

Neighborhood Environment and Disparities in Health Care Access Among Urban Medicare Beneficiaries With Diabetes: A Retrospective Cohort Study

INQUIRY: The Journal of Health Care Organization, Provision, and Financing
Volume 55: 1–12
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DOI: 10.1177/0046958018771414
journals.sagepub.com/home/inq



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Abstract

Older adults' health is sensitive to variations in neighborhood environment, yet few studies have examined how neighborhood factors influence their health care access. This study examined whether neighborhood environmental factors help to explain racial and socioeconomic disparities in health care access and outcomes among urban older adults with diabetes. Data from 123 233 diabetic Medicare beneficiaries aged 65 years and older in New York City were geocoded to measures of neighborhood walkability, public transit access, and primary care supply. In 2008, 6.4% had no office-based "evaluation and management" (E&M) visits. Multilevel logistic regression indicated that this group had greater odds of preventable hospitalization in 2009 (odds ratio = 1.31; 95% confidence interval: 1.22-1.40). Nonwhites and low-income individuals had greater odds of a lapse in E&M visits and of preventable hospitalization. Neighborhood factors did not help to explain these disparities. Further research is needed on the mechanisms underlying these disparities and older adults' ability to navigate health care. Even in an insured population living in a provider-dense city, targeted interventions may be needed to overcome barriers to chronic illness care for older adults in the community.

Keywords

health disparities, chronic disease, neighborhood environment, access to care, older adults, Medicare

What do we already know about this topic?

Older adults' health is sensitive to variations in the neighborhood environment.

How does your research contribute to the field?

This is one of few studies that examine how neighborhood factors—such as walkability, access to public transportation, and health care supply—influence disparities in health care access for older adults.

What are your research's implications toward theory, practice, or policy?

Even in an insured population living in a provider-dense city, targeted interventions may be needed to overcome barriers to chronic illness care for community-dwelling older adults, especially those affected by persistent disparities in access to care.

on function, quality of life, and health care costs.² Racial disparities are also amplified by geographic differences, with the amputation rate for black diabetic patients 7 times that of white diabetics in some regions of the United States.³

Prior research has examined the extent to which geographic variations in health care access across areas such as regions and counties are associated with disparate outcomes.^{4,5} However, less is known about how more granular, neighborhood-level variations influence health care use and associated outcomes. Yet researchers have found that variations in neighborhood environmental characteristics—such as walkability and access to public transportation—are associated with other health-related behaviors such as physical activity,⁶ and

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Received 5 September 2017; revised 20 March 2018; revised manuscript accepted 20 March 2018

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Introduction

Health disparities among older adults remain a critical public health problem in the United States. For example, racial minorities with diabetes are at greater risk of lower-extremity amputation than white diabetics,¹ an outcome with a detrimental impact



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outcomes such as obesity, onset of chronic disease, and disability.⁷⁻⁹

This study extends the existing research on geography and health by examining environmental factors—measured at a more granular, “neighborhood” level—that may contribute to racial and socioeconomic disparities in health care access and outcomes among urban older adults with chronic illness. The analysis presented here addresses this overarching goal with 2 objectives. First, we describe racial and socioeconomic variations in outpatient physician service use and potentially preventable hospitalizations for ambulatory care-sensitive conditions (ACSCs)^{10,11} among diabetic older adults in New York City (NYC). Second, we examine whether variations in neighborhood built environment characteristics—such as walkability and access to public transportation—help to explain the observed racial and socioeconomic variations, while accounting for local variations in physician supply and neighborhood socioeconomic factors such as poverty. We achieved these objectives using a uniquely configured data set comprised of health care claims linked with geographic data on individuals’ neighborhood of residence for a large sample of diabetic Medicare beneficiaries aged 65 years and older living in NYC, an area that overall has a high density of health care providers.

New Contribution

Our study offers a unique contribution to existing research on geographic variation in health care utilization by linking Medicare beneficiary data to geographic units more granular than typically done in prior research. In addition, this study adds to the body of work on the health effects of the built environment, which has focused largely on physical activity, obesity, and onset of chronic disease, but less so on health care access. Whereas prior research has examined the influence of the built environment on health behavior such as diet and exercise, less is known about the role of the built environment in health service use behavior. Given that older adults’ ability to manage their health may be particularly sensitive to environmental factors,¹² examining the relationships between the built environment and older adults’ patterns of health care access could shed light on mechanisms underlying health disparities among older adults. The unique data linkages achieved in this study allowed us to examine these relationships, which thus far have been relatively understudied.

Background and Conceptual Framework

Geographic Variation in Health Care Access

An extensive body of work has examined geographic variations in health care access across areas such as counties, hospital referral regions, primary care service areas, and metropolitan areas.^{4,13,14} Variations across smaller geographic units have been examined in the context of

Philadelphia, where a team of researchers mapped geographic access to primary care at the census tract level.¹⁵ This study found a 10-fold difference in the adults-to-provider ratio comparing the lowest-supply with the highest-supply areas in a publicly insured population. The findings of the Philadelphia study underscore the importance of disaggregating regional or county-level measures of health care supply and drilling down to variations at a geographic level that captures the more immediate environment of a person’s place of residence.

Neighborhood Socioeconomic Status, Social Environment, and Health

Another dimension of the relationship between health and geography includes more granular variations in the neighborhood environment. A large body of research has demonstrated associations between neighborhood socioeconomic status (SES) and health, including the impact of neighborhood poverty rates and income levels on health outcomes such as depression, cardio-metabolic risk, allostatic load, and mortality.¹⁶⁻²⁰ A study of adults with diabetes found that greater levels of neighborhood poverty at the census tract level were associated with poorer self-rated physical health, mental health, social functioning, and other health status measures.¹⁶ These findings raise questions about the explanatory mechanisms underlying these associations and point to a need to identify environmental processes that may be amenable to policy intervention. Research has found measures of neighborhood social capital—eg, trust in neighbors and civic participation—to be associated with overall self-rated health, mental health, and health behavior.²¹⁻²⁵ Some studies suggest that social capital is a mediator in the relationship between neighborhood SES and health.^{26,27}

Health Effects of the Built Environment

In addition to the neighborhood social environment, the built environment encompasses several mechanisms shown to impact health behavior and outcomes. A growing body of research has examined the health effects of the built environment, with particular focus on the availability of parks and recreational spaces, neighborhood safety, and “walkability” measures—such as the presence of sidewalks, street connectivity, the mix of residential and commercial land use, and traffic safety.^{28,29} Research suggests that people who live in more walkable neighborhoods are more physically active⁶ and have better cardiorespiratory fitness.³⁰ Moreover, a systematic review suggests that blacks, Hispanics, and individuals of lower SES are disproportionately concentrated in neighborhoods with worse environments in terms of safety, places to exercise, and access to healthy foods.²⁸ Thus, variations in neighborhood built environment are a potential mechanism contributing to health disparities.

Built Environment and the Health of Older Adults

Prior research has focused specifically on the relationship between the built environment and health among older adults.¹² Studies have shown associations between greater walkability and greater physical activity,³¹ walking for errands,³² greater lower-extremity strength,³³ and lower blood pressure.³⁴ Greater street connectivity has been linked to fewer limitations in activities of daily living among older men⁸ and lower risk of obesity among older women.⁹

Conceptual Frameworks

Given the influence of built environment factors on older adults' activities such as walking for errands and physical exercise, it is possible that some of these factors also influence how older adults utilize health services. This study draws on two conceptual frameworks to contextualize these processes. The first is the behavioral model of health service use, which focuses on 3 domains of population characteristics as predictors of health service use and subsequent outcomes, namely, predisposing, enabling, and need factors.³⁵ *Predisposing* factors include age, sex, and race/ethnicity, as sociodemographic factors influence a person's social status and, in turn, the ability to command necessary resources to cope with health problems. *Enabling* factors are resources that facilitate or hinder service use, such as income level and health insurance. *Need* factors include both the patient's perception and provider's evaluation of health care needs, including health status and diagnoses. These 3 types of factors are determinants of health service use and personal health practices, which in turn influence health status and satisfaction with services. The model also acknowledges the impact of the external environment on health service use, including physical, political, and economic aspects of the environment,³⁵ as well as safety net and public policy supports for low-income populations.³⁶

The second conceptual framework that informs this study is the ecological model in the epidemiology of aging.³⁷ The basic premise of this model is that a range of individual-level and contextual factors influences an individual's health, physical and cognitive function over the life course, and survival. Individual variables include demographic, socioeconomic, physiological, and psychosocial characteristics, and contextual variables include characteristics of the local environment—including the built environment and supply of services—and social capital. The ecological model of aging has conceptual roots in Lawton's model of "environmental press," which suggests that individual competencies, the demands of the environment, and the interaction between the person and the environment shape individual behavior and well-being over the life course.³⁸ The concept of the individual continually adapting to environmental demands throughout the life course is an underlying principle in the growing body of research on the social determinants of health.

Bridging these 2 conceptual frameworks, the current study assumes that health service use behavior is informed by a continual adaptation to the opportunities and constraints introduced by a person's surrounding environment. These opportunities and constraints may influence disparities in health care access and outcomes.

Methods

Study Aims and Hypotheses

This study aimed to (a) describe racial and socioeconomic variations in outpatient physician service use and potentially preventable hospitalizations for ACSCs; and (b) examine whether variations in neighborhood built environment characteristics—such as walkability and access to public transportation—help to explain the observed racial and socioeconomic variations, while accounting for local variations in physician supply. We hypothesized that, controlling for local variations in health care supply and neighborhood poverty, living in a neighborhood with better access to public transportation and greater walkability will facilitate health care use in a timely fashion. Moreover, we hypothesized that variations in access to transportation and walkability will partly explain disparities in access to care. We tested these hypotheses using a multilevel analysis described below.

Design

This retrospective cohort study used data on a sample of community-dwelling Medicare fee-for-service beneficiaries in NYC aged 65 years and older. Beneficiary data were acquired from the Centers for Medicare and Medicaid Services (CMS). Beneficiary addresses were linked to geographic data on neighborhood demographic and socioeconomic composition, walkability, public transit access, and primary care supply.

Individual-Level Data Sources and Measures

Beneficiary data included Medicare enrollment information, demographics, and claims for all services provided under Medicare fee-for-service during 2008-2009. As a proxy for low income, a binary indicator for dual eligibility for Medicare and Medicaid was defined as whether the beneficiary was eligible for Medicaid for at least 1 month during 2008. Binary variables for particular chronic conditions were defined using CMS' Chronic Condition Warehouse (CCW) indicators; a count variable was created for the total number of chronic conditions.

We derived a count variable for noninstitutionally based physician visits provided during 2008 under Medicare Part B that were coded for "evaluation and management" (E&M).³⁹ E&M codes are used for visits that offer routine screening

and management of chronic conditions, occurring in outpatient “offices” (eg, private physician offices, hospital outpatient departments, or clinics). We created a binary indicator for having no E&M visit during 2008 as a measure of a lapse in outpatient care, coded as “1” for having no E&M visit and “0” for at least one E&M visit. We created a binary indicator for whether the individual had at least one ACSC hospital admission in 2009 (coded as “1” for yes, “0” for no) using established definitions of ACSCs.^{10,11}

Geographic Data Sources and Measures

Geographic variables were derived from publicly available data sources. An index of the mix of residential and commercial land use was derived from PLUTO (2007), a tax-lot level file maintained by the NYC Department of City Planning (DCP). We calculated the proportion of tax lots in the census tract designated for nonresidential use, as well as a land use mix index described in prior research, which suggests that heterogeneity in land use makes a neighborhood more walkable.²⁹ We calculated intersection density at the census tract level as the number of intersections per square kilometer, using a street-level data source maintained by the DCP. Previous research suggests that greater intersection density indicates greater street connectivity, which enables walking for transit and exercise.²⁹

Public transit access was measured using data from the NYC Metropolitan Transit Authority on the geographic coordinates of all bus and subway stops in NYC. Because NYC buses are considered more elder-friendly than subways, we focused on bus stop density in this analysis (ie, the count of bus stops per square kilometer at the census tract level). We also used US Census (2000) data to measure access to public transportation based on the proportion of respondents who use public transit to get to work, as well as to account for population density and poverty rate at the census tract level.

We used a geographic measure of primary care supply available from the Primary Care Service Area (PCSA) Project (2007) of the Dartmouth Institute. PCSAs represent geographic approximations of markets for primary care services.¹⁴ We assigned beneficiaries to a PCSA based on zip code of residence (which are nested within PCSAs), totaling 52 PCSAs in our data set. We used Dartmouth’s age- and sex-adjusted measure of the number of primary care providers per 100 000 residents at the PCSA level. In addition, we derived a binary indicator of the availability of a Federally Qualified Health Center (FQHC) at the zip code-level with data made publicly available by the Health Resources and Services Administration.

Analytic Sample

The sample drew from the full universe of Medicare beneficiaries who were age 65 years or older as of January 1, 2008, and lived in NYC’s 5 boroughs. We selected individuals for

the current analysis if they (1) were community-dwelling, defined as having no days in a skilled nursing facility or other nonhospital inpatient facility during 2008; (2) had no months of Medicare managed care coverage during 2008-2009 as managed care claims are not included in the available data; (3) had a diabetes diagnosis; and (4) had an address that successfully matched to the census tract. The match rate for addresses was 96%; there were no notable biases in geographic distribution by borough comparing those that did and did not match. The resulting matched sample included 123 233 individuals dispersed throughout 2217 census tracts across NYC’s 5 boroughs.

Analytic Methods

Descriptive analyses examined individual characteristics and service use for the overall sample and across racial groups. We also compared characteristics of neighborhoods of residence by race. Significance tests for racial differences included chi-square tests for binary variables and analysis of variance for continuous variables. Multilevel (mixed effects) logistic regressions examined the effects of individual and neighborhood characteristics on (1) having a lapse in E&M visits (ie, “no E&M visit in 2008”) and (2) having one or more ACSC admissions in 2009. We focused on a 1-year lapse in E&M visits because diabetic older adults with such a lapse are unlikely to be receiving the recommended diabetes monitoring.⁴⁰ In the models predicting ACSC admissions, we included “no E&M visit in 2008” as an independent variable to test whether a lapse in E&M visits is associated with greater odds of ACSC admission in the following year.

We present 3 models for each dependent variable. First, the “null model” estimates the distinct types of variance at the census tract and PCSA level without including any individual- or area-level variables. The census tract and PCSA level variances are established as “crossed” random effects because an individual is assigned to both a census tract and a PCSA, but neither geographic unit is designed to be nested within the other. (Although the variable for FQHC availability is linked at the zip code level, conducting the model with a third crossed random effect was not feasible due to the computational complexity of the crossed random effects.) Second, we show the “level 1” model, which adds the individual-level variables of interest. Last, we show the “level 2” model, which includes both the individual-level and area-level variables of interest. We conducted tests for multicollinearity to ensure appropriate selection of individual- and neighborhood-level covariates and to minimize potential confounding. In addition, we compared model fit with different combinations of covariates, including additional measures of neighborhood SES (eg, median income, education levels) as level 2 controls. The main findings in the final models shown here were found to be robust in sensitivity analyses that controlled for different neighborhood covariates.

Table 1. Individual Characteristics, Service Use, and Outcomes by Racial Group (N = 123 233).

| | Total N = 123 233 | White n = 70 660 | Black n = 19 499 | Hispanic n = 19 065 | Asian/PI n = 10 247 | Other/UK n = 3762 |
|--|----------------------|---------------------|---------------------|------------------------|------------------------|----------------------|
| Racial category, % of total | 100.0 | 57.3 | 15.8 | 15.5 | 8.3 | 5.7 |
| Female, % | 62.4 | 58.4 | 70.6 | 69.6 | 61.3 | 62.1 |
| Age, mean (SD) | 77.3 (7.3) | 78.0 (7.3) | 76.4 (7.4) | 76.2 (7.0) | 77.0 (6.9) | 76.1 (6.8) |
| Age category, % | | | | | | |
| 65-74 | 40.1 | 35.9 | 47.2 | 46.7 | 40.1 | 47.4 |
| 75-84 | 42.2 | 43.9 | 37.2 | 39.7 | 45.0 | 40.2 |
| 85+ | 17.8 | 20.2 | 15.7 | 13.6 | 14.9 | 12.5 |
| Dually eligible, % | 46.4 | 32.1 | 45.4 | 75.6 | 81.8 | 76.0 |
| Number of chronic conditions, mean (SD) | 6.2 (2.4) | 6.5 (2.4) | 5.7 (2.3) | 5.9 (2.4) | 5.6 (2.1) | 6.6 (2.6) |
| Selected chronic conditions | | | | | | |
| Hypertension, % | 81.6 | 79.1 | 85.0 | 85.5 | 83.5 | 87.0 |
| Heart failure, % | 33.9 | 36.8 | 32.3 | 31.0 | 20.1 | 39.2 |
| Chronic kidney disease, % | 18.4 | 16.9 | 22.6 | 19.4 | 19.1 | 18.7 |
| Chronic obstructive pulmonary disease, % | 11.7 | 13.1 | 8.8 | 10.4 | 10.0 | 11.8 |
| Asthma, % | 7.5 | 6.2 | 7.4 | 12.9 | 7.4 | 6.8 |
| Ischemic heart disease, % | 62.4 | 67.7 | 52.0 | 55.7 | 55.5 | 68.9 |
| Alzheimer disease/related dementias, % | 16.2 | 15.6 | 17.3 | 18.4 | 12.2 | 20.4 |
| Depression, % | 11.7 | 13.3 | 6.4 | 13.9 | 5.0 | 16.8 |
| Arthritis (rheumatoid or osteoarthritis), % | 43.7 | 46.6 | 34.2 | 41.3 | 42.2 | 53.6 |
| Selected service use and outcome measures | | | | | | |
| No. of E&M visits (E&M) in 2008, mean, SD | 13.9 (12.7) | 15.9 (13.6) | 9.7 (9.2) | 10.6 (9.7) | 14.1 (12.2) | 17.0 (15.7) |
| No. of E&M visits, median | 11.0 | 12.0 | 8.0 | 8.0 | 11.0 | 12.0 |
| No E&M visits in 2008, % | 6.4 | 3.8 | 12.8 | 10.7 | 3.9 | 5.7 |
| Had at least one ACSC hospitalization in 2009, % | 10.1 | 9.2 | 12.2 | 12.8 | 7.1 | 9.5 |

Note. All differences by race were significant at $P < .0001$. PI = Pacific Islander; UK = Unknown; SD = standard deviation; E&M = Evaluation & Management; ACSC = ambulatory care-sensitive condition.

Construction of variables and descriptive analysis were performed in SAS Version 9.3.⁴¹ Geocoding was performed using the Geosupport Desktop Edition software version 11.4.⁴² Multilevel logistic regression models were run in R version 3.1.2 using the “lme4” package.⁴³ All study procedures were approved by the Institutional Review Board of the Visiting Nurse Service of New York.

Results

Individual-Level Characteristics and Service Use Measures

Descriptive statistics on individual beneficiary characteristics and service use are shown in Table 1. Beneficiaries had a mean age of 77.3 (SD = 7.3), and 62.4% were female. The sample was 57.3% white, 15.8% black, 15.5% Hispanic, and 8.3% Asian/Pacific Islander (PI). Although 46.4% were dually eligible (a proxy for low income), the proportion varied by race, ranging from 32.1% among whites to 81.8% among Asians/Pis. In the overall sample, the most prevalent chronic comorbidities were hypertension (81.6%), ischemic heart disease (62.4%), arthritis (43.7%), and heart failure (33.9%). Prevalence of specific conditions varied by race,

although there was not a consistent pattern in these differences. For example, hypertension and chronic kidney disease were more prevalent among nonwhites, whereas heart failure and depression were more prevalent among whites. The overall mean number of chronic conditions was 6.2 (SD = 2.4). This figure varied by race, with 6.5 among whites, 5.7 among blacks, 5.9 among Hispanics, and 5.6 among Asians/Pis. Racial differences in all of the aforementioned characteristics were statistically significant ($P < .0001$), although small P values are not surprising given the large sample size.

In 2008, the mean number of E&M visits was 13.9 (SD = 12.7; interquartile range = 14.0), and the median was 11.0. However, 6.4% of the sample had no E&M visits that year (ie, a “lapse” in visits). This figure varied by race ($P < .0001$), with blacks and Hispanics at 12.8% and 10.7%, respectively. Overall, 10.1% of the sample had an ACSC hospitalization in 2009, with significantly higher rates ($P < .0001$) among blacks (12.2%) and Hispanics (12.8%) compared with whites (9.2%).

Environmental “Exposures” by Race

Characteristics of a person’s neighborhood and surrounding health care environment varied by racial group (Table 2); all of these differences were statistically significant ($P < .0001$).

Table 2. Characteristics of Neighborhood of Residence by Racial Group (N = 123 233).

| | Total | White | Black | Hispanic | Asian/PI | Other/UK |
|--|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | N = 123 233 | n = 70 660 | n = 19 499 | n = 19 065 | n = 10 247 | n = 3762 |
| Population density at CT level, mean (SD) | 22 905 (16 420) | 20 554 (15 626) | 22 373 (14 451) | 30 873 (18 728) | 25 578 (16 525) | 22 168 (13 957) |
| Poverty rate at CT level, mean (SD) | 0.19 (0.13) | 0.15 (0.11) | 0.24 (0.14) | 0.28 (0.14) | 0.20 (0.11) | 0.20 (0.11) |
| Bus stop density at CT level, mean (SD) | 25.2 (21.2) | 22.6 (19.6) | 28.8 (21.2) | 31.7 (24.9) | 24.3 (21.4) | 22.9 (19.5) |
| Proportion of residents at CT level who use public transit to get to work, mean (SD) | 0.50 (0.15) | 0.46 (0.16) | 0.57 (0.13) | 0.57 (0.12) | 0.50 (0.13) | 0.52 (0.13) |
| Intersection density at CT level, mean (SD) | 82.1 (34.0) | 79.8 (33.1) | 80.7 (33.1) | 86.8 (33.6) | 91.2 (39.6) | 81.7 (33.8) |
| Proportion of tax lots in the CT for nonresidential use, mean (SD) | 0.29 (0.19) | 0.27 (0.19) | 0.30 (0.19) | 0.32 (0.19) | 0.33 (0.21) | 0.27 (0.18) |
| Proportion with FQHC in zip code, mean (SD) | 0.46 (0.50) | 0.35 (0.48) | 0.66 (0.47) | 0.64 (0.48) | 0.50 (0.50) | 0.45 (0.50) |
| PCP density at PCSA level, mean (SD) | 59.3 (17.4) | 61.5 (18.3) | 52.8 (14.5) | 57.1 (14.9) | 61.2 (16.4) | 61.3 (19.2) |

Note. PI = Pacific Islander; UK = unknown; CT = census tract; SD = standard deviation; FQHC = Federally Qualified Health Center; PCP = primary care provider; PCSA = Primary Care Service Area. All differences by race were significant at $P < .0001$.

Whites lived in neighborhoods with a mean poverty rate of 15%, compared with 24% for blacks, 28% for Hispanics, and 20% for Asians/PIs. All of the nonwhite groups lived in neighborhoods with greater population density than whites. Nonwhites also lived in areas with greater bus stop access and a greater proportion who use public transit to get to work.

Overall, nonwhites lived in PCSAs with lower provider density. Whites lived in PCSAs with a mean of 61.5 primary care providers per 100 000 residents; this compared with 52.8 for blacks, 57.1 for Hispanics, and 61.1 for Asians/PIs. When examining the availability of FQHCs, which by design are placed in underserved areas, the pattern by race was reversed. About a third of whites lived in areas with at least 1 FQHC available, compared with 66% of blacks, 64% of Hispanics, and 50% of Asians/PIs.

Multilevel Models Predicting a Lapse in E&M Visits

The multilevel logistic regressions predicting whether an individual had no E&M visit in 2008 (ie, a “lapse”) are shown in Table 3. The level 1 model shows the individual-level fixed effects while accounting for the variance at both the census tract and PCSA levels. Females and those with more chronic conditions had lower odds of a lapse in E&M visits, while older beneficiaries had greater odds of a lapse, controlling for other factors. Dual eligibles had a 5-fold

odds of a lapse compared with nonduals (odds ratio [OR] = 5.27; 95% confidence interval [CI]: 4.94-5.63). The odds of a lapse also varied significantly by race. Blacks had double the odds (OR = 2.00; 95% CI: 1.85-2.17) and Hispanics 22% greater odds (OR = 1.22; 95% CI: 1.12-1.32) than whites of a lapse in E&M visits, while Asians/PIs had a lower odds of a lapse (OR = 0.41; 95% CI: 0.36-0.46). The Level 1 model was also run controlling for specific comorbidities (not shown here), with similar findings on race, dual eligibility, age, and sex.

The level 2 model shows both individual-level and area-level fixed effects. The overall variances at both the census tract and PCSA levels were decreased from the level 1 to the level 2 model, suggesting that the addition of the area-level variables in the level 2 model helps to explain at least some of the area-level variation. However, differences by race and dual eligibility remained robust after controlling for walkability (eg, land use, intersection density), public transit access, primary care supply, and poverty rate. Living in a neighborhood where residents rely more heavily on public transportation was associated with increased odds of a lapse in E&M visits, although this finding only bordered on statistical significance (OR = 1.52; 95% CI: 1.00-2.31). Higher odds of a lapse were also associated with living in a neighborhood with a greater proportion of nonresidential land (OR = 2.15; 95% CI: 1.71-2.69) and living in an area with a FQHC available (OR = 1.24; 95% CI: 1.12-1.38).

Table 3. Mixed Effects Logistic Regression Predicting 'No E&M Visit in 2008' (N = 123 233).

| | Null model | Level 1 model | Level 2 model |
|---|------------|---------------------|---------------------|
| | | OR (95% CI) | OR (95% CI) |
| Individual-level variables | | | |
| Female | | 0.90 (0.85-0.94)*** | 0.90 (0.85-0.95)*** |
| Age (reference = 65-74) | | | |
| 75-84 | | 1.11 (1.05-1.18)*** | 1.10 (1.04-1.17)*** |
| 85+ | | 2.61 (2.45-2.79)*** | 2.59 (2.43-2.77)*** |
| Dually eligible | | 5.27 (4.94-5.63)*** | 5.16 (4.84-5.51)*** |
| Race (reference = white) | | | |
| Black | | 2.00 (1.85-2.17)*** | 1.95 (1.80-2.12)*** |
| Hispanic | | 1.22 (1.12-1.32)*** | 1.20 (1.10-1.30)*** |
| Asian/PI | | 0.41 (0.36-0.46)*** | 0.41 (0.36-0.46)*** |
| Other/UK | | 0.91 (0.78-1.06) | 0.90 (0.77-1.05) |
| Number of chronic conditions | | 0.82 (0.81-0.83)*** | 0.82 (0.81-0.83)*** |
| Neighborhood-level variables | | | |
| Poverty rate | | | 0.71 (0.46-1.10) |
| Density of bus stops (increases in 10) | | | 0.99 (0.97-1.02) |
| Proportion of residents using public transit | | | 1.52 (1.00-2.31)* |
| Intersection density | | | 1.00 (1.00-1.00) |
| Proportion of tax lots for nonresidential use | | | 2.15 (1.71-2.69)*** |
| FQHC availability | | | 1.24 (1.12-1.38)*** |
| PCP density (increases in 10) | | | 0.97 (0.92-1.02) |
| Variance at census tract level | 0.7466 | 0.5602 | 0.5079 |
| Variance at PCSA level | 0.3243 | 0.0797 | 0.0734 |
| Model statistics | | | |
| Intercept | -2.8958 | -3.0813 | -3.4195 |
| Deviance | 52029.7 | 47093.8 | 46764.7 |
| Akaike information criterion | 52035.7 | 47117.8 | 46802.7 |
| Log-likelihood | -26014.9 | -23546.9 | -23382.3 |

Note. E&M = Evaluation & Management; OR = odds ratio; CI = confidence interval; PI = Pacific Islander; UK = unknown; FQHC = Federally Qualified Health Center; PCP = primary care provider; PCSA = Primary Care Service Area.

* $p < .05$. ** $p < .001$. *** $p < .0001$.

Multilevel Models Predicting ACSC Hospital Admission

The multilevel models predicting whether an individual had an ACSC hospitalization in 2009 are shown in Table 4. As shown in the level 1 model, females, older individuals, and those with a greater number of chronic conditions had greater odds of ACSC admission. Those who did not have an E&M visit in 2008 had 30% greater odds of ACSC admission in 2009 than those who had at least one E&M visit (OR = 1.30; 95% CI: 1.21-1.40). The odds of ACSC admission varied significantly by race; compared with whites, blacks had 49% greater odds (OR = 1.49; 95% CI: 1.40-1.59) and Hispanics 38% greater odds (OR = 1.38; 95% CI: 1.30-1.47) of admission. Dual eligibles also had greater odds of ACSC admission (OR = 1.39; 95% CI: 1.33-1.46).

Similar to the model predicting a lapse in E&M visits, the effects of race and dual eligibility remained robust after controlling for environmental factors; the magnitudes of these effects were similar across the level 1 and level 2

models. Living in a neighborhood with a higher poverty rate was associated with higher odds of ACSC admission, as was living in a neighborhood with a greater proportion of nonresidential land use. Living in a PCSA with greater primary care density was associated with slightly lower odds of ACSC admission; an increase of 10 providers in the PCSA was associated with a 4% reduction in the odds of admission (OR = 0.96; 95% CI: 0.94-0.98). However, living in an area with a FQHC available was associated with slightly greater odds of admission (OR = 1.08; 95% CI: 1.02-1.14).

Discussion

We found significant racial and socioeconomic disparities in the odds of having a lapse in outpatient physician service use and in the odds of having a hospitalization for a condition that, ideally, would be proactively managed in the outpatient setting. Guided by principles from the behavioral model of health service use³⁵ and the ecological model of aging,^{37,38}

Table 4. Mixed Effects Logistic Regression Predicting ACSC Admission in 2009 (N = 123 233).

| | Null model | Level 1 model | Level 2 model |
|---|------------|---------------------|---------------------|
| | | OR (95% CI) | OR (95% CI) |
| Individual-level variables | | | |
| Female | | 0.92 (0.88-0.95)*** | 0.92 (0.88-0.95)*** |
| Age (reference = 65-74) | | | |
| 75-84 | | 1.35 (1.29-1.42)*** | 1.36 (1.30-1.42)*** |
| 85+ | | 2.23 (2.13-2.36)*** | 2.25 (2.13-2.37)*** |
| Dually eligible | | 1.39 (1.33-1.46)*** | 1.36 (1.29-1.42)*** |
| Race (reference = white) | | | |
| Black | | 1.49 (1.40-1.59)** | 1.42 (1.33-1.52)*** |
| Hispanic | | 1.38 (1.30-1.47)*** | 1.32 (1.24-1.41)*** |
| Asian/PI | | 0.78 (0.72-0.86)*** | 0.77 (0.71-0.85)*** |
| Other/UK | | 0.96 (0.86-1.08) | 0.96 (0.85-1.07) |
| Number of chronic conditions | | 1.24 (1.23-1.25)*** | 1.24 (1.23-1.25)*** |
| No E&M visit in 2008 | | 1.30 (1.21-1.40)*** | 1.31 (1.22-1.40)*** |
| Neighborhood-level variables | | | |
| Poverty rate | | | 1.88 (1.52-2.34)*** |
| Density of bus stops (increases in 10) | | | 1.01 (1.00-1.02) |
| Proportion of residents using public transit | | | 0.82 (0.68-1.00) |
| Intersection density | | | 1.00 (1.00-1.00) |
| Proportion of tax lots for nonresidential use | | | 1.19 (1.05-1.34)** |
| FQHC availability | | | 1.08 (1.02-1.14)** |
| PCP density (increases in 10) | | | 0.96 (0.94-0.98)*** |
| Random effects | | | |
| Variance at census tract level | 0.0562 | 0.0385 | 0.0365 |
| Variance at PCSA level | 0.0449 | 0.0130 | 0.0051 |
| Model statistics | | | |
| Intercept | -2.1453 | -4.1102 | -3.9690 |
| Deviance | 80011.2 | 75109.0 | 74855.4 |
| Akaike information criterion | 80017.2 | 75135.0 | 74895.4 |
| Log-likelihood | -40005.6 | -37554.5 | -37427.7 |

Note. ACSC = ambulatory care-sensitive condition; OR = odds ratio; CI = confidence interval; PI = Pacific Islander; UK = unknown; E&M = Evaluation & Management; FQHC = Federally Qualified Health Center; PCP = primary care provider; PCSA = Primary Care Service Area.
P* < .05. *P* < .001. ****P* < .0001.

we hypothesized that greater neighborhood walkability and access to public transportation would facilitate timely health care use and would at least partly explain the observed disparities in access to care. However, the observed disparities remained robust after controlling for environmental characteristics, including neighborhood walkability, public transit access, and primary care supply. At least as measured in our study, the built environment and health care supply indicators did not help to explain variation in access to care, nor did these factors attenuate the impact of race and low income on health care access and outcomes in our sample of NYC-dwelling older adults with diabetes. Thus, variation in the built environment does not appear to influence health service use behavior as it does other health-related behavior among older adults.¹² Rather, several individual-level factors highlighted by Andersen's behavioral model were particularly robust predictors of service use. This included predisposing factors such as age, sex, and race, an enabling factor (dual

eligibility as a proxy for SES), and a summary-level need factor (the number of chronic conditions).

We found that a nontrivial portion of the study population did not have an outpatient physician visit for evaluation and management in the course of an entire calendar year. On average, after adjusting for individual and neighborhood characteristics, this group had 31% greater odds of a preventable hospitalization in 2009 compared with those who had at least 1 E&M visit. This suggests that, in this particular cohort of diabetic, community-dwelling older New Yorkers, there is a subpopulation of nearly 8000 individuals—6.4% of the sample—with a lapse in outpatient care aimed at managing chronic conditions in the course of just 1 calendar year. If the cohort were to be expanded to additional years and to individuals without diabetes but with other chronic conditions, we could possibly identify a substantial population with inadequate access to outpatient care and heightened risk for costly, potentially preventable hospitalizations—even in this

insured population residing in NYC, which is relatively provider-dense. This raises questions about the possible unmeasured factors—environmental, social, economic, clinical, functional, and behavioral—influencing service use in this vulnerable population.

It is possible that the disparate patterns in having a lapse in outpatient care are partly due to racial/ethnic differences in attitudes and beliefs about health care, as well as socioeconomic variations in health literacy, which were unmeasured in our study. Research has found that blacks and Hispanics have greater distrust of physicians than whites, posing a potential barrier to the use of physician services.⁴⁴ Prior research on health care use among Latinos suggests that, among some nationalities, cultural preferences for folk treatments may influence service use.⁴⁵ Researchers have also found that lower SES is associated with lower health literacy,⁴⁶ posing obstacles to service use and effective patient-provider relationships. Although these various factors were unmeasured in our study, it is possible that they partly account for the observed disparities in physician service use. Further work is needed to examine the role of these factors in the population of interest. This would call for primary data on health literacy and health care attitudes and beliefs that could be linked with the Medicare data.

Limitations

Some methodological challenges and limitations are worth noting. First, the Medicare claims data lack information on potentially important factors in health care utilization such as social support, functional and cognitive status, education level, psychosocial measures, and behavioral processes. The best available measure for individual SES within the claims data is dual eligibility for Medicare and Medicaid, which serves as a proxy for low income; this does not capture all aspects of SES that might be important for accessing health care, such as education and its potential correlate, health literacy.⁴⁶ Future work could examine the aforementioned factors using survey data such as the National Health and Aging Trends Study (NHATS), which allows for linkages of social, functional, and other self-reported items with claims data.⁴⁷ However, using national survey data would limit the use of more granular geographic linkages that are possible when focusing on a large sample within a particular urban area.

Moreover, interpretation of certain findings proved challenging. In our data set, nonwhites had fewer documented chronic conditions than whites, which contradicts prior evidence on racial disparities in the burden of chronic disease.⁴⁸ This may be related to the younger mean age among nonwhites in the sample, as well as lower service use levels among nonwhites leading to underestimation of claims-based diagnosis indicators. The association found between FQHC availability and poorer access might seem counterintuitive; the FQHC measure may be serving as a proxy for socioeconomic disadvantage that was otherwise unmeasured

in the model. Results on the land use measure were also difficult to interpret. We ran the models with and without it, as well as with the land use mix index described in prior research, without substantial changes to the other coefficients in the model.

The geographic granularity posed an additional challenge. With over 2000 census tract units, the multilevel logistic regressions were highly computationally intensive; we addressed this with parsimonious selection of covariates. This included narrowing down the set of covariates on neighborhood characteristics and, in particular, neighborhood SES. In sensitivity analyses (not shown), we included potential confounders such as neighborhood median income and education levels, without any noteworthy changes in the key parameters of interest or in model fit. We therefore selected neighborhood poverty as our main indicator of neighborhood SES in the final models, with the goal of controlling for an important aspect of neighborhood disadvantage that may be related to health care access, rather than attempting to capture a broader array of neighborhood SES factors. Another area of potential confounding at the neighborhood level is the domain of social capital.^{21,23,25} Measures of social capital are typically derived from survey data from neighborhood residents,^{21-23,49} which were not available for this study.

Potential self-selection bias into neighborhoods is also a concern in research on neighborhood effects.⁵⁰ Prior research suggests that in the case of neighborhood effects on health, self-selection may be likely to lead to an underestimation of neighborhood effects,⁵¹ though it is unknown whether this is the case in our study. An instrumental variable approach offers one possible solution to the problem of neighborhood selection bias.⁵² Although this approach was considered for this study, identifying a viable instrument proved challenging. Another approach suggested in the literature is the difference-in-difference method,⁵¹ which relies on panel data. This might be a potential option in a future study with access to equivalent data for a later time period.

It is also possible that regression results were biased due to spatial autocorrelation (ie, characteristics of adjacent geographic areas may be dependent upon one another).⁵³ Although a recent study applied a geospatial filtering approach to a multilevel model in which individuals were nested within geographic areas,⁵⁴ this method appears to still be in development. We believe our key findings would likely be robust even with spatial filtering, given prior evidence that fixed effects coefficients do not change dramatically when applying spatial filtering to a multilevel model.⁵⁵

Last, there have been significant developments in health care policy since the time of the study period. While our data offer baseline findings on determinants of access to care in an urban population of chronically ill Medicare beneficiaries, future research could examine data since the enactment of the Affordable Care Act to determine whether the observed disparities have changed over time.⁵⁶

Conclusion

In sum, racial and socioeconomic disparities in health care access and outcomes are a significant public health problem, with widespread implications for the burden of chronic disease as people age. We found significant racial and socioeconomic disparities in outpatient physician service use and potentially preventable hospitalizations in our sample of NYC-dwelling older adults with diabetes. Variations in neighborhood walkability, public transit access, and primary care supply did not help to explain these disparities. Given the growing interest in community-based approaches to chronic illness prevention and management,⁵⁷ further research is needed to better understand the multiple factors that influence the ability to navigate health services among older adults with chronic illness, especially those at risk of unmet health care needs. Developing effective strategies to improve older adults' navigation of urban health systems will be critical to efforts such as the World Cities Project^{58,59} and the World Health Organization's Age-Friendly Cities initiative,⁶⁰ which call for global collaboration to identify effective policy interventions to improve accessibility of health care systems and population health. Even in an insured population living in a provider-dense city, targeted interventions may be needed to overcome barriers to chronic illness care for older adults in the community.

Acknowledgment

The authors would like to thank Kathryn Bowles, PhD, RN, FAAN, FACMI, Christopher Murtaugh, PhD, and Yolanda Barrón, MS, for their review of earlier versions of this manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Research reported in this publication was supported by the National Institute on Aging of the National Institutes of Health under Award Number K01AG039463. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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