Chronic Medication Nonadherence and Potentially Preventable Healthcare Utilization and Spending Among Medicare Patients

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BACKGROUND: The association between nonadherence to chronic medications and potentially preventable healthcare utilization and spending is largely unknown.
OBJECTIVES: To examine the associations of chronic medication nonadherence with potentially preventable utilization and spending among patients who were prescribed diabetic medications, renin-angiotensin system antagonists (RASA) for hypertension, or statins for high cholesterol, and compare the associations by patient race/ethnicity and socioeconomic status.
DESIGN: Retrospective cohort study. Medicare fee-for-service claims data from 2013 to 2016 for 177,881 patients.
MEASURES: Medication nonadherence was defined as having a below 80% proportion of days covered in each 6-month interval after the index prescription. Potentially preventable utilization was measured by preventable emergency department visits and preventable hospitalizations. Potentially preventable spending was calculated as the geographically adjusted spending associated with preventable encounters.
RESULTS: After adjustment for other patient characteristics, medication nonadherence was associated with a 1.7-percentage-point increase (95% confidence interval [CI]: 1.4 to 2.0 percentage points, $p < 0.001$) in the probability of preventable utilization among the diabetic medication cohort, a 1.7-percentage-point increase (95% CI: 1.5 to 1.9 percentage points, $p < 0.001$) among the RASA cohort, and a 1.0-percentage-point increase (95% CI: 0.8 to 1.1 percentage points, $p < 0.001$) among the statin cohort. Among patients with at least one preventable encounter, medication nonadherence was associated with $679–$898 increased preventable spending. The incremental probability of preventable utilization and incremental spending associated with nonadherence were higher among racial/ethnic minority and low socioeconomic groups.
CONCLUSIONS: Improving medication adherence is a potential avenue to reducing preventable utilization and spending. Interventions are needed to address racial/ethnic and socioeconomic disparities.

KEY WORDS: medication adherence; healthcare utilization; healthcare costs; healthcare quality; Medicare.

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INTRODUCTION

Unnecessary and preventable utilization may account for 25% of total healthcare spending in the USA.[1] To slow the spending growth and reduce overall healthcare spending, recent research has focused on improving care among patients with potentially preventable utilization.[2–5] These services, such as preventable emergency department (ED) visits, are usually used to treat uncontrolled chronic conditions (e.g., diabetes and hypertension), although these conditions can be managed through primary care or adherence to medications. Previous studies have found that 5–10% of Medicare spending was associated with potentially preventable hospitalizations and ED visits.[3, 4]

Pharmacological therapies are often an important part of chronic condition management. Medication adherence, defined as taking medications following providers' recommendations,[6] is critical for improving patient outcomes. Medication nonadherence is common among patients with chronic conditions[7, 8] and was associated with increased healthcare utilization and adverse outcomes.[7, 9, 10] Previous studies have primarily focused on medication nonadherence and total healthcare spending and utilization, with limited evidence on preventable utilization and spending.[10–13] Reducing preventable utilization has been identified as one of the key strategies to lower spending and improve quality.[14] Therefore, understanding how medication nonadherence is related to potentially preventable utilization and spending is important to inform effective care management strategies.

Using a sample of Medicare fee-for-service (FFS) patients from the New York metropolitan area during 2013–2016, we examined the association between medication nonadherence and potentially preventable utilization and spending among patients who were prescribed medications for type 2 diabetes, hypertension, and high cholesterol. Patients from racial/ethnic minority groups and those with lower socioeconomic status have higher nonadherence rates and may be more likely to use preventable acute care to manage chronic conditions, because

of their limited primary care access or other reasons.[15, 16] We therefore conducted analyses by patient race/ethnicity and socioeconomic status. We hypothesized that medication nonadherence is associated with increased potentially preventable utilization and spending, and patients who are racial/ethnic minorities or those with lower socioeconomic status have higher incremental probability of preventable utilization and incremental spending associated with medication nonadherence.

METHODS

Study Sample and Data

We identified patients enrolled in the Medicare FFS program, including Medicare-Medicaid dually enrolled patients who received care in the health systems affiliated with the INSIGHT Clinical Research Network (CRN), a network including five major health systems in New York City.[17] We identified Medicare patients who had at least one encounter in INSIGHT-affiliated health systems between 2013 and 2016.

We closely followed the inclusion/exclusion criteria for medication adherence measures of diabetes medications, renin-angiotensin system antagonists (RASA) for hypertension, and statins for high cholesterol defined by the Centers for Medicare and Medicaid Services (CMS)[18] and the Pharmacy Quality Alliance (PQA)[19], or as required by the purpose of this study. We considered all patients who had at least two pharmacy claims on different dates for at least one type of medication between July 1st, 2013, and June 30th, 2016. The date of their first prescription in each type of medication was defined as the index date. To include patients who were newly prescribed these medications, we required patients to be continuously enrolled in Medicare Part D and had no pharmacy claims for a given type of medication during the 6 months prior to the index date. In addition, patients were included if they (1) were continuously enrolled in Medicare Parts A, B, and D for at least 6 months after the index date so we could observe the medication use and healthcare utilization and (2) did not switch Part D plans during the study period so the plan benefits were consistent during the study period. Following the criteria adopted by the CMS and PQA, patients with end-stage renal disease (ESRD) were excluded from the diabetic medication cohort and RASA cohort. Because of our focus on non-insulin medications for type 2 diabetes, patients with one or more insulin prescriptions were excluded.[18]

Medication Nonadherence

We measured medication adherence for type 2 diabetes medications, RASA for hypertension, and statins for high cholesterol using the proportion of days covered (PDC) method. These measures were adopted by CMS as part of the Medicare Part D quality star ratings.[18, 19] The PDC is calculated as the number of days in the measurement period covered by a given type of medication divided by number of days in the measurement period.[20] The NQF defines high adherence as a PDC of at least 80%.[19] Thus, we classified patient intervals as "nonadherent" based on a PDC < 80% for a given type of medications.

We measured medication nonadherence over 6-month intervals following the index date. We included an interval in the analysis if the patient had continuous enrollment in Medicare Parts A, B, and D during this interval. Following the CMS's algorithm, we adjusted for overlapping fills of medications with the same ingredient(s) and patient stays in hospital, SNF, and hospice during each interval.[18] The algorithm assumes that a beneficiary receives their medications from the institutional provider during these stays. If a beneficiary accumulates an extra supply of their Part D medications during these stays, that supply can and will be used once the patient returns home.[18]

Potentially Preventable Utilization and Spending

Potentially preventable utilization included preventable ED visits and preventable hospitalizations.[3–5] Specifically, we used an algorithm created by Billings to identify potentially preventable ED visits, which has been validated and widely used in the literature.[21, 22] For each ED visit, this algorithm assigns a probability that the principal diagnosis of the ED visit falls into each of four categories: nonemergent; emergent but primary care treatable; emergent, ED care needed but preventable; and emergent, ED care needed, and not preventable. We determined an ED visit to be preventable if the combined probabilities of "nonemergent," "emergent but primary care treatable," and "emergent, ED care needed but preventable" were 75% or higher.[23] We included only ED visits not resulting in hospitalization.[3] Preventable ED visits followed by hospitalizations were treated as preventable hospitalizations.

To identify preventable hospitalizations, we used AHRQ's Prevention Quality Indicators (PQIs).[24] The PQIs include measures to identify hospitalizations for ambulatory care–sensitive conditions (ACSCs) that could potentially be prevented with chronic condition management.

The healthcare spending associated with a preventable ED visit or hospitalization could vary substantially. We thus included costs for all services during a preventable encounter (a preventable ED or hospitalization) and all other services delivered within 30 days after discharge, including physician, outpatient, hospitalizations, and post-acute care services (e.g., SNF).[3–5] We geographically standardized the cost to account for variations in Medicare payment rates across regions. Consistent with previous literature,[25, 26] we applied a county-level ratio of standardized spending over actual spending for each type of services (e.g., imaging and acute inpatient stay) derived from a CMS public use file to the claims of the same type of services, based on the geographic location of the provider

who delivered the services. Preventable health spending was inflation-adjusted using the Personal Consumption Expenditure Index of health services and presented in 2016 dollars.[27]

Patient Characteristics

We included patients' demographic and medical characteristics and neighborhood socioeconomic indicators of each interval as covariates in the analysis. Demographic characteristics included age, gender, and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and others). Medical characteristics included number of chronic conditions (< 3, 3–5, 6–8, 9 or more), ESRD (for the statin cohort only), and indicators of serious medical illness and frailty that were associated with high preventable utilization.[3, 4] We used the Chronic Condition Warehouse–defined conditions to calculate the number of chronic conditions.[28] Serious illness and frailty were defined using previously developed algorithms.[29, 30] We used the status of dual enrollment in both Medicare and Medicaid as proxy for patient socioeconomic status. We additionally controlled for neighborhood social economic conditions at the zip-code tabulation area (ZCTA) level, including median household income, % of population in poverty, % of population without high school degree, and unemployment rate.

Statistical Analyses

For each type of medication, we estimated two models at the patient-6-month interval level. We first estimated a logistic model for the outcome of having any preventable utilization (i.e., either a preventable hospitalization or preventable ED visit) in a 6-month interval. For patients with at least one preventable encounter in an interval, we estimated a generalized linear model with a log link and gamma distribution for the spending associated with the preventable utilization. In all models, the coefficient of interest is the one pertaining to nonadherence of the medication. All models controlled for demographic, medical, and social characteristics described above, ordinal indicators of the intervals (e.g., second, third, ..., up to seventh, with the first interval as the reference), and calendar year indicators. The models generated robust standard errors taking into account repeated measures (intervals) of the same patient.

We interacted race/ethnicity with medication nonadherence to examine how incremental preventable utilization and spending associated with medication nonadherence differed by patient race/ethnicity.

We conducted a series of secondary analyses. First, we interacted dual-enrollment status with medication nonadherence to examine variations in incremental preventable utilization and incremental spending associated with medication nonadherence by dual-enrollment status. Second, we restricted the sample to patients with at least two 6-month intervals to assess robustness of results. Third, as preventable utilization may not occur right after medication nonadherence, we examined the association between medication nonadherence in a given interval and outcomes in the following interval, using a restricted sample of patients with at least two consecutive intervals and the same model specification with the primary analysis. All analyses were conducted using STATA MP 14.0 software. The Institutional Review Board at Weill Cornell Medicine approved this study.

RESULTS

Patient Characteristics

A total of 177,881 unique Medicare patients were included in the analysis across all three types of medications, including 32,652 for diabetic medications (104,084 patient intervals), 78,222 for RASA (265,952 patient intervals), and 103,805 for statins (356,968 patient intervals). Patients who were dispensed two types of medications accounted for 16.6% of all patients and those dispensed all three types of medications accounted for 2.1%. Table 1 presents patient characteristics by medication type. Patients in the diabetic medication group had a mean age of 73; those in the RASA and the statin groups had a mean age of 75. Over half of patients were female and White patients accounted for over 60%. Over 30% of patients in all three groups were dually enrolled in Medicare and Medicaid. Approximately 90% of patients in all three groups had three or more chronic conditions. In addition, 16–19% of patients had frailty and 15–19% had serious medical illness.

Medication Nonadherence and Preventable Utilization and Spending

The mean PDC across all patient intervals was 71.1% for diabetic medications, 70.6% for RASA, and 67.4% for statins, indicating that 67–71% of days during an interval were covered by a medication. On average, 40.9% of patient intervals had medication nonadherence (PDC < 80%) for diabetic medications, 40.1% for RASA, and 46.4% for statins. These rates fell within the ranges reported in the literature.[31–34] The mean rate of preventable utilization was 8.7% across all patient intervals of diabetic medications, 9.2% of the RASA, and 8.8% of the statins.

Medication nonadherence was associated with an increased probability of preventable utilization and increased preventable spending across all three cohorts. Specifically, medication nonadherence was associated with a 1.7-percentage-point increase (95% confidence interval [CI]: 1.4 to 2.0 percentage points, $p < 0.001$) in the probability of preventable utilization among the diabetic medication cohort, a 1.7-percentage-point increase (95% CI: 1.5 to 1.9 percentage points, $p < 0.001$) among the RASA cohort, and a 1.0-percentage-point increase (95% CI: 0.8 to 1.1 percentage points, $p < 0.001$) among the statin cohort (Fig. 1). Among patients with at least one preventable encounter, medication nonadherence was associated with $737 (95% CI: $350–1123, $p < 0.001$) higher mean

Table 1 Demographic, Medical, and Social Characteristics by Medication Type Across Patient Intervals

	Diabetic medications (*N* = 104,084)	RASA (*N* = 265,952)	Statins (*N* = 356,968)
Patient characteristics			
Age, mean (SD)	73 (11)	75 (11)	75 (10)
Age categories (%)			
< 65	15.0	10.5	11.0
65–74	37.3	34.4	36.7
75–84	33.6	36.2	35.8
≥ 85	14.1	18.8	16.6
Female (%)	55.8	58.0	59.6
Race/ethnicity (%)			
White	61.9	68.6	68.8
Black	15.5	13.1	12.3
Hispanic	12.5	10.0	10.7
Other	10.1	8.3	8.2
ESRD (%)	–	–	2.1
Dual enrollment (%)	39.1	33.5	32.5
Frailty (%)	16.0	18.0	17.3
Serious medical illness (%)	14.2	16.5	15.4
Number of chronic conditions (%)			
< 3	9.5	13.4	13.1
3–5	37.9	38.4	39.0
6–8	35.5	31.8	32.2
≥ 9	17.1	16.4	15.8
Social conditions at ZCTA level by quintiles			
Median family income			
Quintile 1	18.0	16.5	16.3
Quintile 2	9.7	9.3	8.9
Quintile 3	15.8	14.7	14.2
Quintile 4	21.8	21.7	21.5
Quintile 5	34.8	37.9	39.2
% of families below poverty level			
Quintile 1	16.3	18.6	18.7
Quintile 2	22.2	23.4	24.3
Quintile 3	16.8	16.2	16.3
Quintile 4	16.9	16.3	15.9
Quintile 5	27.8	25.4	24.8
% of population without high school degree			
Quintile 1	13.0	15.7	16.5
Quintile 2	17.1	18.4	18.9
Quintile 3	17.5	17.2	17.3
Quintile 4	16.4	15.6	15.2
Quintile 5	36.0	33.1	32.1
Unemployment rate			
Quintile 1	6.4	7.1	7.7
Quintile 2	23.6	25.4	26.1
Quintile 3	27.0	27.2	26.9
Quintile 4	26.7	25.9	25.1
Quintile 5	16.4	14.3	14.2

ZCTA zip-code tabulation area, ESRD end-stage renal disease, RASA renin-angiotensin system antagonists

preventable spending among the diabetic medication cohort, $898 (95% CI: $616 to 1179, $p < 0.001$) among the RASA cohort, and $679 (95% CI: $450 to 907, $p < 0.001$) among the statin cohort (Fig. 2).

The incremental probability of preventable utilization associated with medication nonadherence varied by patient race/ethnicity. Medication nonadherence was associated with a greater probability of preventable utilization among Black patients, compared with White patients, across all three types of medications (Fig. 3). For example, medication nonadherence was associated with 3.4-percentage-point higher probability of preventable utilization among Black patients in the diabetic medication cohort, as compared with 1.4 percentage points among White patients (2.0-percentage-point difference, 95% CI: 0.9 to 3.1 percentage points, $p < 0.001$).

Among patients with at least one preventable encounter, the preventable spending associated with medication nonadherence did not differ significantly by race/ethnicity (Fig. 4). For example, medication nonadherence was associated with $790 higher preventable spending among Hispanic patients in the diabetic medication cohort, as compared with $765 among White patients ($26 difference, 95% CI: −$998 to 1049, $p = 0.96$).

Secondary Analyses

The incremental probability of preventable utilization associated with medication nonadherence varied by dual-enrollment status (eFigure 1), but there was no statistically significant difference in preventable spending associated with medication nonadherence (eFigure 2). We found similar results when only including patients with at least two 6-month intervals for each type of medication (eFigures 3 to 8). The associations of medication nonadherence in an interval with preventable utilization and spending in the following interval were also consistent with the primary analysis (eFigures 9 to 14). We also found that preventable ED visits were the driving factor for the higher probability of preventable utilization associated with medication nonadherence (eFigures 15 to 20).

DISCUSSION

Using Medicare data for 177,881 patients between 2013 and 2016, we found that medication nonadherence was associated with increased probabilities of preventable utilization and higher preventable spending among patients dispensed diabetic medications, RASA, or statins. Black and Hispanic patients (compared with White patients) and dual-enrolled patients (compared with Medicare-only patients) were disproportionately affected by medication nonadherence for having preventable utilization. A set of secondary analyses provided consistent findings. Compared with previous studies, major contributions of this study include that we expanded the definition of preventable utilization by including preventable ED visits and we estimated healthcare spending associated with preventable utilization, including the spending during the preventable encounters and the downstream post-acute spending triggered by these encounters.

Patients from racial/ethnic minority and socially disadvantaged groups are more likely to have preventable utilization.[35, 36] However, the sources and potential solutions for these disparities are not well understood. Primary care–based interventions have been widely adopted by health systems to reduce preventable utilization.[37, 38] Our findings provide evidence supporting interventions targeting medication adherence to reduce overall preventable utilization and related disparities. Improving medication adherence is a complex process involving collaborations among insurers, providers,

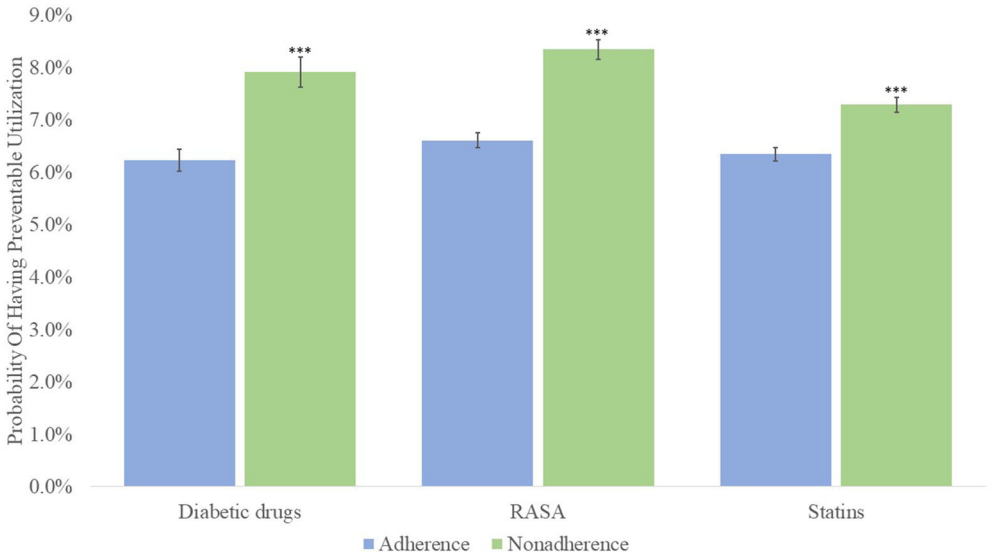

Figure 1 Association between medication nonadherence and the probability of preventable utilization for patients dispensed diabetic medications, RASA, or statins. Notes: Probabilities were predicted from the logistic regressions where having preventable utilization was the outcome and medication nonadherence was the independent variable of interest. Regressions were controlled for demographic, clinical, and social characteristics, as well as interval fixed effects and calendar year indicators. RASA: renin-angiotensin system antagonists. Statistical significance pertains to the difference in predicted probability conditional on adherence (reference group) and on nonadherence. ***$p < 0.001$.

pharmacies, and beneficiaries. Further research is needed to identify barriers faced by each stakeholder to improving medication nonadherence and design interventions to address these barriers.

Medication nonadherence is related to various patient and provider characteristics.[7, 39] The cost of medications has been identified as a major contributing factor to medication nonadherence. Approximately 8% of adults in the USA do not take medications as prescribed because they cannot afford it.[40] Other patient factors include low health literacy, lack of motivation, and perceptions toward the effectiveness, risks, and necessity of the prescribed medications.[7, 41, 42] Provider factors include patient-physician relationship and the experience and credibility of the providers.[7, 43] In addition, the lack of accessibility of pharmacies in patients' neighborhoods is also associated with medication nonadherence.[44] The high medication nonadherence rates observed in our and previous studies call for multifactorial approaches to improve medication adherence and reduce unnecessary utilization and spending.

Our findings suggest that, for patients from racial/ethnic minority groups and those with lower socioeconomic

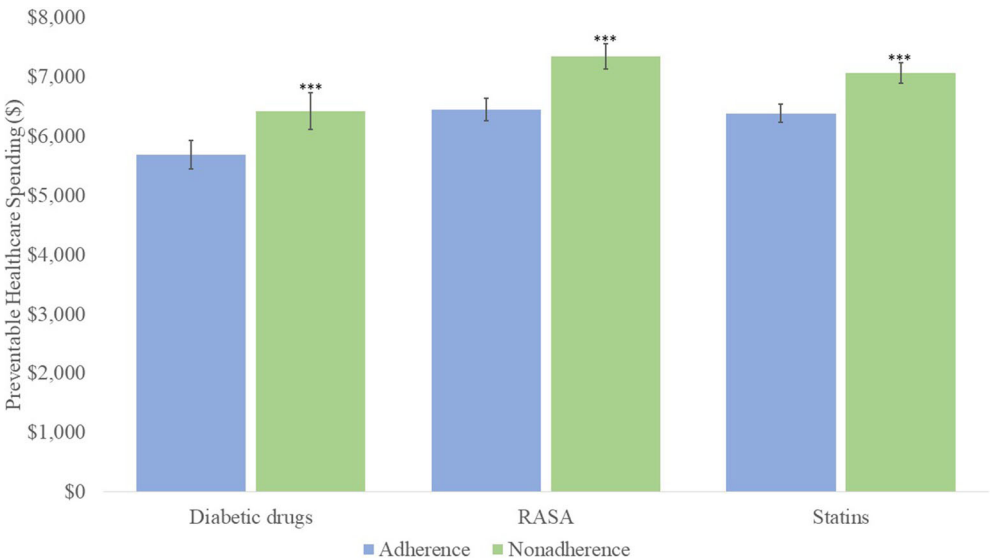

Figure 2 Association between medication nonadherence and preventable spending for patients dispensed diabetic medications, RASA, or statins. Notes: Preventable spending was predicted from the generalized linear models where preventable spending was the outcome and medication nonadherence was the independent variable of interest. Regressions were controlled for demographic, clinical, and social characteristics, as well as interval fixed effects and calendar year indicators. RASA: renin-angiotensin system antagonists. Statistical significance pertains to the difference in preventable spending conditional on adherence (reference group) and on nonadherence. ***$p < 0.001$.

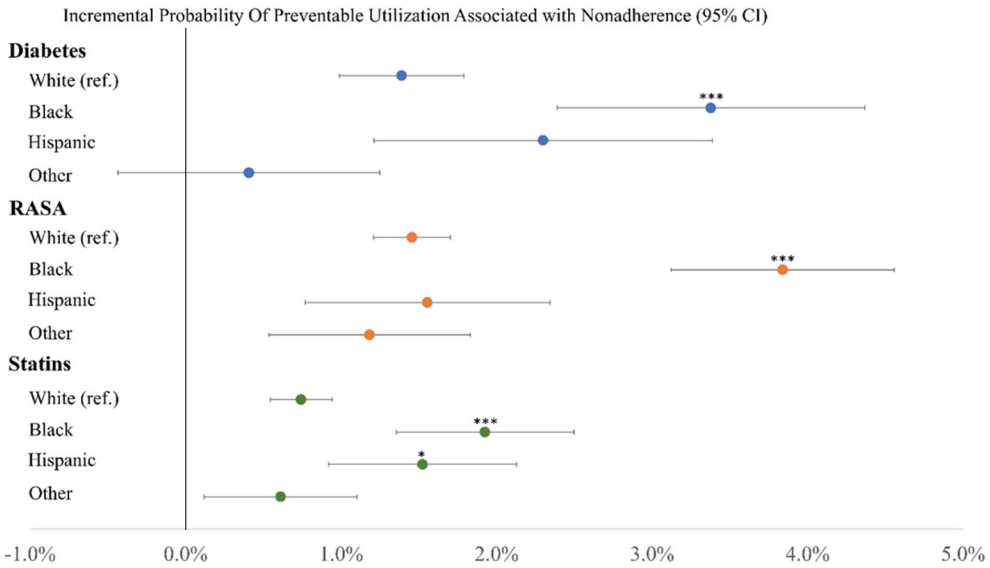

Figure 3 Incremental probability of preventable utilization associated with medication nonadherence, by patient race/ethnicity. Notes: Probabilities were predicted from the logistic regressions where having preventable utilization was the outcome and the interactions between race/ethnicity and medication nonadherence were the independent variables of interest. Regressions were controlled for demographic, clinical, and social characteristics, as well as interval fixed effects and calendar year indicators. RASA: renin-angiotensin system antagonists. Statistical significance pertains to the difference in incremental probability of preventable utilization associated with nonadherence between Black, Hispanic, other, and White (reference group). ***$p < 0.001$; *$p < 0.05$.

status, chronic medication nonadherence may have had greater adverse effects in terms of preventable utilization and spending, compared with White patients and patients with higher socioeconomic status. This could be because racial/ethnic minority patients and patients with lower socioeconomic status had poorer access to timely primary care when they have uncontrolled conditions as a result of medication nonadherence,[45–47] resulting in greater preventable acute care and spending.

Another important reason for the greater incremental preventable utilization associated with medication nonadherence for dual-enrolled patients could be poor care coordination. Dually enrolled patients on average used a higher level of healthcare from a larger group of providers under the dual-payer reimbursement model.[48, 49] Medicare and Medicaid usually have little incentives to coordinate care for dually enrolled patients.[49, 50] For example, coordinating care delivery between nursing homes and hospitals could generate cost

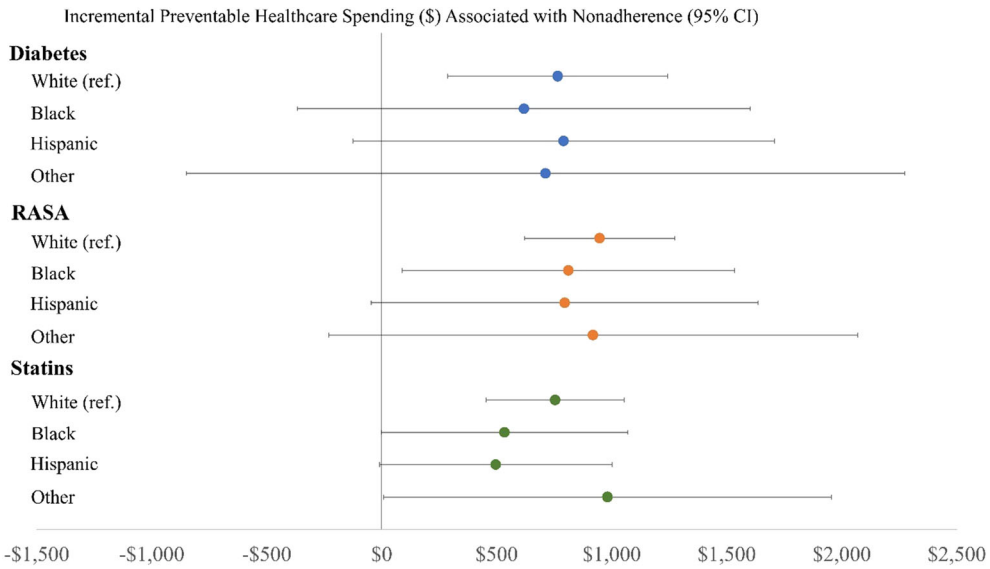

Figure 4 Incremental preventable spending associated with medication nonadherence, by patient race/ethnicity. Notes: Preventable spending was predicted from the generalized linear model where preventable spending was the outcome and the interactions between race/ethnicity and medication nonadherence were the independent variables of interest. Regressions were controlled for demographic, clinical, and social characteristics, as well as interval fixed effects and calendar year indicators. RASA: renin-angiotensin system antagonists. Statistical significance pertains to the difference in incremental preventable spending associated with nonadherence between Black, Hispanic, other, and White (reference group).

savings by reducing preventable hospitalizations. However, Medicaid may have little incentive to implement it as hospitalizations are paid by Medicare. The misaligned incentives can discourage care coordination when dual-enrolled patients have uncontrolled chronic conditions that lead to greater use of preventable acute care services. More research is needed to understand the barriers to medication adherence among minority patients to address health disparities.

This study has several limitations. First, we used data pertaining to Medicare patients who received care in health systems in NYC. Findings of this study may not be generalizable to Medicare patients in other regions or patients who are enrolled in Medicaid or commercial plans. Second, although the definitions of the preventable ED visits and preventable hospitalizations have been widely used in the literature, they may not encompass all preventable utilization. The algorithms may overestimate preventable utilization. For example, not all hospitalizations for "ambulatory-sensitive" conditions may in fact be preventable.[51] In addition, ED diagnoses are associated with high clinical uncertainty and diagnostic codes encompass conditions with varying severity. As a result, the Billings algorithm may misclassify some ED visits as preventable. Third, we were not able to include Medicaid data for dual-enrolled patients. The preventable utilization and spending may thus be underestimated for dual-enrolled patients. Fourth, excluding patients with any insulin claims means that we excluded patients with type 2 diabetes who took both insulin injections and oral medications. However, this exclusion is necessary as oral diabetes medications may need to be tapered and discontinued when insulin is initiated, leading to a false classification of non-adherent to oral medications. Finally, although we have controlled for a comprehensive set of patient and regional characteristics, patients with nonadherence were still likely different from adherent patients in other ways that make them more susceptible to preventable utilization. Therefore, our findings may overestimate associations between nonadherence and preventable utilization.

CONCLUSION

Our study highlights the importance of improving medication adherence as a potential avenue to reduce unnecessary healthcare utilization and spending. Probably more importantly, interventions to improve chronic medication adherence and their evaluations should be targeted at minority patients and patients with lower socioeconomic status for whom the adverse consequences of nonadherence could be direr.

Supplementary Information *The online version contains supplementary material available at https://doi.org/10.1007/s11606-021-07334-y*

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Declarations:

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

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