who were not dually eligible
- Compared to beneficiaries living in very low poverty neighborhoods, those in moderate or high-poverty neighborhoods were less likely to receive recommended diabetes care

Data Source: Medicare FFS claims data for 6,957,566 beneficiaries with diabetes.

[i] When citing other research in the introduction and discussion, we refer to racial and ethnic groups as described in the cited works, e.g. "White" vs "non-Hispanic White." In the descriptions of new analyses conducted in this study, we use White, Black, Hispanic, API, AI/AN and Other, consistent with other CMS publications.

# Methods

This study examined disparities in diabetes care quality and health care utilization for potentially preventable complications of diabetes by race and ethnicity, dual eligibility, rurality of residence and neighborhood-level poverty, education and English proficiency among Medicare FFS beneficiaries, using two sources of data. Beneficiary-level characteristics (race and ethnicity, dual eligibility, rurality and health care utilization) were ascertained using 2017 claims data from the CMS Virtual Research Data Center's Chronic Conditions Data Warehouse (CCW) (www.ccwdata.org). The CCW includes the 100% sample of Medicare FFS institutional and noninstitutional claims, enrollment, eligibility, assessment data and Medicare Part D prescription drug event data. Additionally, 2017 American Community Survey (ACS) five-year estimate files were analyzed to examine neighborhood-level SDOH factors: poverty rate, median educational attainment and proportion with limited English proficiency (Table 1, Appendix 1).

## Quality Measures

- *Retinal Eye Exam*: Beneficiaries had a retinal or dilated eye examination.
- *Received Statin Therapy:* Beneficiaries were dispensed at least one statin medication of any intensity.
- *Statin Adherence:* Beneficiaries remained on a statin medication of any intensity for at least 80% of the treatment period.

## Health Care Utilization Measures

- *ED Utilization for Potentially Preventable Complications of Diabetes:* Beneficiaries with diabetes and an ED visit for a potentially preventable complication of diabetes as their primary diagnosis, for which the ED visit did not result in an inpatient stay.
- *IP Utilization for Potentially Preventable Complications of Diabetes:* Beneficiaries with diabetes and an acute IP or observation stay for a potentially preventable complication of diabetes (any diagnosis).

The study population consisted of 6,957,566 Medicare FFS beneficiaries with type 1 or type 2 diabetes who were 18 years of age or older as of December 31, 2017.[16] Different subsets of these beneficiaries were included in analyses for each quality of diabetes care measure because the eligible age range varies by measure (Appendix 2).

Quality of diabetes care was assessed using three Health Effectiveness Data and Information Set (HEDIS®[ii]) measures:[16] Retinal Eye Exam, Receipt of Statin Therapy and Adherence to Statin Therapy. Two measures of health service utilization were analyzed: ED and inpatient (IP) utilization for potentially preventable complications of diabetes. Potentially preventable complications were defined as short-term complications, long-term complications, uncontrolled diabetes and lower extremity amputations (Appendix 2). For simplicity, in the rest of this report we refer to "potentially preventable complications of diabetes" as "complications of diabetes."

Separate multivariable logistic regression analyses were used to examine the association of race, ethnicity and SDOH factors with each quality or health care utilization measure. First, three separate models were estimated for the diabetes quality of care measures. These models included only the race, ethnicity and SDOH factors as covariates. The analytic sample was then stratified by age into beneficiaries 18–64 years of age and 65 and older. Models for the ED and IP utilization measures were estimated in each stratum, for a total of four models. In addition to race, ethnicity and SDOH covariates, the health care utilization models were also risk-adjusted by controlling for age, sex and 31 Elixhauser comorbidities.[17,18] Analyses were conducted using SAS (V.7.1; SAS, Cary, NC).

Results were summarized using adjusted odds ratios (OR) and their 95% confidence intervals (95% CI). Due to the large sample size and number of statistical comparisons, a combination of methods was used to highlight results that were both *statistically significant* and of sufficient magnitude that they were likely to be *clinically meaningful*. Highlighted

[ii] HEDIS® is a registered trademark of the National Committee for Quality Assurance (NCQA).

results met three criteria: 1.) They were statistically significant at $p$ <0.0033[iii]; 2.) they had an OR estimate ≥1.100 (or its inverse, ≤0.909); and 3.) they had a lower bound of the OR 95% CI ≥1.05 (or its inverse, the upper bound of the 95% CI ≤0.952).

**Table 1: Availability of Demographic and SDOH Information**

| Demographic or SDOH Variable | Source | Categories |
|---|---|---|
| Race and ethnicity | Enrollment | **White**, Black, Hispanic, API, AI/AN, Other |
| Dual eligibility | Enrollment | **Non-dual**, Dual |
| Rurality of residence | Address | **Metro**, Micro, Non-CBSA |
| *Neighborhood* poverty | ACS | **Very Low (≤9%)**, Low (>9%–14%), Moderate (>14%–20%), High (>20%) |
| Median *Neighborhood* educational attainment | ACS | < High school, High school, Some college, **Bachelor's degree or higher** |
| *Neighborhood* limited English proficiency | ACS | **Very Low (≤1.2%)**, Low (>1.2% to 3.2%), Moderate (>3.2% to 8.0%), High (>8.0%) |

***Note:*** Reference categories appear in **bold text**. ACS = American Community Survey. CBSA = Core-based statistical area. API = Asian or Pacific Islander. AI/AN = American Indian or Alaska Native

For additional information, see Appendix 1.

# Results

Bar charts presenting the prevalence of diabetes by demographic or SDOH category among Medicare FFS beneficiaries appear in Appendix 3. About 24% of the Medicare FFS population aged 18-75 had diabetes (as defined by HEDIS in 2017). The prevalence of diabetes was higher among beneficiaries who were Black, Hispanic, API, AI/AN or whose race was recorded as "Other," compared to White beneficiaries. Diabetes prevalence was also higher among beneficiaries who were dually eligible (compared to those who were not), and among those living in neighborhoods with high levels of poverty or with median educational attainment of high school or less, compared to those living in areas with relatively low poverty rates and higher median education levels. The strength and direction of the associations between race, ethnicity and SDOH factors and quality of diabetes care are summarized using a heat map in Table 2. A heat map is a graphical representation of data where colors represent the direction of an association and shading represents the strength of an association. Red cells indicate undesirable outcomes (i.e., less likely to receive recommended care or more likely to experience potentially preventable complications of diabetes resulting in ED or IP use in comparison to the reference group); green cells indicate desirable outcomes compared to the reference group. Regarding color shading, light cells indicate weak associations, medium cells indicate moderate associations and dark cells indicate strong associations. Results for the ED and IP utilization measures appear in Table 3. Full numeric results from these models are presented in Appendices 4–6.

Overall, Black beneficiaries and dually eligible beneficiaries were less likely to receive recommended diabetes care and more likely to experience complications of diabetes resulting in ED and IP utilization, compared to White beneficiaries and beneficiaries who were not dually eligible, respectively. Additionally, residents of moderate and high-poverty neighborhoods had slightly worse quality of diabetes care compared to residents of very low-poverty neighborhoods. Residents of neighborhoods with median educational attainment of high school or less had much

[iii]The threshold used results from dividing the commonly-used p <0.05 threshold by the number of comparisons (15). This approach is referred to as a Bonferroni correction.

worse rates of retinal eye exams and slightly worse rates of statin adherence, compared to residents of neighborhoods with median educational attainment of a bachelor's degree or higher.

Neither poverty rates nor median educational attainment were consistently associated with preventable ED or IP utilization. Although included in the regression models, neighborhood-level limited English proficiency and rurality of residence did not have associations that met the study's criteria for clinically meaningful differences; therefore, these variables were omitted from the summary tables.

Additionally, we found relatively weak and inconsistent evidence of disparities among beneficiaries with diabetes with respect to ever receiving statins, but much more consistent evidence of disparities in statin adherence. Black, Hispanic and AI/AN beneficiaries were much less likely to adhere to statins, compared to White beneficiaries.

**Table 2: Demographic Characteristics and Social Determinants of Health Associations With Quality of Diabetes Care Measures**

| | | Quality of Care Measures | | |
|---|---|---|---|---|
| | | Retinal Eye Exam | Receipt of Statin Therapy | Statin Adherence |
| Race and ethnicity (ref=White) | Black | Slightly worse | Slightly worse | Much worse |
| | Hispanic | | | Much worse |
| | API | Slightly better | Much better | Slightly worse |
| | AI/AN | Moderately better | Slightly worse | Much worse |
| Dual Eligibility (ref=Not Dual) | Dual | Moderately worse | | Slightly worse |
| Neighborhood Poverty Level (ref=Very Low) | Low | Slightly worse | | |
| | Moderate | Slightly worse | Slightly worse | Slightly worse |
| | High | Slightly worse | Slightly worse | Slightly worse |
| Neighborhood Education (ref=Bachelor's+) | ≤High school | Much worse | | Slightly worse |
| | Some college | Slightly worse | | |

Legend:

| Worse Quality | | Better Quality | |
|---|---|---|---|
| Slightly worse | OR 0.834–0.909 | Slightly better | OR 1.100–1.199 |
| Moderately worse | OR 0.770–0.833 | Moderately better | OR 1.200–1.299 |
| Much worse | OR ≤0.769 | Much better | OR ≥1.300 |

White cells indicate OR is similar to the reference group. Colored cells, in addition to the ranges shown in the legend, indicate a lower confidence interval bound ≥1.050 (green) or an upper confidence interval bound ≤0.952 (red).

API = Asian or Pacific Islander; AI/AN = American Indian or Alaska Native

Appendix 4 contains detailed results (adjusted odds ratios and confidence intervals) for these analyses.


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**Table 3: Demographic Characteristics and Social Determinants of Health Associations With Emergency Department (ED) and Inpatient (IP) Utilization for Potentially Preventable Complications of Diabetes**

| | | ED Utilization | | IP Utilization | |
|---|---|---|---|---|---|
| | | 18-64 | 65+ | 18-64 | 65+ |
| Race and ethnicity (ref=White) | Black | Moderately more likely | Much more likely | | Much more likely |
| | Hispanic | Slightly more likely | Slightly more likely | Slightly less likely | |
| | API | Moderately less likely | Much less likely | Much less likely | Much less likely |
| | AI/AN | Moderately more likely | Much more likely | | Much more likely |
| Dual Eligibility (ref=Not Dual) | Dual | Moderately more likely | Much more likely | Slightly more likely | Much more likely |
| Neighborhood Poverty Level (ref=Very Low) | Low | | | | |
| | Moderate | Slightly more likely | | | |
| | High | Slightly more likely | | | |
| Neighborhood Education (ref=Bachelor's+) | ≤High school | | | | |
| | Some college | | | | |

| Legend | Less Likely to Have Any Utilization | | More Likely to Have Any Utilization | |
|---|---|---|---|---|
| | Slightly less likely | OR 0.834–0.909 | Slightly more likely | OR 1.100–1.199 |
| | Moderately less likely | OR 0.770–0.833 | Moderately more likely | OR 1.200–1.299 |
| | Much less likely | OR ≤0.769 | Much more likely | OR ≥1.300 |

White cells indicate OR is similar to the reference group. Colored cells, in addition to the ranges shown in the legend, indicate a lower confidence interval bound ≥ 1.050 (red) or an upper confidence interval bound ≤ 0.952 (green).

API = Asian or Pacific Islander; AI/AN = American Indian or Alaska Native

Appendix 5 (18–64 years) and Appendix 6 (65-plus years) contain detailed results (adjusted odds ratios and confidence intervals) for these analyses.

*Race and Ethnicity*

Black beneficiaries with diabetes were significantly less likely to receive all three aspects of recommended diabetes care, with particularly large differences observed in statin adherence, relative to White beneficiaries. Additionally, Black beneficiaries 65 and older were more likely to use both ED and IP services for complications of diabetes, and Black beneficiaries 18–64 were also more likely to use ED services, compared to White beneficiaries in the same age groups.

Hispanic beneficiaries were less likely to adhere to statin therapy and were more likely to have complications of diabetes that resulted in use of ED services, relative to White beneficiaries. Younger (18–64) Hispanic beneficiaries, however, were less likely to experience complications of diabetes resulting in IP use compared to White beneficiaries in the same age group.

Results with respect to receiving recommended diabetes care were mixed among API beneficiaries, who were less likely than their White counterparts to adhere to statin therapy but more likely to receive a retinal eye exam or receive statin therapy. They were also less likely to experience complications of diabetes resulting in ED and IP utilization than White beneficiaries.

AI/AN beneficiaries were less likely to receive and adhere to statin therapy but were more likely to have a retinal eye exam than White beneficiaries. AI/AN beneficiaries 65 and older were more likely to experience complications of diabetes resulting in ED and IP use, and AI/AN beneficiaries younger than 65 were more likely to experience complications resulting in use of ED services, compared to White beneficiaries in the same age groups.

*Dual Eligibility*

Beneficiaries with diabetes who were dually eligible for Medicare and Medicaid were less likely to have a retinal eye exam and adhere to statin therapy than beneficiaries who were not dually eligible. Furthermore, dually eligible beneficiaries were more likely to experience complications of diabetes resulting in the use of ED and IP services, particularly among beneficiaries 65 and older, compared to beneficiaries in the same age group who were not dually eligible.

*Neighborhood Poverty*

Beneficiaries with diabetes living in moderate or high-poverty neighborhoods were less likely to receive recommended diabetes care than beneficiaries living in very low poverty neighborhoods. Differences with respect to service utilization measures were less consistent, however. Beneficiaries younger than 65 years living in moderate or high-poverty neighborhoods were more likely to experience complications of diabetes resulting in ED use than those living in very low poverty neighborhoods and in the same age group, but no other clinically meaningful disparities were observed.

*Neighborhood Education*

Beneficiaries living in neighborhoods with a lower median education (high school or less or some college) were less likely to have a retinal eye exam than beneficiaries living in neighborhoods with a higher median education (at least a bachelor's degree). Beneficiaries living in neighborhoods where the median educational attainment was a high school diploma or less were also less likely to adhere to statin therapy, compared to residents of neighborhoods with median educational attainment of a bachelor's degree or higher. There were no clinically meaningful disparities observed for ED or IP utilization.

*Rurality and Neighborhood Limited English Proficiency*

No clinically meaningful differences in receipt of recommended diabetes care or utilization for complications of diabetes were observed with respect to rurality or limited English proficiency.


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# Conclusion

Social and demographic factors shape access to and quality of health care, contributing to the systematic health disparities experienced by people with chronic conditions like diabetes. This study analyzes disparities in both quality of diabetes care and health care utilization for complications of diabetes, using data on nearly 7 million Medicare FFS beneficiaries and a broad range of SDOH and demographic factors. Overall, the most consistent disparities were observed with respect to race and ethnicity, dual-eligibility status and neighborhood poverty level. Black beneficiaries (compared to White beneficiaries), dually eligible beneficiaries (compared to beneficiaries who were not dually eligible) and residents of moderate and high-poverty neighborhoods (compared to residents of very low-poverty neighborhoods) were generally less likely to receive recommended diabetes care and more likely to experience complications of diabetes that resulted in use of ED and IP services. Additionally, AI/AN beneficiaries were less likely to receive or adhere to statin therapy and more likely to utilize ED and IP services for complications of diabetes, compared to White beneficiaries.

Analyses also found no clinically meaningful associations between either rurality or neighborhood level of English proficiency and the selected quality of diabetes care or health care utilization measures analyzed in this study. However, there were small but statistically significant associations for some measures; for example, residents of micropolitan and non-core-based statistical area (non-CBSA) regions had lower odds of receiving retinal eye exams or statin therapy, compared to residents of Metropolitan areas. These findings of small differences by rurality are consistent with prior work showing that urban-rural disparities in receipt of diabetes care were not significant after controlling for other patient-level characteristics.[19]

These results take on new significance in light of the novel coronavirus (COVID-19) pandemic. Most recently, surveillance efforts have demonstrated that the COVID-19 pandemic has disproportionately impacted Black/African American and Hispanic communities.[20–22] Diabetes, a condition that is more prevalent in racial and ethnic minority populations, has also been reported as a risk factor for increased SARS-CoV-2 severity and hospitalization.[23,24] COVID-19 disparities have thus shed light on long-standing racial and ethnic inequities in health care that predate the pandemic.

There are several limitations to this study. These analyses were cross-sectional, limiting the ability to infer causal relationships of race, ethnicity and SDOH variables with the quality of diabetes care and downstream health service utilization. It is possible that the associations in this report may be confounded by unobserved beneficiary or neighborhood characteristics, like health literacy[25], which are important topics for future work. Future research should consider including additional demographic characteristics, SDOH factors and area-level factors like availability of health care providers. Additionally, the Research Triangle Institute (RTI) race variable used in this study accurately identifies Hispanic, White and Black Medicare beneficiaries, but has relatively low validity for API and AI/AN beneficiaries.[26] This measurement error in race and ethnicity could bias these results. Finally, this study identified disparities but did not examine the mechanisms by which disparities occurred.

Taken together, these findings indicate that there are disparities in diabetes care quality and health services utilization for complications of diabetes, particularly among Black beneficiaries, dually eligible beneficiaries and those living in higher-poverty areas. Findings suggest three areas of action for future consideration and research.

First, efforts to expand comprehensive and consistent collection of standardized demographic and SDOH data will support work to identify disparities and facilitate work to mitigate them. Although this study considered a broader range of demographic and SDOH factors than are typically available to researchers, many relevant variables (such as educational attainment) had to be assigned at the neighborhood level rather than be observed at the individual beneficiary level. Efforts to improve equity in diabetes care would be greatly strengthened by standardizing sociodemographic data collection. This echoes recommendation 1.1 from the March 2020 HHS Assistant Secretary for Planning and Evaluation's (ASPE) March 2020 report, *Social Risk Factors and Performance in Medicare's Value-Based Purchasing Program*.[27]

Second, future research should aim to identify the mechanisms by which demographic characteristics and SDOH shape diabetes care disparities. The results presented in this data highlight do not identify how disparities emerge.

For example, are disparities the result of the same providers treating patients of different race and ethnic groups differently, or do disparities emerge because patients of different race and ethnic groups receive care from different providers? Prior research indicates that some disparity in diabetes outcomes by race is attributable to within-physician differences.[28] Research using a similar within- vs. between-provider approach to study the source of disparities has also been used to study care provided by hospitals.[29] Identifying these mechanisms is critical for designing targeted policy solutions and clinical interventions to reduce disparities.

Third, results point to the need for evidence-based quality improvement efforts to mitigate the adverse effects of social risk factors and reduce disparities. Relatively consistent disparities in diabetes quality of care and health service utilization for Black beneficiaries, dually eligible beneficiaries and those living in higher-poverty neighborhoods suggest that interventions targeted to these groups may yield disproportionate benefits in terms of increasing equity in diabetes care. Previous reports have highlighted interventions (including home visits from community health workers and culturally-tailored diabetes education programs) that show success in improving diabetes health outcomes and may help reduce disparities.[30]


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Paid for by the U.S. Department of Health and Human Services.

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Paid for by the U.S. Department of Health and Human Services.

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**Suggested Citation**
Philip Saynisch, Kelsy Kinderknecht, Amy Storfer-Isser, Denys Lau, Theresa Hwee and Meagan Khau. Disparities in Diabetes Quality of Care and Potentially Preventable Utilization Among Medicare FFS Beneficiaries. CMS OMH Data Highlight No.25. Baltimore, MD: CMS Office of Minority Health. 2021.



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# Appendix

## Appendix 1. Race, Ethnicity and Social Determinants of Health Variable Descriptions

*Variables from the Chronic Conditions Warehouse (CCW)*

The following section provides descriptions of race, ethnicity and the SDOH variables included in these analyses.

- *Race and ethnicity* were based on the master beneficiary summary file (MBSF) in the CCW. Race and ethnicity were obtained from enrollment records, which are enhanced by the Research Triangle Institute (RTI) using first- and last-name algorithms. There are six categories: White, Black, Hispanic, API, and AI/AN, Other.
- *Dual eligibility* was obtained from MBSF enrollment records. Beneficiaries were categorized as either dually eligible during any month in 2017 or not dually eligible in 2017.
- *Rurality of residence* was based on the beneficiary's home address and was obtained from the geographic variation file the in CCW. There are three categories: metropolitan, micropolitan and non-CBSA (otherwise known as rural). In analyses presented here, sample sizes in both micropolitan and non-CBSA areas were adequate to study these regions independently and were preserved as separate categories to provide more nuanced results on disparities by rurality.

*Variables from the American Community Survey (ACS)*

The 2017 American Community Survey (ACS) five-year estimate files were used to obtain three SDOH variables that were not available in the CCW: neighborhood-level estimates of poverty, educational attainment and limited English proficiency. The CCW includes beneficiary ZIP Code, which is mapped to ZIP Code tabulation areas (ZCTA)[§] using the Uniform Data System Mapper crosswalk. ACS and CCW files were then linked using ZCTA. Table 1 summarizes categories for each variable and lists their sources.

- *Neighborhood poverty* was defined as the percentage of residents in the beneficiary's ZCTA of residence who fell below the federal poverty level. Neighborhood poverty level was then summarized using quartiles of the distribution among beneficiaries with diabetes. The four resulting groups were very low (≤9%), low (>9%-14%), moderate (>14%–20%), and high (>20%).
- *Neighborhood education* was based on the median education level among individuals 25 years of age and older in the beneficiary's ZCTA of residence. Four categories were created: less than high school, high school, some college, and bachelor's or higher.
- *Neighborhood limited English proficiency* was based on the percentage of residents in the beneficiary's ZCTA who were older than 5 years and spoke English less than "very well." This was categorized using quartiles of the distribution (rounded to the nearest 10th) for the population with diabetes: very low (≤1.2%), low (>1.2%–3.2%), moderate (>3.2%–8.0%), and high (>8.0%).

[§] ZCTAs are geographic units adapted from US Postal Service ZIP Codes for use by the Census Bureau. They typically correspond to the same area as a ZIP Code but include adjustments to keep census blocks together in a single ZCTA, whereas they can be split across ZIP Codes.[31] In this study, ZCTAs were used only to merge claims data with ACS records. No data are displayed at the ZIP Code or ZCTA level.


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## Appendix 2. Quality of Diabetes Care Measures and Emergency Department and Inpatient Utilization for Potentially Preventable Complications of Diabetes

*Quality of Care Measures*

Three diabetes care quality measures were analyzed: Retinal Eye Exam, Receipt of Statin Therapy (at least one statin prescription filled), and Adherence to Statin Therapy (statin prescriptions filled to cover at least 80% of days in a measurement period). A brief description of each measure is included below. Full measure specifications are available in the Health Effectiveness Data and Information Set (HEDIS®**) *Volume 2: Technical Specifications for Health Plans*.[16]

- *Retinal Eye Exam:* Beneficiaries 18–75 years of age with diabetes were coded as having a retinal eye exam if they received any of the following: 1.) retinal or dilated eye exam by an optometrist or ophthalmologist in 2017; 2.) retinal or dilated eye exam by an optometrist or ophthalmologist in 2016 that was negative for retinopathy; and 3.) bilateral eye enucleation.
- *Receipt of Statin Therapy:* Beneficiaries 40–75 years with diabetes were coded as having received statin therapy if they had at least one dispensing event for a statin medication of any intensity (high, moderate or low) in 2017 and statin therapy was not contraindicated due to comorbid conditions.
- *Adherence to Statin Therapy:* Beneficiaries 40–75 years with diabetes were coded as being adherent to statin therapy if they remained on a statin medication of any intensity (high, moderate or low) for at least 80% of the treatment period in 2017.

Receipt of Statin Therapy and Adherence to Statin Therapy could only be measured in beneficiaries who were enrolled in Medicare Part D. In order to assess the comparability of the populations with and without Part D, we provide a table of summary statistics in this Appendix.

About 75% of the Medicare FFS population aged 18-75 with diabetes were continuously enrolled in Medicare Part D, where continuous enrollment was defined as having ≥11 months of coverage in a calendar year. Compared to those not continuously (<11 months of coverage) enrolled in Part D, those enrolled in Part D had a higher proportion of beneficiaries who were dually eligible or living in neighborhoods with high poverty, median educational attainment of high school or less, or high levels of limited English proficiency.

*ED and IP Utilization for Potentially Preventable Complications of Diabetes*

ED and IP use are adverse outcomes for which all people with diabetes are at risk. Moreover, people with diabetes who have access to care and whose care is coordinated across providers should be less likely to destabilize and require these services for exacerbation of diabetes. These utilization measures, which are similar to Agency for Healthcare Research and Quality's (AHRQ's)Prevention Quality Indicator Diabetes Composite measures, were created by adapting the 2018 HEDIS Hospitalization for Potentially Preventable Complications and the ED Utilization measures to reflect this study's focus on diabetes rather than on all-cause utilization, and include beneficiaries 18 years and older.

** HEDIS® is a registered trademark of the National Committee for Quality Assurance (NCQA).

There were four categories of potentially preventable complications of diabetes: short-term complications (e.g., ketoacidosis), long-term complications (e.g., diabetic nephropathy), uncontrolled diabetes (e.g., hyperglycemia) and lower-extremity amputation among patients with diabetes (e.g., detachment of right foot). The definitions of ED and IP utilization are below.

- *ED Utilization for Potentially Preventable Complications of Diabetes:* Beneficiaries 18 years and older with diabetes were coded as having ED utilization if they had an ED visit in 2017 for a potentially preventable complication of diabetes as their primary diagnosis, and the ED visit did not result in an inpatient stay.
- *IP Utilization for Potentially Preventable Complications of Diabetes:* Beneficiaries 18 years and older with diabetes were coded as having IP utilization if they had an acute IP or observation stay in 2017 for a potentially preventable complication of diabetes (any diagnosis).

**Table: Medicare FFS Population Aged 18-75 with Diabetes Demographic Characteristics and SDOH Stratified by Part D Enrollment (Column Percentages)**

| | Continuously Enrolled in Part D (n=3,613,539) | Not Continuously Enrolled in Part D (n=1,212,386) |
|---|---|---|
| Race and Ethnicity | | |
| White | 69.15 | 70.88 |
| Black | 15.02 | 14.59 |
| Hispanic | 9.27 | 7.76 |
| API | 3.29 | 2.52 |
| AI/AN | 0.87 | 1.54 |
| Other | 0.82 | 1.19 |
| Unknown | 1.59 | 1.52 |
| Dual Eligibility | | |
| Not Dual Eligible | 61.86 | 97.16 |
| Dual Eligible | 38.14 | 2.84 |
| Rurality | | |
| Metropolitan | 76.01 | 78.59 |
| Micropolitan | 13.45 | 12.10 |
| Non-CBSA | 10.53 | 9.24 |
| Unknown | 0.01 | 0.07 |
| Neighborhood Poverty | | |
| Very Low | 26.34 | 28.50 |
| Low | 23.20 | 25.19 |
| Moderate | 23.40 | 23.20 |
| High | 26.83 | 22.26 |
| Unknown | 0.23 | 0.84 |
| Median Neighborhood Education | | |
| <HS | 0.41 | 0.20 |
| HS Degree | 35.64 | 30.88 |
| Some College | 54.73 | 60.30 |
| Bachelor's Degree or Higher | 9.00 | 7.79 |
| Unknown | 0.22 | 0.84 |
| Neighborhood Limited English Proficiency | | |
| Very Low | 24.98 | 23.95 |
| Low | 24.99 | 27.22 |
| Moderate | 24.01 | 25.99 |
| High | 25.81 | 22.00 |
| Unknown | 0.22 | 0.83 |


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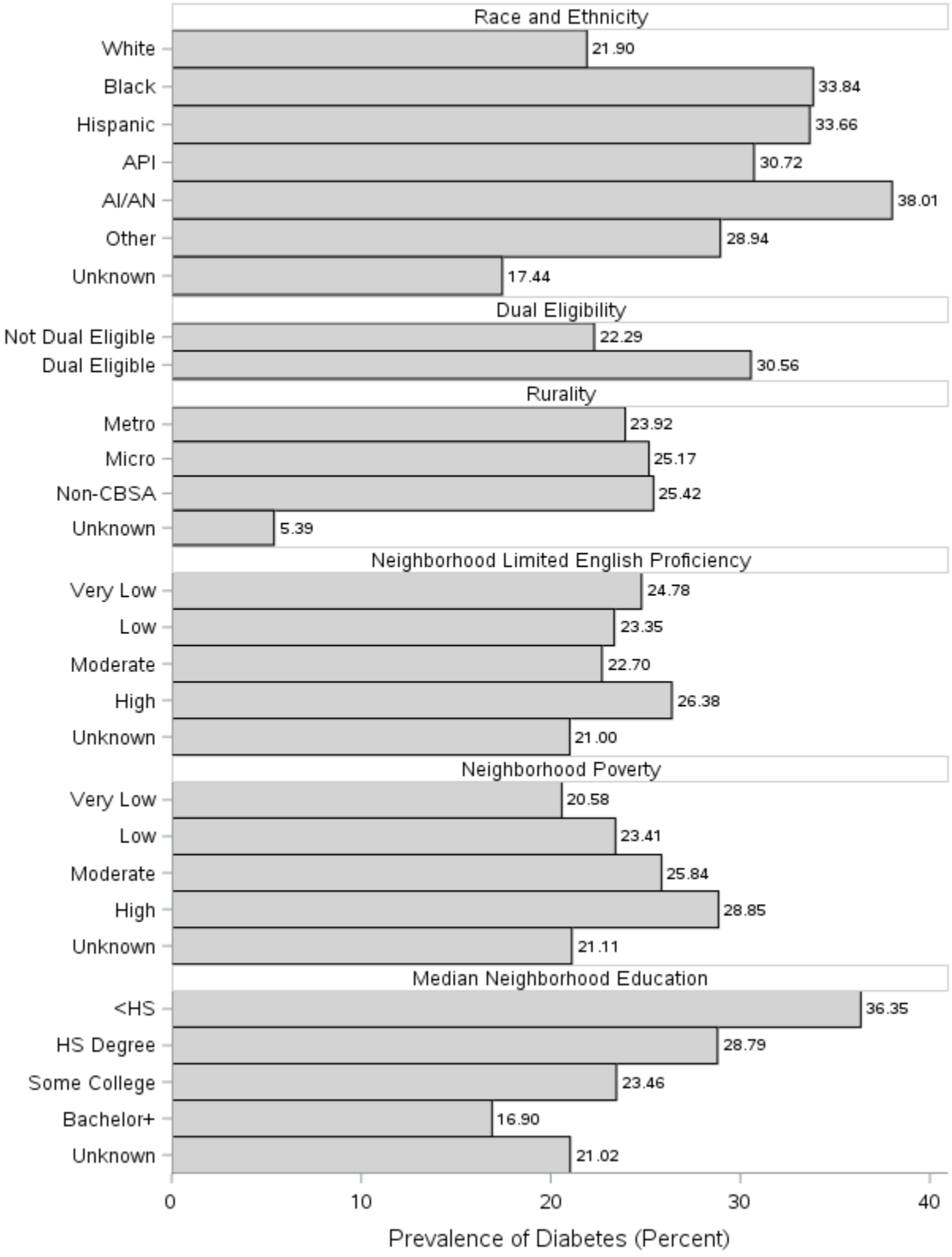
**Appendix 3: Prevalence of Diabetes in the Medicare FFS Population Aged 18-75 by Demographic or SDOH Category**





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## Appendix 4: Adjusted Odds Ratios for Quality of Diabetes Care Measures

| | Retinal Eye Exam (N=4,825,925) | | | | Received Statin Therapy (N=2,185,073) | | | | Adherence to Statin Therapy (N=1,499,870) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | aOR | 95% CI | | p-values | aOR | 95% CI | | p-values | aOR | 95% CI | | p-values |
| Race and ethnicity (ref=White) | | | | | | | | | | | | |
| Black | 0.891 | 0.887 | 0.896 | <.0001 | 0.901 | 0.894 | 0.909 | <.0001 | 0.563 | 0.557 | 0.569 | <.0001 |
| Hispanic | 0.927 | 0.920 | 0.933 | <.0001 | 1.056 | 1.044 | 1.067 | <.0001 | 0.600 | 0.591 | 0.608 | <.0001 |
| Asian or Pacific Islander | 1.163 | 1.149 | 1.175 | <.0001 | 1.304 | 1.280 | 1.326 | <.0001 | 0.894 | 0.875 | 0.912 | <.0001 |
| American Indian or Alaska Native | 1.225 | 1.203 | 1.248 | <.0001 | 0.856 | 0.831 | 0.883 | <.0001 | 0.461 | 0.444 | 0.479 | <.0001 |
| Other | 1.119 | 1.098 | 1.142 | <.0001 | 1.109 | 1.074 | 1.145 | <.0001 | 0.845 | 0.812 | 0.880 | <.0001 |
| Dual Eligibility (ref=Not Dual Eligible) | | | | | | | | | | | | |
| Dual Eligible | 0.775 | 0.772 | 0.778 | <.0001 | 0.932 | 0.926 | 0.938 | <.0001 | 0.899 | 0.892 | 0.907 | <.0001 |
| Neighborhood Federal Poverty Level (ref=Very Low) | | | | | | | | | | | | |
| Low | 0.903 | 0.898 | 0.908 | <.0001 | 0.933 | 0.925 | 0.941 | <.0001 | 0.948 | 0.937 | 0.959 | <.0001 |
| Moderate | 0.863 | 0.858 | 0.868 | <.0001 | 0.908 | 0.900 | 0.917 | <.0001 | 0.898 | 0.887 | 0.908 | <.0001 |
| High | 0.835 | 0.830 | 0.840 | <.0001 | 0.903 | 0.894 | 0.912 | <.0001 | 0.843 | 0.833 | 0.854 | <.0001 |
| Rurality (ref=Metropolitan) | | | | | | | | | | | | |
| Micropolitan | 0.974 | 0.968 | 0.979 | <.0001 | 0.952 | 0.943 | 0.961 | <.0001 | 1.015 | 1.003 | 1.028 | .0144 |
| Non-CBSA | 0.930 | 0.924 | 0.936 | <.0001 | 0.962 | 0.952 | 0.972 | <.0001 | 1.010 | 0.996 | 1.025 | .1446 |
| Median Neighborhood Education (ref=Bachelor's degree or higher) | | | | | | | | | | | | |
| High school or less | 0.745 | 0.739 | 0.751 | <.0001 | 0.940 | 0.928 | 0.951 | <.0001 | 0.869 | 0.855 | 0.883 | <.0001 |
| Some college | 0.845 | 0.838 | 0.850 | <.0001 | 0.944 | 0.934 | 0.954 | <.0001 | 0.938 | 0.924 | 0.951 | <.0001 |
| Neighborhood Limited English Proficiency (ref=Very Low) | | | | | | | | | | | | |
| Low | 1.044 | 1.038 | 1.050 | <.0001 | 1.016 | 1.008 | 1.025 | .0002 | 0.999 | 0.987 | 1.010 | .8006 |
| Moderate | 1.034 | 1.029 | 1.040 | <.0001 | 1.027 | 1.017 | 1.035 | <.0001 | 0.986 | 0.975 | 0.998 | .0209 |
| High | 1.019 | 1.013 | 1.025 | <.0001 | 1.058 | 1.049 | 1.068 | <.0001 | 0.990 | 0.978 | 1.002 | .0982 |


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## Appendix 5: Adjusted Odds of Emergency Department and Inpatient Utilization for Potentially Preventable Complications of Diabetes—Beneficiaries 18–64 Years

| | Emergency Department | | | | Inpatient | | | |
|---|---|---|---|---|---|---|---|---|
| **Age 18-64 years (n=1,079,587)** | aOR | 95% CI | | p-values | aOR | 95% CI | | p-values |
| Race and Ethnicity (ref=White) | | | | | | | | |
| Black | 1.202 | 1.183 | 1.220 | <.0001 | 0.966 | 0.940 | 0.992 | .0105 |
| Hispanic | 1.137 | 1.114 | 1.161 | <.0001 | 0.846 | 0.816 | 0.878 | <.0001 |
| Asian or Pacific Islander | 0.808 | 0.770 | 0.847 | <.0001 | 0.556 | 0.508 | 0.609 | <.0001 |
| American Indian or Alaska Native | 1.229 | 1.175 | 1.286 | <.0001 | 1.095 | 1.015 | 1.181 | .0196 |
| Other | 0.889 | 0.818 | 0.965 | .0051 | 0.795 | 0.689 | 0.918 | .0017 |
| Dual Eligibility (ref=Not Dual Eligible) | | | | | | | | |
| Dual Eligible | 1.284 | 1.266 | 1.301 | <.0001 | 1.140 | 1.114 | 1.168 | <.0001 |
| Neighborhood Federal Poverty Level (ref=Very Low) | | | | | | | | |
| Low | 1.080 | 1.058 | 1.102 | <.0001 | 1.000 | 0.966 | 1.035 | .9930 |
| Moderate | 1.116 | 1.093 | 1.138 | <.0001 | 1.000 | 0.966 | 1.036 | .9842 |
| High | 1.110 | 1.087 | 1.134 | <.0001 | 1.036 | 0.999 | 1.073 | .0544 |
| Rurality (ref=Metropolitan) | | | | | | | | |
| Micropolitan | 1.013 | 0.995 | 1.032 | .1681 | 0.940 | 0.910 | 0.971 | .0002 |
| Non-CBSA | 0.925 | 0.906 | 0.946 | <.0001 | 0.956 | 0.921 | 0.993 | .0203 |
| Median Neighborhood Education (ref=Bachelor's degree or higher) | | | | | | | | |
| High school or less | 1.014 | 0.983 | 1.045 | .3967 | 1.026 | 0.972 | 1.083 | .3494 |
| Some college | 1.075 | 1.045 | 1.107 | <.0001 | 1.057 | 1.005 | 1.111 | .0310 |
| Neighborhood Limited English Proficiency (ref=Very Low) | | | | | | | | |
| Low | 1.047 | 1.029 | 1.066 | <.0001 | 1.001 | 0.971 | 1.032 | .9596 |
| Moderate | 1.077 | 1.058 | 1.097 | <.0001 | 1.008 | 0.976 | 1.041 | .6233 |
| High | 0.967 | 0.948 | 0.985 | .0005 | 0.992 | 0.960 | 1.026 | .6485 |

***Note:*** Regression models are adjusted for age, sex, Elixhauser comorbidities, race and ethnicity, dual eligibility, neighborhood federal poverty level, rurality, neighborhood education and neighborhood limited English proficiency.

**Appendix 6: Adjusted Odds of Emergency Department and Inpatient Utilization for Potentially Preventable Complications of Diabetes—Beneficiaries 65+ Years**

| | Emergency Department | | | | Inpatient | | | |
|---|---|---|---|---|---|---|---|---|
| **Age 65+ (n=5,877,979)** | aOR | 95% CI | | p-values | aOR | 95% CI | | p-values |
| Race and Ethnicity (ref=White) | | | | | | | | |
| Black | 1.427 | 1.412 | 1.443 | <.0001 | 1.405 | 1.374 | 1.437 | <.0001 |
| Hispanic | 1.175 | 1.159 | 1.193 | <.0001 | 1.042 | 1.012 | 1.074 | .0063 |
| Asian or Pacific Islander | 0.705 | 0.688 | 0.722 | <.0001 | 0.594 | 0.564 | 0.627 | <.0001 |
| American Indian or Alaska Native | 1.500 | 1.449 | 1.554 | <.0001 | 1.466 | 1.364 | 1.576 | <.0001 |
| Other | 0.907 | 0.872 | 0.943 | <.0001 | 0.802 | 0.736 | 0.874 | <.0001 |
| Dual Eligibility (ref=Not Dual Eligible) | | | | | | | | |
| Dual Eligible | 1.445 | 1.432 | 1.459 | <.0001 | 1.494 | 1.466 | 1.523 | <.0001 |
| Neighborhood Federal Poverty Level (ref=Very Low) | | | | | | | | |
| Low | 1.070 | 1.059 | 1.081 | <.0001 | 0.982 | 0.960 | 1.004 | .1124 |
| Moderate | 1.095 | 1.083 | 1.108 | <.0001 | 0.995 | 0.971 | 1.019 | .6598 |
| High | 1.082 | 1.069 | 1.096 | <.0001 | 1.041 | 1.015 | 1.068 | .0022 |
| Rurality (ref=Metropolitan) | | | | | | | | |
| Micropolitan | 1.047 | 1.035 | 1.060 | <.0001 | 0.949 | 0.925 | 0.974 | <.0001 |
| Non-CBSA | 1.001 | 0.987 | 1.015 | .9021 | 0.983 | 0.955 | 1.011 | .2342 |
| Median Neighborhood Education (ref=Bachelor's degree or higher) | | | | | | | | |
| High school or less | 1.011 | 0.995 | 1.027 | .1657 | 1.045 | 1.012 | 1.080 | .0071 |
| Some college | 1.069 | 1.055 | 1.084 | <.0001 | 0.997 | 0.969 | 1.025 | .8112 |
| Neighborhood Limited English Proficiency (ref=Very Low) | | | | | | | | |
| Low | 1.004 | 0.993 | 1.015 | .4679 | 0.997 | 0.974 | 1.020 | .8003 |
| Moderate | 0.993 | 0.982 | 1.004 | .1920 | 1.015 | 0.991 | 1.039 | .2200 |
| High | 0.858 | 0.848 | 0.869 | <.0001 | 1.004 | 0.980 | 1.029 | .7368 |

***Note:*** Regression models are adjusted for age, sex, Elixhauser comorbidities, race and ethnicity, dual eligibility, neighborhood federal poverty level, rurality, neighborhood education and neighborhood limited English proficiency.


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