Factors Associated with County-Level Variation in the Prescription of Statins

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ABSTRACT

BACKGROUND: The American College of Cardiology/American Heart Association recommends statins for adults aged 40-75 years with a cardiovascular disease risk factor and a 10-year risk of cardiovascular events of 7.5%-19.9%.

OBJECTIVE: To examine the association of county-level social determinant measures of health and composition of health services with use of statin prescriptions under Medicare Part D.

METHODS: We used 2013 Medicare Part D prescriber county-level data to construct 2 measures of statin use: (1) statin beneficiaries ÷ total beneficiaries (prevalence [β_{PR}]) and (2) statin days supplied ÷ (total beneficiaries $\times$ 365; adequacy of supply [β_{AS}]). We used multivariable regression to estimate the association of each measure with county-level demographics and health service measures.

RESULTS: A 1 standard deviation (SD) increase in the proportion of African Americans living in a county is associated with a 0.096 SD decrease in adequacy of supply ($\beta_{AS} = -0.096$; 95% CI = -0.14 to -0.06). The proportion of county residents aged 65+ years who are female was associated with higher prevalence and adequacy of supply ($\beta_{PR} = 0.06$; 95% CI = 0.02 to 0.11; $\beta_{AS} = 0.09$; 95% CI = 0.05 to 0.14). Counties with higher proportions of Medicare Part D prescription expenditures receiving low-income subsidies had lower adequacy of supply ($\beta_{AS} = -0.28$; 95% CI = -0.32 to -0.23). Counties with a higher proportion of Medicare Part D prescribers who are nurse practitioners was associated with lower prevalence and adequacy of supply ($\beta_{PR} = -0.39$; 95% CI = -0.44 to -0.35; $\beta_{AS} = -0.42$; 95% CI = -0.47 to -0.37).

CONCLUSIONS: Race and ethnicity, income, and distribution of provider types were significantly associated with county-level variation in statin use, despite being unlikely to measure differences in actual medical need. Such variation more likely reflects predisposing and enabling factors potentially affected by social, economic, and public health policy. Tracking variation in county-level statin use associated with these factors could help policymakers assess progress in reducing health care disparities and better target program resources.

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What this study adds

- County-level Medicare Part D statin prescription rates vary by county-level measures of race and ethnicity, with lower adequacy of supply (statin prescription days per beneficiary day) in counties with a higher proportion of residents who are black or African American (standardized $\beta = -0.096$), Hispanic/Latino (standardized $\beta = -0.084$), or American Indian/Alaskan Native (standardized $\beta = -0.102$).
- Adequacy of supply is lower in counties with higher proportions of uninsured residents (standardized $\beta = -0.202$) and where a higher proportion of county-level Medicare Part D drug costs are eligible for low-income subsidy (standardized $\beta = -0.276$).
- Counties with a higher proportion of prescribing providers who are nurses (standardized $\beta = -0.418$) or physician assistants (standardized $\beta = -0.379$) have lower adequacy of supply.

Cardiovascular disease is the leading cause of mortality in the United States.¹ The United States Preventive Services Task Force currently recommends statins for adults aged 40-75 years with at least 1 cardiovascular disease risk factor and a 10-year risk of cardiovascular events of $\geq 10\%$, while the American College of Cardiology/American Heart Association (ACC/AHA) currently recommends statins for adults with risk of atherosclerotic cardiovascular disease as low as 7.5% after a clinician-patient risk discussion.^{2,3}

Previous studies have shown differences in statin use by race and ethnicity, gender, and class. Specifically, nonwhites and Hispanics/Latinos are less likely to use statins than non-Hispanic/Latino whites; women are less likely to use statins than men; and those with lower incomes are less likely to use statins than those with higher incomes.⁴⁻⁸ Adopting the terminology of Andersen's behavioral model of health services use,⁹ to the extent that observed differences are a result of predisposing and enabling factors such as race and ethnicity, gender, and socioeconomic class rather than medical need, such differences may indicate disparities.

If national individual-level survey evidence holds true more generally, we would expect to find confirmatory evidence in national prescription data. Therefore, we used an ecological model to examine associations between social determinants of health (SDOH) and Medicare Part D statin prescription rates at the U.S. county level in 2013, which serves as an

What is already known about this subject

- The American College of Cardiology/American Heart Association recommends statins for adults aged 40-75 years with a cardiovascular disease risk factor and a 10-year risk of cardiovascular events of 7.5%-19.9%.
- In U.S. survey and self-reported data, statin use varies by race and ethnicity, income, and gender at the individual level.

important baseline year for comparison, since ACC/AHA guidelines issued that year expanded the population considered appropriate for primary prevention with statins to an estimated one third of U.S. adults.¹⁰

Our primary objective for this study was to examine the association of variables related to race and ethnicity, gender, and class with statin prescription. The secondary objective was to explore the effects of predisposing and enabling covariates for hypothesis generation.

Methods

Data Sources

We obtained data on prescription drugs prescribed by physicians and other health care providers that were paid under the Medicare Part D prescription drug program from the 2013 Medicare Part D Prescriber Public Use File.¹¹ Provider summary and drug detail files included total beneficiaries, costs, claims, and days supply by drug category for each provider, as well as general provider information.¹² Prescriptions for Part D prescribers that were filled under low-cost retail pharmacy programs outside of Part D were not captured.

We compiled a list of heart-related medications from the literature.^{14,15} We then selected providers in the continental United States who had prescribed a heart-related medication, had credential and specialty information indicating work in a primary care function, and who were listed as either an MD or DO, a prescribing nurse, or a physician assistant. To assign providers to counties, we compiled a list of provider ZIP codes spanning more than 1 county, using the U.S. Census 2010 ZIP Code Tabulation Area Relationship File.¹⁶ For ZIP codes contained within 1 county, we used the `sashelp.zip` table (listing the primary county for each ZIP code) to assign provider county. For providers in ZIP codes spanning multiple counties, we used the Texas A&M University (TAMU) geocoder.¹⁷

Dependent Variables

We derived 2 county-level statin utilization dependent variables: Statin prescription prevalence (β_{PR}) was defined as the number of Part D beneficiaries in a county receiving statins divided by the total number of county Part D beneficiaries; statin adequacy of supply (β_{AS}) was defined as the sum of days supply of statins to Part D beneficiaries within a county divided by the total number of Part D beneficiaries within a county, multiplied by 365. We included the latter measure to better incorporate continuity of treatment.¹³

Covariates

County-level covariates were derived from a variety of sources, including the 2015 County Health Rankings (CHR), which comprises various secondary sources mostly from 2013.^{18,19} Other data sources included American Fact Finder,²⁰ the Centers for Medicare & Medicaid Services (CMS) Open Payments List of

Teaching Hospitals,²¹ Medicare Part D Enrollment Dashboard data, and Medicare Geographic Variation Public Use File.²²⁻²⁴ We selected covariates in 2 stages. First, we assessed validity for inclusion among variables representing similar constructs by using theoretical considerations and reviewing the statin prescription literature. Second, we excluded potential covariates if they significantly increased the variance inflation index or significantly reduced the number of counties available for analysis. When possible, we replaced variables reducing the number of observations with comparable covariates that did not reduce the number of observations. The data sources for all covariates are given in Table 1.

Covariates to test the main hypotheses included the proportion of county residents who identify according to U.S. Census-based race categories (Black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Pacific Islander) and Hispanic or Latino ethnicity. We included the proportions of all county residents and of residents aged 65 years and over who were female because potential sex-related differences in cardiovascular mortality could alter county gender composition.²⁵ Covariates related to socioeconomic class included median household income in U.S. dollars, the proportion of county residents who were uninsured, the proportion unemployed, and the proportion of county Medicare Part D prescription total costs covered under Medicare Part D low-income subsidies. Other predisposing contextual factors included proportions of county residents living in a rural area, the proportion aged 65 years and older, the proportion not proficient in English, the number of social associations (membership organizations) per 10,000 population,²⁶ and the proportion of residents who attended at least some college.

Covariates related to health services delivery enabling factors included the proportion of selected prescribing providers who were doctors (MD or DO), nurses, or physician assistants and the proportion who were female. We also included the rate of primary care physicians per 100,000 population, the number of primary care physicians per Part D beneficiary, proportion of Medicare Part D prescription costs that were generic, proportion of Medicare Part D prescription costs that were through Medicare Advantage, and Medicare Part D enrollment. To estimate county-level access to teaching hospitals, we calculated the average distance between the geographic coordinates of each county ZIP code centroid to the coordinates of the addresses of teaching hospitals listed in the CMS Open Payments List of Teaching Hospitals.

Finally, we included county-level average Hierarchical Condition Category (HCC) risk scores from 2013 Medicare geographic variation data,^{23,24} as well as the proportion of county residents who self-reported being physically inactive or diabetic as factors that may be related to actual medical need for statins.

Factors Associated with County-Level Variation in the Prescription of Statins

TABLE 1 Variables Included in the County-Level Analysis that Explored Primary Care Statin Prescription Prevalence and Adequacy of Supply in 2013 Medicare Part D Providers

Variable (N = 3,029 ^a)	Calculation Within the Dataset (If Applicable)	Mean (SD)
Dependent variables		
Statin prescription prevalence ^b (n = 2,994)	Statin beneficiaries in county ÷ total beneficiaries in county	0.241 (0.063)
Statin adequacy of supply ^b (n = 2,994)	Sum (statin day supply in county) ÷ (total beneficiaries in county × 365)	0.153 (0.044)
Covariates related to main hypotheses		
Proportion black or African American ^c		0.091 (0.144)
Proportion American Indian or Alaska Native ^c		0.019 (0.065)
Proportion Asian ^c		0.013 (0.022)
Proportion Native Hawaiian or other Pacific Islander ^c		0.001 (0.001)
Proportion Hispanic or Latino ^c		0.088 (0.133)
Proportion female ^c		0.5 (0.022)
Proportion females in 65+ age group ^d	# females 65+ in county ÷ # 65+ in county	0.554 (0.027)
County median income ^e , \$		45,832 (11,584)
Proportion uninsured ^c		0.212 (0.064)
Proportion unemployed ^c		0.073 (0.026)
Fraction of drug costs prescribed as generic ^b (n = 3,027)	Generic drug costs in county ÷ total drug costs in county	0.299 (0.043)
Fraction of drug costs prescribed under LIS ^b (n = 3,028)	LIS drug costs in county ÷ total drug costs in county	0.538 (0.141)
Fraction of drug costs prescribed under MAPD plans ^b (n = 3,016)	MAPD costs in county ÷ total drug costs in county	0.207 (0.139)
Control variables		
Proportion female providers ^b	# female providers in county ÷ # total providers in county	0.494 (0.169)
Proportion doctors ^b	# doctors in county ÷ # total providers in county	0.6 (0.194)
Proportion nurses ^b	# nurses in county ÷ # total providers in county	0.266 (0.185)
Proportion physician assistants ^b	# physician assistants in county ÷ # total providers in county	0.134 (0.159)
Proportion living in a rural area ^c		0.576 (0.311)
Proportion aged over 65 years ^c		0.172 (0.043)
Proportion non-English speakers ^c		0.018 (0.029)
Proportion inactive ^c		0.27 (0.053)
Proportion obese ^c		0.307 (0.044)
Proportion diabetic ^c		0.11 (0.023)
Rate of primary care physicians per 100,000 population ^c (n = 2,919)		55.848 (33.671)
Proportion with at least some college ^c		0.556 (0.114)
Rate of social associations per 10,000 population ^c		13.884 (6.884)
Medicare Part D enrollment count ^c (n = 3,027)		11,523 (32,998)
Average Medicare risk score ^f (n = 3,027)		0.947 (0.095)
Average distance in miles to nearest teaching hospitals ^g	Sum (distance in miles from county provider's ZIP code centroid to the nearest teaching hospital) ÷ # providers in county	23.349 miles (23.871)
Fraction of Part D prescribing doctors over the number of Part D enrollees ^h (n = 3,027)	# Primary care providers who are doctors in county ÷ # Part D enrollees in county	0.004 (0.003)

^aUnless otherwise indicated.

^bSourced or calculated from Part D Prescriber Data 2013.¹¹

^cSourced from County Health Rankings 2015.^{18,19}

^dSourced from the American Community Survey 2009-2013.²⁰

^eSourced from Medicare Program Statistics Enrollment Dashboard Data File 2013.²²

^fSourced from Medicare Geographic Variation 2013.^{23,24}

^gSourced from Part D Prescriber Data 2013 and Open Payments List of Teaching Hospitals.^{11,21}

^hSourced from Part D Prescriber Data 2013 and Program Statistics Enrollment Dashboard.^{11,22}

LIS = low-income subsidy; MAPD = Medicare Advantage Prescription Drug plan; SD = standard deviation.

Analysis

All selected covariates previously described were included in multivariable linear regression models for each dependent variable. The model for prevalence and adequacy of supply is as follows:

$$y_j = \alpha + X_j\beta + \varepsilon_j, \text{ for } j = 1, \dots, J$$

where j indexes the total counties J ; X_j is a vector of 28 covariates; and β is a 28x1 vector of county-level coefficients. Counties missing data for any covariates were excluded from the final models.

We assessed goodness of fit using R squared (R^2) and the Akaike Information Criterion (AIC). To better compare the

TABLE 2 Statin Prescription Prevalence and Adequacy of Supply Among 2013 Medicare Part D Primary Care and Related Providers

Variable	Statin Prescription Prevalence Estimate (95% CI)	Statin Prescription Adequacy of Supply Estimate (95% CI)
Intercept	−0.011 (−0.039 to 0.017)	−0.010 (−0.039 to 0.019)
Proportion black or African American	−0.022 (−0.063 to 0.018)	−0.096 (−0.137 to −0.055)
Proportion American Indian or Alaska Native	−0.116 (−0.15 to −0.082)	−0.102 (−0.136 to −0.068)
Proportion Asian	0.020 (−0.022 to 0.063)	0.029 (−0.014 to 0.072)
Proportion Native Hawaiian or Other Pacific Islander	0.002 (−0.03 to 0.034)	0.002 (−0.031 to 0.034)
Proportion Hispanic or Latino	−0.040 (−0.098 to 0.019)	−0.084 (−0.144 to −0.025)
Proportion female	0.003 (−0.032 to 0.039)	0.003 (−0.033 to 0.039)
Proportion females aged 65+ years	0.063 (0.02 to 0.107)	0.091 (0.047 to 0.135)
County median income in dollars	0.043 (−0.011 to 0.096)	−0.017 (−0.072 to 0.037)
Proportion uninsured	−0.164 (−0.216 to −0.112)	−0.202 (−0.255 to −0.15)
Proportion unemployed	0.088 (0.049 to 0.127)	0.053 (0.013 to 0.093)
Fraction of drug costs prescribed as generic	−0.076 (−0.111 to −0.04)	−0.062 (−0.098 to −0.026)
Fraction of drug costs prescribed under a low-income subsidy	−0.157 (−0.202 to −0.112)	−0.276 (−0.321 to −0.23)
Fraction of drug costs prescribed under Medicare Advantage plans	0.094 (0.061 to 0.128)	0.046 (0.012 to 0.08)
Proportion female providers	0.042 (0.005 to 0.079)	0.024 (−0.013 to 0.062)
Proportion nurses	−0.391 (−0.435 to −0.347)	−0.418 (−0.463 to −0.374)
Proportion physician assistants	−0.324 (−0.363 to −0.285)	−0.379 (−0.418 to −0.339)
Proportion living in a rural area	0.073 (0.025 to 0.121)	0.051 (0.002 to 0.099)
Proportion aged over 65 years	−0.011 (−0.058 to 0.036)	−0.014 (−0.062 to 0.034)
Proportion of non-English speakers	0.087 (0.028 to 0.145)	0.095 (0.035 to 0.154)
Proportion inactive	−0.015 (−0.068 to 0.037)	−0.037 (−0.09 to 0.016)
Proportion obese	0.008 (−0.045 to 0.06)	0.013 (−0.041 to 0.066)
Proportion diabetic	0.141 (0.077 to 0.205)	0.108 (0.043 to 0.173)
Proportion with at least some college	−0.039 (−0.091 to 0.013)	−0.061 (−0.114 to −0.008)
Rate of social associations per 10,000 population	−0.075 (−0.116 to −0.033)	−0.063 (−0.105 to −0.021)
Medicare Part D enrollment count	−0.073 (−0.108 to −0.037)	−0.069 (−0.105 to −0.033)
Average Medicare risk score	0.238 (0.192 to 0.283)	0.174 (0.128 to 0.22)
Average distance in miles to nearest teaching hospital	0.013 (−0.017 to 0.043)	0.025 (−0.005 to 0.056)
Fraction of doctors in dataset over number of Part D enrollees	−0.308 (−0.345 to −0.271)	−0.307 (−0.345 to −0.269)

Note: Bold type signifies a statistically significant result (95% CI excluding 0).
CI=confidence interval.

coefficients of the different covariates with a wide range of variability between predictors, we standardized dependent variables and covariates by subtracting the mean and dividing by 1 SD. Therefore, regression coefficients should be interpreted as the association of a 1 SD difference in the covariate with a 1 SD change in the outcome. We conducted all analyses using SAS Enterprise Guide version 6.1 (SAS Institute, Cary, NC).

Results

Cardiovascular prescription data were available for the 268,473 selected providers in 3,029 counties in the continental United States. Across the 2,994 counties that had 1 or more providers where the number of statin beneficiaries were nonredacted, the mean statin prescription prevalence was 24.1% (SD 6.3%), and the mean statin adequacy of supply was 15.3% (SD 4.4%). Means and SDs for all variables are given in Table 1.

The regression analyses included 2,986 counties with complete data. The statin prescription prevalence ($_{PR}$) model had higher R^2 and lower AIC values ($R^2_{PR}=0.38$; $AIC_{PR}=-1,371$) than the statin prescription adequacy of supply ($_{AS}$) model ($R^2_{AS}=0.36$; $AIC_{AS}=-1,296$). Standardized beta coefficients (β) and 95% confidence intervals (CI) for each of the covariates in the 2 models are shown in Table 2.

On average, 9.1% (SD 14.4%) of county residents were black or African American; 8.8% (SD 13.3%) were Hispanic/Latino; and 2% (SD 6.5%) were American Indian or Alaska Native. All other variables held equal, a 1 SD (14.4%) increase in the proportion of black or African Americans within a county was associated with a -0.096 SD (95% CI= -0.137 to -0.055), or a -0.4% difference in adequacy of supply. For a typical 2013 U.S. county with approximately 12,000 Medicare Part D beneficiaries, the difference would be approximately 50 fewer full-year prescriptions. A 1 SD increase in the proportion of Hispanic/Latinos within a county was associated on average with a -0.084

SD (95% CI=-0.144 to -0.025) difference in the adequacy of supply. A 1 SD increase in the proportion of American Indian/Alaska Natives was associated with a -0.116 SD (95% CI=-0.15 to -0.08) difference in statin prevalence and a -0.102 SD (95% CI=-0.14 to -0.07) difference in adequacy of supply. However, proportion of non-English speakers was associated with higher statin prevalence and adequacy of supply ($\beta_{PR}=0.09$; 95% CI=0.03 to 0.15; $\beta_{AS}=0.10$; 95% CI=0.04 to 0.15).

On average, 50% (SD 2%) of all county residents and 55% (SD 3%) of county residents aged 65 years and over were female. We found no significant association between the proportion of all county residents who were female with either outcome. However, counties with higher proportions of female residents aged 65 years and over had higher statin prevalence ($\beta_{PR}=0.06$; 95% CI=0.02 to 0.11) and adequacy of supply ($\beta_{AS}=0.09$; 95% CI=0.05 to 0.14).

Counties with higher proportions of uninsured residents had both lower statin prevalence ($\beta_{PR}=-0.16$; 95% CI=-0.22 to -0.11) and adequacy of supply ($\beta_{AS}=-0.20$; 95% CI=-0.26 to -0.15). Counties with higher proportions of Part D drug costs covered under the low-income subsidy (LIS) program also had lower statin prevalence ($\beta_{PR}=-0.16$; 95% CI=-0.20 to -0.11) and adequacy of supply ($\beta_{AS}=-0.28$; 95% CI=-0.32 to -0.23). In the original scale of the outcome, a 1 SD (14%) increase in the proportion of Part D drug costs covered under LIS was associated with a 1.2% (0.276 SD) decrease in statin adequacy of supply. For a county of 12,000 Medicare Part D beneficiaries, the difference would be approximately 141 fewer full-year prescriptions. However, all else being equal, counties with higher unemployment had higher statin prevalence and adequacy of supply ($\beta_{PR}=0.09$; 95% CI=0.05 to 0.13; $\beta_{AS}=0.05$; 95% CI=0.01 to 0.09). Counties with higher numbers of social organizations per 10,000 population also had lower rates of statin prevalence and adequacy of supply ($\beta_{PR}=-0.08$; 95% CI=-0.12 to -0.03; $\beta_{AS}=-0.06$; 95% CI=-0.11 to -0.02). In addition, counties with higher proportions of residents attending at least some college had lower adequacy of supply ($\beta_{AS}=-0.06$; 95% CI=-0.11 to -0.01).

Of the covariates potentially associated with medical need, the strongest association with higher statin prescription prevalence and supply adequacy was the average Medicare HCC risk score ($\beta_{PR}=0.24$; 95% CI=0.19 to 0.28; $\beta_{AS}=0.17$; 95% CI=0.13 to 0.22). The proportion of county residents with diabetes was also positively associated with higher statin prevalence and adequacy of supply ($\beta_{PR}=0.14$; 95% CI=0.08 to 0.21; $\beta_{AS}=0.11$; 95% CI=0.04 to 0.17).

Of health services-related covariates, the strongest association with lower prevalence and supply adequacy was the proportion of prescribing providers who are nurses ($\beta_{PR}=-0.39$; 95% CI=-0.44 to -0.35; $\beta_{AS}=-0.42$; 95% CI=-0.47 to -0.37). In the original scale of the outcome, a 1 SD (18%) increase in the proportion of nurses reduces the average adequacy of

supply from 15.3% to 13.4%. Other factors most strongly associated with lower statin prescription prevalence and adequacy of supply were the proportion of prescribing providers who are physician assistants ($\beta_{PR}=-0.32$; 95% CI=-0.36 to -0.29; $\beta_{AS}=-0.38$; 95% CI=-0.42 to -0.34) and the fraction of statin-prescribing doctors over the number of Part D enrollees ($\beta_{PR,AS}=-0.31$; 95% CI=-0.35 to -0.27). Proportion of residents living in a rural area was associated with higher statin prevalence and adequacy of supply ($\beta_{PR}=0.07$; 95% CI=0.03 to 0.12; $\beta_{AS}=0.05$; 95% CI=0.00 to 0.10).

Discussion

Our results lend support to the hypothesis that counties with higher proportions of nonwhites and Hispanic/Latinos will have lower statin use, particularly when examining supply adequacy. While associations with statin use at the county level are modest in terms of effect sizes, they are not trivial for an ecological study, particularly when the changes are applied to county population sizes.

We did not find support for lower statin use in counties with higher proportions of females; rather we found evidence that counties with higher proportions of county residents aged 65 years and older who are female have higher statin prevalence and supply adequacy. We can examine differences in survival by gender by including the proportion of county residents aged 65 years and older who are female. However, there are no means by which we can control for need within the male and female subpopulations.

We found support for the hypothesis that counties with poorer socioeconomic status had lower statin use. A surprising result was that the proportion of unemployed had a positive association with the outcome variables. This may be due to policy effects of social safety net programs after controlling for the proportion uninsured—variables that were not included in the models. Counties in states allowing for longer periods of unemployment before losing benefit eligibility will have higher proportions of recorded unemployed. If these counties also facilitate health care use, it would result in a positive association.

The most interesting exploratory results relate to provider composition. A negative association between primary care doctors per Part D enrollees and both outcomes is partially explained by a lack of doctor availability. Counties included in the regression without any recorded Part D doctors ($n=77$) will have zero for the ratio of primary care doctors per Part D enrollees. Yet these counties have nonzero statin prescription prevalence and adequacy of supply, contributing to the negative coefficient.

The strong coefficients for the provider type covariates may have an explanation within provider location. All other variables held equal, counties with higher proportions of prescribing doctors relative to nurses and physician assistants may be areas of greater patient need. Exploring Pearson

TABLE 3 Comparison of Full and Restricted Models

Predictor	Statin Prescription Prevalence Estimate (95% CI), Main Hypothesis Model	Statin Prescription Rate Estimate (95% CI), Main Hypothesis Model	Statin Prescription Prevalence Estimate (95% CI), Full Model	Statin Prescription Rate Estimate (95% CI), Full Model
Intercept	-0.005 (-0.037 to 0.028)	-0.002 (-0.035 to 0.031)	-0.005 (-0.02 to 0.009)	-0.005 (-0.02 to 0.009)
Proportion black or African American	0.045 (0.003 to 0.088)	-0.036 (-0.079 to 0.006)	-0.022 (-0.063 to 0.018)	-0.096 (-0.137 to -0.055)
Proportion American Indian or Alaska Native	-0.149 (-0.184 to -0.114)	-0.150 (-0.186 to -0.115)	-0.116 (-0.15 to -0.082)	-0.102 (-0.136 to -0.068)
Proportion Asian	-0.045 (-0.088 to -0.003)	-0.027 (-0.069 to 0.016)	0.020 (-0.022 to 0.063)	0.029 (-0.014 to 0.072)
Proportion Native Hawaiian or Other Pacific Islander	-0.039 (-0.074 to -0.003)	-0.027 (-0.063 to 0.009)	0.002 (-0.03 to 0.034)	0.002 (-0.031 to 0.034)
Proportion Hispanic or Latino	-0.021 (-0.064 to 0.023)	-0.048 (-0.092 to -0.004)	-0.040 (-0.098 to 0.019)	-0.084 (-0.144 to -0.025)
Proportion female	0.142 (0.101 to 0.183)	0.157 (0.115 to 0.198)	0.003 (-0.032 to 0.039)	0.003 (-0.033 to 0.039)
Proportion females aged 65+ years	0.010 (-0.027 to 0.046)	0.006 (-0.031 to 0.042)	0.063 (0.02 to 0.107)	0.091 (0.047 to 0.135)
County median income in dollars	0.066 (0.011 to 0.121)	0.022 (-0.033 to 0.078)	0.043 (-0.011 to 0.096)	-0.017 (-0.072 to 0.037)
Proportion uninsured	-0.039 (-0.091 to 0.014)	-0.077 (-0.13 to -0.024)	-0.164 (-0.216 to -0.112)	-0.202 (-0.255 to -0.15)
Proportion unemployed	0.226 (0.185 to 0.266)	0.189 (0.148 to 0.23)	0.088 (0.049 to 0.127)	0.053 (0.013 to 0.093)
Fraction of drug costs prescribed as generic	-0.068 (-0.106 to -0.03)	-0.041 (-0.079 to -0.003)	-0.076 (-0.111 to -0.04)	-0.062 (-0.098 to -0.026)
Fraction of drug costs prescribed under low-income subsidy	-0.068 (-0.113 to -0.023)	-0.215 (-0.261 to -0.17)	-0.157 (-0.202 to -0.112)	-0.276 (-0.321 to -0.23)
Fraction of drug costs prescribed under Medicare Advantage plans	0.185 (0.15 to 0.22)	0.133 (0.098 to 0.169)	0.094 (0.061 to 0.128)	0.046 (0.012 to 0.08)

Note: Bold type signifies a statistically significant result (95% CI excluding 0).
CI=confidence interval.

correlations within the data, the proportion of doctors was the most positively correlated with both the Part D enrollees ($R_{MD}=0.19$, $R_N=0.03$, $R_{PA}=-0.19$) and the average Medicare risk score ($R_{MD}=0.13$, $R_N=-0.13$, $R_{PA}=-0.07$).

To explore the effect of including the covariates, we ran models inclusive only of variables from the main hypotheses (M_H) for prevalence and adequacy of supply ($R^2_{MHPR}=0.17$; $AIC_{MHPR}=-546$; $R^2_{MHAS}=0.15$; $AIC_{MHAS}=-487$) and compared the results with the same variables in the full model in Table 3. The full models had higher R^2 values, indicating that inclusion of the covariates improves the models. The negative coefficients for the race and class variables tended to increase with the inclusion of the covariates. These increases appear to indicate that the additional covariates were either confounding (such as the average Medicare risk score) or mediating (such as the provider type covariates) the relationship between demographic variables and the outcomes. While data limitations preclude an exact specification of how the additional covariates interacted with race, gender, and class, this may be a fruitful area of future research.

Limitations

This study carries several limitations. The Medicare Part D data did not encompass a provider's entire practice or even all of a provider's Medicare patients, only patients enrolled in the Medicare Part D prescription program whose use was recorded because claims were processed and recorded by CMS. These beneficiaries comprised 68% of all Medicare beneficiaries.^{11,12} However, poten-

tial claimants may have been lost to low-cost generic programs, and this proportion may vary by county, depending on availability of these programs. The availability of these programs may be associated with some of the factors we considered in the analysis and thus may be a source of confounding.

In addition, we note several technical limitations with the data. Providers who had small numbers of beneficiaries were redacted. To minimize the effects of redaction, we constructed the outcome variables from rows where the number of beneficiaries were nonredacted. While this method excluded some supply information, it prohibited adequacy of supply from artificially exceeding the statin prevalence. CHR source data varied in year of collection. To best align with the Medicare Part D 2013 provider data, we used the CHR 2015 data, with the most 2013 source measures. Unfortunately, the data lacked direct measures of county-level cardiovascular risk. However, we did include other factors likely associated with cardiovascular risk, such as obesity and diabetes.²⁷

While the HCC risk score was for Medicare Parts A and B as opposed to Part D specifically, it allowed for some measure of general poor health. Lipid level information, especially including individual-level information in a multilevel analysis, would provide a better assessment of population need to better direct potential interventions, although this work provides a basis for further study. We also note that our measure of distance to the nearest teaching hospital used provider ZIP code centroids instead of address, thereby reducing accuracy.

Overall, our study design, being observational and ecological, does not permit causal inference between the covariates and outcomes. However, the breadth of the study adds another layer of evidence to smaller-scale individual-level studies. We recognize that our analysis focused on 2013, before a substantial shift in emphasis toward statin usage due to new ACC/AHA guidelines and the policies of the Affordable Care Act had taken effect. However, this study provides an important baseline against which future changes can be assessed. Additional analyses using later years of Medicare Part D Prescriber Public Use Files and updated county information could assess whether factors associated with SDOH are more or less strongly associated with statin use patterns.

Finally, we note that the outcomes we have analyzed may be insufficient to drive additional investment addressing SDOH. Our outcomes were determined by data availability, and we believe that this study shows how low-cost, publicly available data can be used to identify opportunities for improvement, and such data can be easily updated over time. While no single study is likely to drive investment in SDOH on its own, our work adds to the evidence needed to prioritize and track improvements in outcomes associated with policies meant to address SDOH.

Conclusions

Using prescription data rather than the survey data of previous national literature, our study provides confirmatory evidence of race/ethnicity and income findings in the literature of statin prescription differences, demonstrating the continued and increasing importance of considering SDOH in policymaking to eliminate disparities. By using a standardized comparison of covariates in an exploratory analysis, it also shows the importance of including variables related to medical infrastructure, contextual enabling characteristics related to the organization of medical care, in future models of statin prescription differences.⁹ These results suggest that the relationships between provider density, provider mix, and statin prescription be further clarified at a member level. This will help determine the need and efficacy of interventions to reduce potential disparities in statin use.

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