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ORIGINAL RESEARCH

Differences in Cardiovascular Care Between Adults With and Without Opioid Prescriptions in the United States

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BACKGROUND: Patients prescribed opioids often have chronic conditions that increase their risk of adverse cardiovascular outcomes, but little is known about the primary preventive cardiovascular care these patients receive.

METHODS AND RESULTS: We analyzed data from the 2014 to 2016 National Ambulatory Medical Care Survey to evaluate physicians' provision of primary preventive cardiovascular care to adults with and without opioid prescriptions. We included all visits made by adults 40 to 79 years old with at least 1 cardiovascular risk factor but no existing atherosclerotic cardiovascular disease. There were ≈32 million visits by adults who were prescribed opioids and ≈167 million visits by adults not prescribed opioids on an annual basis. The prevalence of primary preventive care was modest in patients with versus those without opioid prescriptions, respectively: (1) statins for patients with dyslipidemia (52.1% versus 46.3%); (2) statins for patients with diabetes mellitus (49.1% versus 37.9%); (3) antihypertensive agents for patients with hypertension (76.5% versus 65.8%); (4) diet/exercise counseling (40.5% versus 45.3%); and (5) smoking cessation therapy (25.3% versus 19.3%). In multivariate analyses, opioid use was associated with higher rates of statin therapy in patients with diabetes mellitus (adjusted relative risk [aRR], 1.25; 95% CI, 1.06–1.47; P=0.007) and antihypertensive medication in patients with hypertension (aRR 1.14; 95% CI, 1.06–1.22; P<0.001).

CONCLUSIONS: Overall adherence to guideline-recommended primary preventive cardiovascular care during ambulatory visits was suboptimal. Findings show that patients prescribed opioids versus those without opioid prescriptions were more likely to receive statin therapy and antihypertensive agents in the setting of diabetes mellitus and hypertension, respectively. Ongoing efforts to bridge these gaps in primary prevention of cardiovascular disease remain a high priority.

Key Words: antihypertensives ■ cardiovascular outcomes ■ opioids ■ primary prevention ■ statins

Patients prescribed opioids often have concurrent chronic conditions that increase their risk of adverse cardiovascular outcomes.[1,2] Several studies have also demonstrated that opioid use is independently associated with cardiovascular risk and death.[3–9] One study of Medicare beneficiaries initiating therapy with analgesics showed that patients treated with opioids had higher rates of cardiovascular events compared with patients treated with nonselective nonsteroidal anti-inflammatory drugs.[6] Another study of Medicaid patients in Tennessee with chronic noncancer pain prescribed long-acting opioids or alternative medications showed that opioids were associated with an increased risk of cardiovascular death.[5] Other studies presented similar findings.[4,8]

However, little is known about the rates of primary preventive cardiovascular care provided to patients prescribed opioids during ambulatory visits—and, to the best of our knowledge, no studies have examined this issue. Due to growing public and health policy concerns about opioid misuse, physicians' efforts to mitigate opioid-related risks and time constraints during

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CLINICAL PERSPECTIVE

What Is New?

- In this retrospective study using the National Ambulatory Medical Care Survey database, the most underutilized primary preventive strategies were provision of statin therapy for patients with diabetes mellitus and provision of smoking cessation therapy.
- Patients with opioid use compared with those without opioid use had higher rates of tobacco use and were more likely to receive primary preventive cardiovascular medications but not preventive lifestyle counseling.

What Are the Clinical Implications?

- Greater clinician awareness of the overall underuse of primary preventive cardiovascular care among patients with opioid use may increase interest to more globally discuss primary preventive practices, not just in terms of the risks associated with initiating or continuing opioid therapy.

Non-standard Abbreviations and Acronyms

ASCVD	atherosclerotic cardiovascular disease
NAMCS	National Ambulatory Medical Care Survey
NHAMCS	National Hospital Ambulatory Medical Care Survey

ambulatory medical visits may be adversely affecting provision of optimal primary preventive cardiovascular care to patients using opioids. Although research on the effects of visit complexity on physician decision making has yielded mixed results,[2,10–12] the importance of examining this relationship is magnified due to the association of opioid use with adverse cardiovascular outcomes. In light of these risks, the aim of the present study was to compare physicians' provision of guideline-recommended care for primary prevention of cardiovascular disease among adults with and without opioid prescriptions.

METHODS

The data and study materials are publicly available, and the analytic methods can be made available to other researchers upon request by contacting the corresponding author, for purposes of reproducing the results or replicating the procedure. The full data set is available at the National Ambulatory Medical Care Survey/National Hospital Ambulatory Medical Care Survey website (https://www.cdc.gov/nchs/ahcd/index.htm).

Data

We analyzed nationally representative, publicly available data from the National Ambulatory Medical Care Survey (NAMCS) for the years 2014 to 2016. The National Center for Health Statistics conducts the NAMCS in the United States on an annual basis. The survey is administered to non–federally employed, office-based physicians, and it focuses on visits made to physician offices. Participating physicians are randomly assigned to a 1-week reporting period in which data from ≈30 random patient visits are collected. Data are recorded in standardized electronic record formats and capture patient, provider, and visit characteristics.[13] Data on community health centers (part of the NAMCS) and outpatient hospital departments (part of the National Hospital Ambulatory Medical Care Survey [NHAMCS]) were unavailable from 2014 to 2016. However, the majority of ambulatory care is performed in office-based visits and captured by the NAMCS. (In recent years, 91% of visits occurred in NAMCS office visits rather than in NHAMCS hospital outpatient departments and, of NAMCS visits, 98% occurred outside of community health centers.[14])

Physicians and staff members recorded up to 5 reasons for each visit, 5 diagnoses for each visit in addition to checkboxes that captured other major comorbid diagnoses, up to 30 medications, and health services provided during the visit. Diagnoses were coded by National Center for Health Statistics staff using the *International Classification of Diseases, Ninth Revision—Clinical Modification* (*ICD-9-CM*)[15] Health services reported included diagnostic testing, procedures, and health education/counseling. Our study was exempt from institutional review board review.

Study Population

We included all office visits made by adults 40 to 79 years old with at least 1 cardiovascular risk factor (primary prevention), and excluded those with established atherosclerotic cardiovascular disease (ASCVD).[13,16] Cardiovascular risk factors were identified using visit diagnoses and patients' chief complaints and included hypertension, diabetes mellitus, dyslipidemia, obesity/overweight, and cigarette smoking. Existing ASCVD included coronary artery disease, stroke, carotid stenosis, peripheral vascular disease, and abdominal aortic aneurysm.

We identified visits of patients prescribed opioids using Multum Lexicon drug codes and National Center for Health Statistics generic codes (Table S1),

applying methods similar to those used in our earlier work.[13,16] We limited the sample to visits with physicians who usually provide preventive cardiovascular care, including primary care physicians (general and family medicine physicians and internists) and cardiologists. General and family medicine physicians and internists are also among the most frequent prescribers of opioids, as compared with other medical specialties.[17]

Primary Measures

We assessed 5 elements of primary cardiovascular prevention based on guidelines issued by the American Heart Association/American College of Cardiology, American Diabetes Association, and the US Preventive Services Task Force.[18–22] These included: (1) statin therapy for adults with dyslipidemia; (2) statin therapy for adults with diabetes mellitus; (3) antihypertensive therapy for adults with hypertension; (4) diet, exercise, and weight-loss counseling; and (5) smoking cessation counseling and/or therapy. Multum Lexicon drug codes and National Center for Health Statistics generic codes for preventive cardiovascular medications are listed in Table S2.

Other Measures

To further assess the association of opioid prescriptions with primary preventive cardiovascular care, we extracted information on patient age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), insurance status (private, Medicare, Medicaid, self-pay or no charge, and other or unknown), US census region (Northeast, Midwest, South, and West), urban or rural setting, and continuity of care. We considered a patient to have good continuity of care if he or she had been seen previously and had at least 1 visit to the practice during the preceding 12 months.[23]

Statistical Analysis

We estimated summary statistics for cardiovascular risk factors and sociodemographic characteristics among adults 40 to 79 years of age. To compare rates of primary preventive cardiovascular care among patients using or not using opioids, we estimated generalized linear models using a Poisson distribution and log link function. We employed Poisson regression because previous research has shown that it can be used to analyze binary data in a manner similar to logistic regression, with a time-at-risk value specified as 1 for each observation.[24–26] The models adjusted for patients' clinical and demographic characteristics, insurance, region, urban/rural setting, and physician specialty, similar to earlier studies using the NAMCS and/or analyzing cardiovascular outcomes. We report adjusted risk ratios (aRRs) and 95% CIs.

We performed sensitivity analyses that: (1) limited the sample of adults not using opioids to those with at least 1 medication listed in their medication list (to test the robustness of our study results); (2) limited the study sample to visits with physicians who reported being the patient's primary care physician (to maximize the accuracy of reported medications, because a patient's primary care physician is likely to be better informed about the patient's medications than physicians who do not identify as the patient's primary care physician); and (3) excluded patients with a diagnosis of cancer, because some of these patients may not be appropriate candidates for primary preventive cardiovascular care. In addition, we tested the validity of the Poisson regression models using multivariate linear probability models; these analyses yielded findings similar to our main results and are shown in Table S3.

All analyses accounted for the complex sampling design of the NAMCS and were performed using Stata version 14 (StataCorp, College Station, TX).[27]

RESULTS

Among adults 40 to 79 years old and eligible for primary prevention of cardiovascular disease, there were ≈32 million visits annually by adults who were prescribed opioids and ≈167 million visits annually by adults not prescribed opioids from 2014 to 2016 (Table 1). Patients with opioid use compared with those without opioid use had higher rates of tobacco use (25.8% versus 14.8%, $P<0.001$); were more likely to be insured by Medicare (36.9% versus 29.2%, $P<0.001$) or Medicaid (10.0% versus 7.1%, $P<0.001$), or more likely to be uninsured (3.1% versus 2.2%, $P=0.005$), and had better continuity of care (90.5% versus 84.1%, $P<0.001$). Patients who were prescribed opioids were less likely to be seen by cardiologists (3.8% versus 7.3%, $P<0.001$) compared with patients not prescribed opioids.

Medications for Primary Prevention of Cardiovascular Disease

Rates of use of primary preventive cardiovascular medications were substantially lower than guideline recommendations overall. Among patients eligible for primary prevention—with and without opioid prescriptions—the prevalence of statin use for patients with dyslipidemia was 52.1% (95% CI, 44.5%–59.7%) and 46.3% (95% CI, 42.0%–50.6%); the prevalence of statin use for patients with diabetes mellitus was 49.1% (95% CI, 41.8%–56.4%) and 37.9% (95% CI, 32.6%–43.2%); and antihypertensive use for patients

Table 1. United States Ambulatory Care Visits for Adults 40 to 79 Years Old, by Opioid Prescriptions, 2014–2016

Characteristic	Adults 40–79 Years Old Prescribed an Opioid				Adults 40–79 Years Old Not Prescribed an Opioid				*P* Value*
	Unweighted Visits, n	Annual Weighted Visits, n	%	SE	Unweighted Visits, n	Annual Weighted Visits, n	%	SE	
All visits	2262	32 347 000	100.0	0.0	11 102	167 100 000	100.0	0.0	
Age, y									
40 to 49	473	6 472 000	20.0	1.8	2439	36 642 000	21.9	1.2	
50 to 59	700	10 610 000	32.8	2.2	3240	50 055 000	30.0	0.8	
60 to 69	635	9 673 000	29.9	1.9	3263	48 685 000	29.1	0.8	
70 to 79	454	5 592 000	17.3	1.4	2160	31 704 000	19.0	0.9	0.873
Sex									
Female	1354	18 257 000	56.4	2.0	6300	94 943 000	56.8	1.1	
Male	908	14 090 000	43.6	2.0	4802	72 143 000	43.2	1.1	0.856
Race/ethnicity									
Non-Hispanic white	1285	17 866 000	55.2	2.9	6423	87 974 000	52.7	2.3	
Non-Hispanic black	225	3 108 000	9.6	1.2	1027	19 179 000	11.5	1.4	0.206
Hispanic	132	3 158 000	9.8	1.7	839	21 989 000	13.2	1.9	0.074
Other/unknown	620	8 215 000	25.4	2.9	2813	37 943 000	22.7	1.8	0.649
Insurance									
Private	864	12 841 000	39.7	1.6	5816	89 681 000	53.7	1.5	
Medicare	852	11 936 000	36.9	1.8	3266	48 757 000	29.2	1.3	<0.001
Medicaid	218	3 243 000	10.0	1.5	699	11 887 000	7.1	0.8	<0.001
Other/unknown	252	3 313 000	10.2	1.9	1002	13 029 000	7.8	1.3	0.002
Uninsured	76	1 015 000	3.1	0.6	319	3 732 000	2.2	0.3	0.005
United States region									
Northeast	236	5 129 000	15.9	3.1	1786	34 560 000	20.7	1.9	
Midwest	660	8 085 000	25.0	2.6	2926	33 473 000	20.0	1.7	0.035
South	809	12 000 000	37.1	3.2	4056	65 868 000	39.4	2.7	0.379
West	557	7 133 000	22.1	2.7	2334	33 185 000	19.9	2.3	0.139
Setting									
Urban	1894	27 664 000	85.5	2.5	9502	148 400 000	88.8	1.5	
Rural	368	4 683 000	14.5	2.5	1600	18 699 000	11.2	1.5	0.044
Physician specialty									
General medicine/internist	2105	31 110 000	96.2	0.8	9870	154 900 000	92.7	0.9	
Cardiologist	157	1 237 000	3.8	0.8	1232	12 186 000	7.3	0.9	<0.001
Chronic conditions									
Obese/overweight	366	5 315 000	16.4	1.5	1537	23 477 000	14.1	0.8	0.120
Dyslipidemia	789	12 215 000	37.8	2.4	4410	68 800 000	41.2	1.4	0.172
Diabetes mellitus	558	7 922 000	24.5	1.7	2368	39 898 000	23.9	0.9	0.743
Hypertension	1207	16 806 000	52.0	2.0	5459	82 800 000	49.6	1.3	0.275
Smoker	566	8 360 000	25.8	2.0	1992	24 743 000	14.8	0.7	<0.001
Good continuity of care	2019	29 265 000	90.5	1.3	9132	140 500 000	84.1	1.0	<0.001

All analyses account for the complex sampling design of the National Ambulatory Medical Care Survey. SE indicates standard error.

*Calculated with Wald chi-square test from simple ordinal (age) or binomial/multinomial (sex, race/ethnicity, insurance, setting, risk factors, comorbid diseases) logistic regression models comparing patients with an opioid prescription versus patients without an opioid prescription.

with hypertension was 76.5% (95% CI, 71.6%–81.4%) and 65.8% (95% CI, 62.5%–69.1%), respectively (Figure). Patients prescribed opioids were more likely to be prescribed statin therapy for ASCVD prevention in diabetes mellitus (aRR, 1.25; 95% CI, 1.06–1.47; *P*=0.007) and antihypertensive medications (aRR, 1.14; 95% CI, 1.06–1.22; *P*<0.001). Being seen by a cardiologist was not associated with improved primary preventive cardiovascular medication use (Table 2).

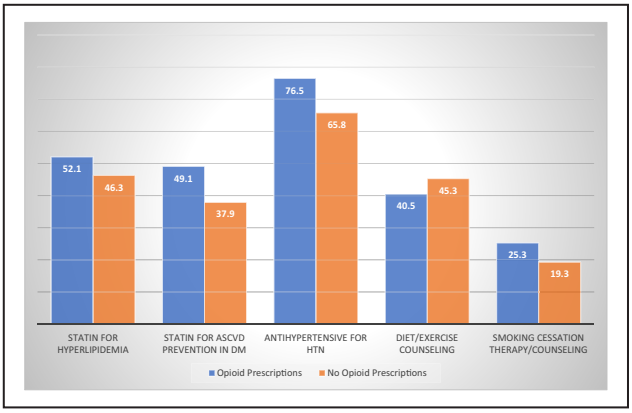

Figure. Prevalence of primary prevention of cardiovascular disease in adult patients 40 to 79 years old seeing physicians in ambulatory care visits in the United States, by opioid prescription (2014–2016).
ASCVD indicates atherosclerotic cardiovascular disease; DM, diabetes mellitus; and HTN, hypertension.

Lifestyle Modification Counseling for Primary Prevention of Cardiovascular Disease

Physician rates of providing lifestyle counseling to adults with cardiovascular risk factors were modest. The proportion of visits during which diet/exercise counseling was provided was 40.5% (95% CI, 31.1%–49.9%) and 45.3% (95% CI, 38.8%–51.8%) in patients with versus without opioid prescriptions, respectively. The proportion of visits during which smoking cessation counseling or pharmacotherapy was provided was 25.3% (95% CI, 16.3%–34.3%) and 19.3% (95% CI, 15.4%–23.2%) in patients with versus without opioid prescriptions, respectively. Adjusted differences for diet/exercise counseling and smoking cessation therapy between patients with versus without opioid prescriptions were not significant (aRR for diet/exercise counseling, 0.88; 95% CI, 0.73–1.07; *P*=0.201; aRR for smoking cessation counseling/therapy, 1.05; 95% CI, 0.70–1.58; *P*=0.805). Being seen by a cardiologist was also not associated with improved lifestyle modification counseling (Table 3).

Sensitivity Analyses

On the basis of our results, we performed further analyses to determine whether our findings were robust to limiting the study population to patients who were taking at least 1 medication, because patients who are not taking any medications despite having cardiovascular risk factors may differ from other patients in ways that are meaningful but unobserved. This analysis reduced the annual number of patient visits among patients not prescribed opioids from 167 to 139 million (17% relative decrease), with ≈60% of the difference attributable to patients with cardiovascular risk factors. There was a significant attenuation of our main findings, indicating that our results were driven by patients with cardiovascular risk factors but not taking medications (Tables S4 and S5).

In another sensitivity analysis, we limited our study sample to visits with physicians who reported being the patient's primary care physician, because these physicians would be most likely to be well informed about their patient's medications. The results are shown in Tables S6 and S7 and are similar to our main findings. Excluding patients with a diagnosis of cancer also did not significantly affect our results (Tables S8 and S9). Results of a multivariate linear probability model sensitivity analysis are shown in Table S3 and are also similar to our main findings.

DISCUSSION

Our findings indicate that the overall rates of primary preventive cardiovascular care were substantially lower than guideline recommendations. The 2 primary preventive strategies with the lowest adherence rates in our study were provision of statin therapy to patients with diabetes mellitus and provision of smoking cessation therapy or counseling. These findings were in the context of approximately a quarter of all ambulatory visits being made by patients with diabetes mellitus, and more than a quarter of all ambulatory visits by patients using opioids also involving tobacco use. Despite tobacco use being a major modifiable risk factor for ASCVD, we found that patients were only provided smoking cessation therapy in ≈25% of the visits made by patients with opioid prescriptions. These findings highlight major gaps in primary prevention, and also underscore the potential for primary care physicians and cardiologists to reduce cardiovascular risk in primary care populations with evidence-based therapy. The practical implication of our findings for medical decision making is that clinicians can use clinical encounters related to pain management as an opportunity to more globally discuss preventive practices, not just in terms of the risks associated with initiating or continuing opioid therapy, but also in terms of preventing other adverse health events.

Although we hypothesized that increased physician attention on opioid therapy combined with limited time during ambulatory visits would hinder optimal primary preventive cardiovascular care, the opposite proved to be true. We suspect that the association we detected between opioid use and primary preventive cardiovascular medications may reflect a modest inclination on the part of physicians prescribing opioids toward more frequent prescribing overall (across multiple drug classes), or a modest inclination on the part

Table 2. Adjusted Relative Risk of Primary Preventive Cardiovascular Medication Use in Adults 40–79 Years Old Seeing Physicians in United States Ambulatory Care Visits, 2014–2016

Characteristics	Statin for Dyslipidemia		Statin for ASCVD Prevention in DM		Antihypertensive for Hypertension	
	Adjusted Relative Risk (95% CI)	*P* Value	Adjusted Relative Risk (95% CI)	*P* Value	Adjusted Relative Risk (95% CI)	*P* Value
Prescribed an opioid	1.11 (0.96–1.27)	0.147	1.25 (1.06–1.47)	0.007	1.14 (1.06–1.22)	<0.001
Sex						
Men	1.00		1.00		1.00	
Female	0.87 (0.79–0.97)	0.011	0.86 (0.75–0.99)	0.033	0.94 (0.89–1.00)	0.070
Race/ethnicity						
White	1.00		1.00		1.00	
Non-Hispanic black	0.96 (0.75–1.23)	0.767	0.85 (0.65–1.11)	0.227	1.01 (0.88–1.17)	0.849
Hispanic	0.58 (0.44–0.78)	<0.001	0.52 (0.34–0.80)	0.003	0.95 (0.85–1.05)	0.276
Other/unknown	0.99 (0.84–1.17)	0.938	1.10 (0.91–1.33)	0.325	1.04 (0.94–1.16)	0.436
Age, y						
40–49	1.00		1.00		1.00	
50–59	1.09 (0.88–1.35)	0.431	1.13 (0.86–1.48)	0.370	0.98 (0.88–1.09)	0.723
60–69	1.12 (0.91–1.37)	0.300	1.04 (0.76–1.42)	0.829	1.04 (0.94–1.14)	0.455
70–79	1.12 (0.90–1.40)	0.318	1.17 (0.86–1.60)	0.324	1.05 (0.91–1.20)	0.507
Insurance						
Private	1.00		1.00		1.00	
Medicare	1.01 (0.89–1.15)	0.834	1.06 (0.89–1.26)	0.535	1.01 (0.94–1.08)	0.735
Medicaid	0.95 (0.78–1.16)	0.620	1.05 (0.82–1.34)	0.723	0.91 (0.81–1.03)	0.132
Other/unknown	0.96 (0.76–1.22)	0.757	0.97 (0.70–1.35)	0.862	1.05 (0.94–1.17)	0.409
Uninsured	1.09 (0.71–1.68)	0.701	1.24 (0.74–2.08)	0.408	1.07 (0.90–1.28)	0.426
Urban or rural setting						
Urban	1.00		1.00		1.00	
Rural	0.97 (0.77–1.23)	0.820	0.85 (0.62–1.17)	0.313	0.89 (0.73–1.08)	0.225
United States region						
Northeast	1.00		1.00		1.00	
Midwest	1.23 (1.00–1.51)	0.052	1.37 (1.06–1.78)	0.017	1.13 (1.00–1.27)	0.051
South	1.03 (0.82–1.29)	0.808	1.19 (0.90–1.57)	0.223	1.00 (0.88–1.13)	0.998
West	1.05 (0.83–1.32)	0.683	1.12 (0.84–1.51)	0.435	1.07 (0.95–1.21)	0.263
Physician specialty						
General medicine/internist	1.00		1.00		1.00	
Cardiologist	1.13 (0.94–1.35)	0.191	1.02 (0.79–1.31)	0.865	1.09 (0.97–1.22)	0.160
Chronic conditions						
Obese/overweight	1.08 (0.94–1.24)	0.296	1.06 (0.91–1.24)	0.451	1.16 (1.09–1.23)	<0.001
Dyslipidemia	1.00 (1.00–1.00)		1.91 (1.57–2.32)	<0.001	1.03 (0.97–1.11)	0.337
Diabetes mellitus	1.16 (1.05–1.28)	0.002	1.00 (1.00–1.00)		1.03 (0.96–1.09)	0.415
Hypertension	1.35 (1.14–1.60)	<0.001	1.23 (0.98–1.54)	0.072	1.00 (1.00–1.00)	
Smoker	1.01 (0.90–1.13)	0.902	1.06 (0.91–1.24)	0.461	1.02 (0.95–1.09)	0.554
Good continuity of care	1.14 (0.95–1.38)	0.152	1.03 (0.84–1.26)	0.776	1.16 (1.05–1.28)	0.003
Time trend	0.98 (0.91–1.06)	0.643	1.08 (0.97–1.19)	0.150	0.94 (0.89–0.99)	0.028

Reference groups include male sex, white race/ethnicity, age <45 years, private insurance, and urban setting. Other independent variables included in the regression models are obesity, smoker, dyslipidemia, diabetes mellitus, hypertension, cardiovascular disease, and a year-based time trend. All analyses account for the complex sampling design of the National Ambulatory Medical Care Survey. ASCVD indicates atherosclerotic cardiovascular disease; and DM, diabetes mellitus.

of patients who were prescribed opioids to be more willing to use other medications, or both. In addition, patients prescribed opioids were more likely to have good continuity of care, and this may have contributed to improved primary preventive cardiovascular care in ways that our models did not capture. Our

Table 3. Adjusted Relative Risk of Preventive Cardiovascular Lifestyle Counseling in Adults 40–79 Years Old Seeing Physicians in United States Ambulatory Care Visits, 2014–2016

Characteristics	Diet/Exercise Counseling		Smoking Cessation Counseling/Therapy*	
	Adjusted Relative Risk (95% CI)	*P* Value	Adjusted Relative Risk (95% CI)	*P* Value
Prescribed an opioid	0.88 (0.73–1.07)	0.201	1.05 (0.70–1.58)	0.805
Sex				
Men	1.00		1.00	
Female	1.07 (0.90–1.27)	0.432	1.00 (0.77–1.29)	0.982
Race/ethnicity				
White	1.00		1.00	
Non-Hispanic black	1.17 (0.94–1.47)	0.163	1.32 (0.82–2.10)	0.251
Hispanic	1.38 (1.09–1.74)	0.007	0.41 (0.22–0.75)	0.004
Other/unknown	1.20 (0.94–1.54)	0.149	1.06 (0.72–1.58)	0.755
Age, y				
40–49	1.00		1.00	
50–59	0.98 (0.78–1.24)	0.893	1.28 (0.91–1.80)	0.157
60–69	0.87 (0.71–1.06)	0.162	0.97 (0.64–1.46)	0.875
70–79	0.9 (0.6–1.1)	0.252	0.6 (0.4–1.1)	0.108
Insurance				
Private				
Medicare	1.04 (0.85–1.26)	0.721	1.40 (1.00–1.95)	0.050
Medicaid	0.71 (0.49–1.03)	0.068	0.83 (0.49–1.41)	0.487
Other/unknown	0.94 (0.71–1.25)	0.683	1.02 (0.57–1.81)	0.959
Uninsured	0.73 (0.37–1.47)	0.384	0.76 (0.36–1.58)	0.454
Urban or rural setting				
Urban	1.00		1.00	
Rural	0.72 (0.47–1.11)	0.142	0.90 (0.52–1.56)	0.699
United States region				
Northeast	1.00		1.00	
Midwest	0.94 (0.71–1.25)	0.687	0.76 (0.47–1.23)	0.267
South	1.19 (0.91–1.55)	0.216	0.93 (0.57–1.50)	0.768
West	0.82 (0.57–1.19)	0.298	0.74 (0.43–1.25)	0.262
Physician specialty				
General medicine/internist	1.00		1.00	
Cardiologist	0.74 (0.54–1.02)	0.064	0.75 (0.46–1.21)	0.237
Chronic conditions				
Obese/overweight	1.00 (1.00–1.00)		1.10 (0.77–1.58)	0.589
Dyslipidemia	1.27 (1.06–1.52)	0.008	1.10 (0.81–1.51)	0.535
Diabetes mellitus	1.12 (0.98–1.29)	0.104	0.77 (0.53–1.12)	0.178
Hypertension	1.10 (0.94–1.30)	0.237	0.96 (0.74–1.26)	0.777
Smoker	1.16 (0.96–1.39)	0.117	1.00 (1.00–1.00)	
Good continuity of care	1.0 (0.8–1.2)	0.688	0.9 (0.6–1.3)	0.531
Time trend	1.2 (1.1–1.3)	0.002	1.6 (1.4–1.9)	<0.001

*Medications for smoking cessation include nicotine replacement therapy, varenicline, and bupropion.

findings were partially attributable to patients who had cardiovascular risk factors but were not taking any medications.

To the best of our knowledge, consideration of increased cardiovascular risk among patients prescribed opioids is not widely recognized by physicians when deciding whether to initiate or continue opioid therapy. Although we found that these patients were more likely to receive certain primary preventive cardiovascular medications than

patients not prescribed opioids, a substantial proportion of patients were still not receiving guideline-recommended care. Greater clinician awareness of the possibility of increased adverse cardiovascular outcomes among patients treated with opioids may alter future opioid-prescribing practices and increase interest in addressing cardiovascular risk factors as well as providing primary preventive cardiovascular care to these patients.

Our work has limitations, including the possibility of inaccurate documentation of cardiovascular risk factors and medications by physicians, absence of detailed information about blood pressure and cholesterol, and exclusion of adults with cardiovascular risk factors who did not receive care in ambulatory settings. In addition, we were unable to accurately determine indications for opioid use or duration of therapy, which may have increased the robustness and clinical utility of our findings. We were also unable to calculate oral morphine equivalents and determine the impact of dosing on our measures, as these data were unavailable. Furthermore, although we did obtain some sociodemographic measures, we did not have detailed information on income or educational level, both of which may influence opioid prescribing and physician decision making regarding preventive care.

The major policy implication of our work is that it reinforces the importance of national efforts to reduce cardiovascular risk, such as the Million Hearts initiative led by the Center for Medicare & Medicaid Services and the Centers for Disease Control and Prevention. Several studies have reported underuse of primary preventive cardiovascular medications, and our study highlights this underuse in patients prescribed opioids.[28–32] On the basis of our most conservative analysis (the primary care physician analysis, because these physicians are most likely to have complete medication records), approximately one third of visits by patients with hypertension did not include antihypertensive therapy, and smoking cessation counseling/therapy was provided in <25% of visits. There are substantial opportunities to improve care and outcomes.

In conclusion, overall adherence to guideline-recommended primary preventive cardiovascular care during ambulatory visits was suboptimal. Patients using opioids did not receive lower rates of primary prevention compared with patients not using opioids. Findings instead show that patients prescribed opioids were more likely to receive statin therapy and antihypertensives in the setting of diabetes mellitus and hypertension, respectively. Because of the potentially increased risk of adverse cardiovascular events associated with opioid therapy and the overall modest rates of primary prevention, ongoing efforts to bridge these gaps in primary prevention of cardiovascular disease remain a high priority.

ARTICLE INFORMATION

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Disclosures

None.

Supplementary Materials

Tables S1–S9

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SUPPLEMENTAL MATERIAL

Table S1. Multum Lexicon generic drug codes and NCHS generic codes (*5-digit code assigned to each official generic name assigned to every drug entity by the United States Pharmacopeia).*

Opioids List					
Drug	**Drug Code**	**Notes**	**Drug**	**Drug Code**	**Notes**
Acetaminophen, Caffeine, Codeine, Salicylamide	a11047		Brompheniramine w/ Codeine DC Expectorant	04855	
Acetaminophen, Codeine	00280	Acetaminophen with Codeine	Brompheniramine, Codeine, Guaifenesin, Phenylephrine, Phenylpropanolamine	a11065	
Acetaminophen, Codeine	32915	Tylenol no. 2 with Codeine	Buprenorphine	10386	Butrans
Acetaminophen, Codeine	32920	Tylenol no. 3 with Codeine	Buprenorphine HCL	60265	Buprenex
Acetaminophen, Codeine	32925	Tylenol no. 4 with Codeine	Buprenorphine HCL	95036	Buprenorphine
Acetaminophen, Codeine	32930	Tylenol with Codeine	Buprenorphine HCL	50711	Buprenorphine
Acetaminophen, Codeine	32935	Tylenol with Codeine Elixir	Buprenorphine, Naloxone	10166	
Acetaminophen, Codeine	23680	Phenaphen with Codeine	Buprenorphine, Naloxone	03276	Suboxone
Acetaminophen, Codeine	d03423	Acetaminophen with Codeine	Buprenorphine, Naloxone	13141	Zubsolv
Acetaminophen, Oxycodone	00283		Buprenorphine, Naloxone	d04819	
Acetaminophen, Oxycodone	12046	Percocet	Buprenorphine-Naloxone	10166	
Acetaminophen, Oxycodone	23385	Percocet-5	Butalbital, Acetaminophen, Caffeine, and Codeine Phosphate	95178	Fioricet with Codeine
Acetaminophen, Oxycodone	07252	Percocet 7.5	Butalbital, Acetaminophen, Caffeine, and Codeine Phosphate	d03425	Fioricet with Codeine
Acetaminophen, Oxycodone	07251	Percocet 10	Butalbital, Acetaminophen, Caffeine, Codeine	n08029	
Acetaminophen, Oxycodone	99114	Endocet	Butalbital, ASA, Caffeine, Codeine	10238	
Butalbital, Acetaminophen, Caffeine, and Codeine Phosphate	d03425	Fioricet with Codeine	Butalbital, ASA, Caffeine, Codeine	12570	Trade name Fiorinal With Codeine #3
Butalbital, Acetaminophen, Caffeine, Codeine	n08029		Butalbital, ASA, Caffeine, Codeine	d03426	
Butalbital, ASA,	10238		Butorphanol	01021	Butorphanol

Caffeine, Codeine					Tartrate
Butalbital, ASA, Caffeine, Codeine	12570	Trade name Fiorinal With Codeine #3	Butorphanol	29285	Stadol
Butalbital, ASA, Caffeine, Codeine	d03426		Butorphanol	50740	Butorphanol Tartrate
Butorphanol	01021	Butorphanol Tartrate	Chlorpheniramine, Hydrocodone, Pseudoephedrine	d03416	Zutripro
Butorphanol	29285	Stadol	Codeine	07180	
Butorphanol	50740	Butorphanol Tartrate	Codeine	51340	
Butorphanol	d00838	Butorphanol Tartrate	Codeine	d00012	
Chlorpheniramine, Guaifenesin, Hydrocodone, Phenylalanine, Pseudoephedrine	06244	ZTuss Expectorant	Codeine Phosphate	07185	
Chlorpheniramine, Guaifenesin, Hydrocodone, Phenylalanine, Pseudoephedrine	a11760	ZTuss Expectorant	Codeine, Guaifenesin	13838	
Chlorpheniramine, Hydrocodone	08228	Chlorpheniramine Hydrocodone	Codeine, Guaifenesin	95044	Robitussin w/ Codeine
Chlorpheniramine, Hydrocodone	04256	Hydrocodone GF	Codeine, Guaifenesin	d03393	
Chlorpheniramine, Hydrocodone	d03356	Chlorpheniramine Hydrocodone	Codeine, Phenylephrine, Promethazine	25430	Promethazine VC with Codeine
Chlorpheniramine, Hydrocodone, Polistirex	08452	Tussionex Pennkinetic	Codeine, Phenylephrine, Promethazine	d03364	Promethazine VC with Codeine
Chlorpheniramine, Hydrocodone, Polistirex	09147	Tussicaps	Codeine, Promethazine	25432	Promethazine with Codeine
Chlorpheniramine, Hydrocodone, Pseudoephedrine	11402	Zutripro	Codeine, Promethazine	23798	Phenergan with Codeine is trade name
Codeine, Promethazine	d03357	Promethazine with Codeine	Codeine, Promethazine	25390	Promethazine Expectorant with Codeine
Codeine, Pseudoephedrine, Triprolidine	32558	Triprolidine Pseudophed with Codeine	Codeine, Promethazine	25415	Promethazine HCl with Codeine Expectorant
Codeine, Pseudoephedrine, Triprolidine	d03363	Triprolidine Pseudophed with Codeine	Hydrocodone Bitartrate	89038	Hydrocodone Bitartrate with APAP
Codeine-Sulfate	07190		Hydrocodone Bitartrate	98036	Norco

Codeine-Sulfate	70360		Hydrocodone Bitartrate	70217	Hydrocodone Bitartrate with APAP
Dezocine	57046	Dalgan	Hydrocodone Bitartrate and Homatropine Methylbromide	14770	Hycodan
Dihydrocodeine	09574		Hydrocodone Polistirex, Chlorpheniramine	32855	Tussionex
Dihydrocodeine	52647		Hydrocodone Polistirex, Chlorpheniramine	70599	Tussionex
Dihydrocodeine	d03168		Hydrocodone Polistirex, Chlorpheniramine	a10956	Tussionex
Dihydrocodeine, Bitartrate / Acetaminophen, Caffeine, Dihydrocodeine	70405	Trezix	Hydrocodone, Acetaminophen	89039	
Dihydrocodeine, Bitartrate / Acetaminophen, Caffeine, Dihydrocodeine	d04269	Trezix	Hydrocodone, Acetaminophen	92041	Hydrocodone compound
Ethylmorphine	52165		Hydrocodone, Acetaminophen	34110	Vicodin
Fentanyl	94188	Fentanyl	Hydrocodone, Acetaminophen	00251	Vicodin ES
Fentanyl	52225	Fentanyl	Hydrocodone, Acetaminophen	08354	Vicodin HP
Fentanyl	d00233	Fentanyl	Hydrocodone, Acetaminophen	98104	Vicodin Tuss
Fentanyl Citrate	60565	Fentanyl Citrate	Hydrocodone, Acetaminophen	01268	Lorcet Plus
Fentanyl Citrate	70452	Fentanyl Citrate	Hydrocodone, Acetaminophen	93089	Lorcet
Fentanyl transdermal system	92024	Duragesic (Fentanyl Transdermal)	Hydrocodone, Acetaminophen	02132	Lorcet HD
Fentanyl Transmucosal Lozenge	02067	Actiq	Hydrocodone, Acetaminophen	92180	Lortab
Fentanyl Transmucosal Lozenge	70731	Actiq	Hydrocodone, Acetaminophen	02314	Lortab elixir
Guaifenesin, Hydrocodone	d03396		Hydrocodone, Acetaminophen	02082	Maxidone
Homatropine, Hydrocodone	05223	Homatropine-Hydrocodone	Hydrocodone, Acetaminophen	96028	Acetaminophen-Hydrocodone
Homatropine, Hydrocodone	d03340	Homatropine-Hydrocodone	Hydrocodone, Acetaminophen	d03428	
Homatropine, Methyl Bromide,	a10897		Hydrocodone, Ibuprofen	09751	

Hydrocodone					
Hydrocodone	14955	Hydrocodone	Hydrocodone, Ibuprofen	98043	Vicoprofen
Hydrocodone	52650	Hydrocodone	Hydrocodone, Ibuprofen	d04225	
Hydrocodone	d03075	Hydrocodone	Hydromorphone	15005	Hydromorphone
Methadone	53475	Methadone	Hydromorphone	11229	Exalgo
Methadone	d00050	Methadone	Hydromorphone	52670	Hydromorphone
Morphine	19650	Morphine	Hydromorphone	d00255	Hydromorphone
Morphine	19655	Morphine & Atropine	Hydromorphone HCL	09600	Dilaudid
Morphine	53760	Morphine	Hydromorphone HCL	09595	Dilaudid Cough Syrup
Morphine	d00308	Morphine	Hydromorphone HCL	70623	Dilaudid
Morphine Sulfate	99123		Levorphanol	17362	Levorphanol Tartrate (Levo-Dromoran)
Morphine Sulfate	12008	Morphine ER	Levorphanol	53055	Levorphanol Tartrate (Levo-Dromoran)
Morphine Sulfate	41420	Roxanol	Levorphanol	d00825	Levorphanol Tartrate (Levo-Dromoran)
Morphine Sulfate	19699	MS-Contin	Meperidine	18760	Meperidine
Morphine Sulfate	03228	Avinza	Meperidine	96405	Demerol
Morphine Sulfate	98144	Kadian	Meperidine	53335	Meperidine
Morphine Sulfate	70044		Meperidine	d00017	Meperidine
Nalbuphine	60990	Nalbuphine HCL	Meperidine HCL	00200	Meperidine HCL
Nalbuphine	21550	Nubain	Meperidine HCL	70267	Meperidine HCL
Nalbuphine	53855	Nalbuphine HCL	Methadone	18985	Methadone
Nalbuphine	d00839	Nalbuphine HCL	Methadone	10130	Dolophine
Naloxone	d00311		Naloxone	53865	
Narcan	20310		Naloxone HCl	60995	
Oxycodone	12028		Oxymorphone	11270	
Oxycodone	96109	Oxycontin	Oxymorphone HCl	07117	Opana
Oxycodone	09582	Oxycodone CR	Oxymorphone HCl	07223	Opana ER
Oxycodone	05081	OxyIR	Pentazocine	23285	
Oxycodone	54094		Pentazocine	70591	Pentazocine HCl
Oxycodone	d00329		Pentazocine	54290	
Oxycodone HCL	22303		Pentazocine	d00334	
Oxycodone HCL	08246	Oxycodone ER	Pentazocine, Acetaminophen	07701	
Oxycodone HCL	02333	Roxicodone	Pentazocine, Acetaminophen	30513	Talacen
Oxycodone HCL	70269		Pentazocine, Acetaminophen	70951	
Oxycodone HCL, Acetaminophen	22305	Oxycodone HCL & Acetaminophen	Pentazocine, Acetaminophen	d03682	

Oxycodone Terephthalate	70582		Pentazocine, Naloxone	13117	
Oxymorphone	54135		Pentazocine, Naloxone	04538	Talwin Nx
Oxymorphone	d00833		Pentazocine, Naloxone	30535	Talwin
Pentazocine, Naloxone	d03676		Tapentadol	d07453	
Phenylpropanolamin, Hydrocodone	14960	Hydrocodone PA Syrup	Tramadol	96041	Tramadol
Sufentanil Citrate	50040	Sufenta	Tramadol	95050	Ultram
Sufentanil Citrate	55583	Sufenta	Tramadol	08329	Ultram ER
Tapentadol	09286		Tramadol	57160	Tramadol
Tapentadol	11121	Nucynta	Tramadol	d03826	Tramadol
Tramadol HCL	d04766	Tramadol HCL	Tramadol HCL	03319	Tramadol HCL
Tramadol, Acetominophen	09651		Tramadol HCL	12448	Conzip
Tramadol, Acetominophen	01124	Ultracet	Tramadol HCL	70282	Tramadol HCL

Cough medicines were excluded: Brompheniramine w/ Codeine DC Expectorant; Chlorpheniramine, Guaifenesin, Hydrocodone, Phenylalanine, Pseudoephedrine; Chlorpheniramine, Hydrocodone; Chlorpheniramine, Hydrocodone, Polistirex; Chlorpheniramine, Hydrocodone, Pseudoephedrine; Codeine, Guaifenesin; Codeine, Guiatussin; Codeine, Phenylephrine, Promethazine; Codeine, Promethazine; Codeine, Pseudoephedrine, Triprolidine; Homatropine, Hydrocodone; Hydrocodone Bitartrate and Homatropine Methylbromide; Hydrocodone Polistirex, Chlorpheniramine; Phenylpropanolamin, Hydrocodone.

Table S2. Multum Lexicon generic drug codes and therapeutic drug categories.

Medication	Generic code	Therapeutic class code
Statin	d07110, d05348, d05048, d04787, d04105, d00746, d00280, d04787, d00348, d04851, d03183	173
Antihypertensive medication	--	041, 042, 043, 044, 047, 048, 049, 052,053, 055, 056, 274, 275, 154, 155, 156, 157, 158, 274, 275
smoking cessation medication (nicotine replacement therapy, varenicline, or bupropion)	d00316, c00080, d05807, d00181	320

Table S3. Change in probability of preventive cardiovascular care associated with opioid therapy, covariate-adjusted predicted probability, and relative risk estimate.

Preventive cardiovascular care	Change in probability from using opioids	Std. Err.	P value	Predicted probability of preventive care when opioid=0	Predicted probability of preventive care when opioid=1	Adjusted RR
Statin for Dyslipidemia	0.051	0.036	0.155	0.344	0.395	1.148
Statin for Diabetes	0.096	0.037	0.009	0.255	0.351	1.377
Antihypertensive for Hypertension	0.093	0.026	<0.001	0.623	0.715	1.149
Diet/exercise Counseling for Obesity	-0.048	0.041	0.239	0.394	0.346	0.877
Smoking Cessation Advice/Therapy	0.016	0.049	0.739	0.196	0.213	1.083

NOTE: Multivariate linear probability regression models adjusted for the sociodemographic and clinical variables and account for the complex sampling design of the NAMCS

Table S4. Adjusted Relative Risk of Preventive Cardiovascular Medication Use in Adults 40-79 Years-old Seeing Physicians in U.S. Ambulatory Care Visits, 2014-2016 (sensitivity analysis with sample limited to patients taking at least one medication).

Characteristics	Statin for Dyslipidemia				Statin for Diabetes				Antihypertensive for Hypertension			
	Adj. RR (95% CI)			P value	Adj. RR (95% CI)			P value	Adj. RR (95% CI)			P value
Prescribed an opioid	0.98	(0.86-	1.13)	0.812	1.11	(0.94-	1.31)	0.203	1.01	(0.95-	1.07)	0.817
Sex												
Men	1.00				1.00				1.00			
Female	0.87	(0.79-	0.95)	0.004	0.86	(0.76-	0.98)	0.025	0.93	(0.88-	0.98)	0.009
Race/ethnicity												
White	1.00				1.00				1.00			
Non-Hispanic black	0.92	(0.72-	1.17)	0.489	0.83	(0.64-	1.08)	0.164	1.02	(0.90-	1.14)	0.781
Hispanic	0.59	(0.43-	0.80)	<0.001	0.53	(0.34-	0.82)	0.004	0.95	(0.87-	1.03)	0.184
Other/unknown	1.04	(0.90-	1.18)	0.614	1.14	(0.96-	1.35)	0.144	1.08	(1.02-	1.15)	0.009
Age, yrs												
40-49	1.00				1.00				1.00			
50-59	1.14	(0.93-	1.40)	0.220	1.17	(0.90-	1.53)	0.236	0.98	(0.89-	1.08)	0.674
60-69	1.15	(0.94-	1.42)	0.182	1.10	(0.80-	1.50)	0.553	1.06	(0.98-	1.14)	0.175
70-79	1.14	(0.92-	1.41)	0.217	1.23	(0.91-	1.66)	0.186	1.08	(0.99-	1.18)	0.102
Insurance												
Private												
Medicare	1.05	(0.94-	1.18)	0.392	1.06	(0.89-	1.25)	0.522	0.99	(0.93-	1.05)	0.810
Medicaid	0.96	(0.79-	1.16)	0.680	1.09	(0.86-	1.39)	0.461	0.93	(0.84-	1.03)	0.138
Other/unknown	0.95	(0.75-	1.19)	0.640	0.98	(0.70-	1.37)	0.908	0.99	(0.90-	1.10)	0.891
Uninsured	1.09	(0.72-	1.66)	0.684	1.36	(0.85-	2.16)	0.199	1.00	(0.84-	1.20)	0.984
Urban or rural setting												
Urban	1.00				1.00				1.00			
Rural	1.01	(0.85-	1.21)	0.870	0.91	(0.71-	1.17)	0.473	0.94	(0.81-	1.09)	0.405
U.S. region												
Northeast	1.00				1.00				1.00			
Midwest	1.21	(1.01-	1.45)	0.042	1.40	(1.10-	1.78)	0.007	1.13	(1.03-	1.25)	0.009
South	1.04	(0.85-	1.26)	0.716	1.21	(0.92-	1.58)	0.170	1.02	(0.92-	1.12)	0.761
West	1.06	(0.86-	1.32)	0.584	1.12	(0.83-	1.50)	0.457	1.08	(0.98-	1.20)	0.108

Physician specialty												
General medicine/Internist	1.00				1.00				1.00			
Cardiologist	1.23	(1.09-	1.40)	0.001	1.14	(0.95-	1.37)	0.159	1.22	(1.15-	1.29)	<0.001
Chronic Conditions												
Obese/overweight	1.04	(0.91-	1.18)	0.575	1.05	(0.90-	1.22)	0.546	1.10	(1.05-	1.16)	<0.001
Dyslipidemia	1.00	(1.00-	1.00)	.	1.80	(1.49-	2.18)	<0.001	1.01	(0.95-	1.06)	0.839
Diabetes	1.12	(1.02-	1.24)	0.020	1.00	(1.00-	1.00)	.	1.04	(0.99-	1.09)	0.160
Hypertension	1.32	(1.11-	1.56)	0.001	1.24	(1.00-	1.54)	0.052	1.00	(1.00-	1.00)	.
Smoker	1.00	(0.89-	1.11)	0.953	1.06	(0.91-	1.23)	0.472	1.00	(0.95-	1.07)	0.876
Good continuity of care	1.13	(0.95-	1.35)	0.174	1.03	(0.86-	1.24)	0.736	1.15	(1.04-	1.26)	0.004
Time trend	1.01	(0.95-	1.07)	0.861	1.08	(0.99-	1.19)	0.085	0.96	(0.92-	1.00)	0.029

RR, relative risk; CI, confidence interval;

Reference groups are male sex, White race/ethnicity, <45 years-old, private insurance, and urban setting. Other independent variables included in regression models are: obesity, smoker, dyslipidemia, diabetes, hypertension, CVD, and a year-based time trend

Note: All analyses account for the complex sampling design of the NAMCS

*Medications for smoking cessation include nicotine replacement therapy, varenicline, and bupropion

Table S5. Adjusted Relative Risk of Preventive Cardiovascular Lifestyle Counseling in Adults 40-79 Years-old Seeing Physicians in U.S. Ambulatory Care Visits, 2014-2016 (sensitivity analysis with sample limited to patients taking at least one medication).

	Diet/exercise Counseling for Obesity				Smoking Cessation Advice/Therapy			
Characteristics	Adj. RR (95% CI)			P value	Adj. RR (95% CI)			P value
Prescribed an opioid	0.85	(0.70-	1.04)	0.112	0.94	(0.63-	1.41)	0.780
Sex								
Men	1.00				1.00			
Female	1.11	(0.92-	1.34)	0.267	0.99	(0.76-	1.30)	0.966
Race/ethnicity								
White	1.00				1.00			
Non-Hispanic black	1.09	(0.85-	1.39)	0.507	1.42	(0.91-	2.22)	0.126
Hispanic	1.33	(1.07-	1.67)	0.012	0.40	(0.21-	0.77)	0.006
Other/unknown	1.18	(0.91-	1.53)	0.215	1.05	(0.70-	1.56)	0.823
Age, yrs								
40-49	1.00				1.00			
50-59	0.99	(0.77-	1.26)	0.916	1.21	(0.86-	1.70)	0.276
60-69	0.89	(0.70-	1.13)	0.345	1.03	(0.68-	1.57)	0.874
70-79	0.9	(0.6-	1.2)	0.379	0.6	(0.4-	1.1)	0.119
Insurance								
Private								
Medicare	1.06	(0.88-	1.29)	0.530	1.35	(0.97-	1.87)	0.073
Medicaid	0.74	(0.51-	1.07)	0.113	0.85	(0.50-	1.44)	0.542
Other/unknown	0.99	(0.75-	1.31)	0.963	0.97	(0.56-	1.67)	0.899
Uninsured	0.71	(0.33-	1.55)	0.389	0.74	(0.36-	1.53)	0.415
Urban or rural setting								
Urban	1.00				1.00			
Rural	0.80	(0.55-	1.17)	0.248	0.89	(0.51-	1.56)	0.681
U.S. region								
Northeast	1.00				1.00			
Midwest	0.95	(0.70-	1.28)	0.733	0.72	(0.44-	1.19)	0.202
South	1.22	(0.92-	1.61)	0.164	0.90	(0.55-	1.48)	0.674
West	0.91	(0.65-	1.28)	0.595	0.76	(0.44-	1.32)	0.328
Physician specialty								

General medicine/Internist	1.00				1.00			
Cardiologist	0.72	(0.51-	1.02)	0.062	0.76	(0.46-	1.26)	0.284
Chronic Conditions								
Obese/overweight	1.00	(1.00-	1.00)	.	1.16	(0.82-	1.64)	0.398
Dyslipidemia	1.29	(1.07-	1.55)	0.008	1.05	(0.75-	1.48)	0.780
Diabetes	1.15	(0.99-	1.34)	0.061	0.73	(0.50-	1.06)	0.100
Hypertension	1.08	(0.90-	1.30)	0.408	0.95	(0.71-	1.27)	0.731
Smoker	1.16	(0.95-	1.41)	0.147	1.00	(1.00-	1.00)	.
Good continuity of care	1.0	(0.8-	1.3)	0.859	1.0	(0.7-	1.3)	0.769
Time trend	1.2	(1.1-	1.3)	0.001	1.6	(1.4-	1.9)	<0.001

Table S6. Adjusted Relative Risk of Preventive Cardiovascular Medication Use in Adults 40-79 Years-old Seeing Physicians in U.S. Ambulatory Care Visits, 2014-2016 (sensitivity analysis with sample limited to physicians who identify as the patient's primary care doctor).

	Statin for Dyslipidemia		Statin for Diabetes		Antihypertensive for Hypertension	
Characteristics	Adj. RR (95% CI)	P value	Adj. RR (95% CI)	P value	Adj. RR (95% CI)	P value
Prescribed an opioid	1.06 (0.92- 1.24)	0.411	1.23 (1.03- 1.47)	0.020	1.12 (1.04- 1.21)	0.003
Sex						
Men	1.00		1.00		1.00	
Female	0.88 (0.79- 0.98)	0.022	0.88 (0.77- 1.01)	0.067	0.95 (0.88- 1.02)	0.154
Race/ethnicity						
White	1.00		1.00		1.00	
Non-Hispanic black	1.02 (0.79- 1.32)	0.878	0.90 (0.68- 1.19)	0.470	1.03 (0.89- 1.20)	0.702
Hispanic	0.59 (0.43- 0.81)	0.001	0.55 (0.35- 0.87)	0.011	0.94 (0.84- 1.05)	0.282
Other/unknown	1.00 (0.84- 1.19)	0.995	1.10 (0.90- 1.35)	0.335	1.06 (0.95- 1.19)	0.308
Age, yrs						
40-49	1.00		1.00		1.00	
50-59	1.07 (0.84- 1.35)	0.601	1.11 (0.84- 1.48)	0.469	0.94 (0.82- 1.07)	0.320
60-69	1.09 (0.87- 1.37)	0.430	1.00 (0.72- 1.39)	0.997	1.02 (0.92- 1.14)	0.687
70-79	1.12 (0.89- 1.42)	0.339	1.12 (0.81- 1.56)	0.491	1.03 (0.88- 1.20)	0.711
Insurance						
Private						
Medicare	1.01 (0.88- 1.16)	0.866	1.09 (0.90- 1.31)	0.373	0.99 (0.93- 1.07)	0.873
Medicaid	0.96 (0.77- 1.20)	0.706	1.06 (0.82- 1.37)	0.667	0.91 (0.80- 1.03)	0.146
Other/unknown	0.97 (0.75- 1.25)	0.820	0.91 (0.63- 1.31)	0.607	1.04 (0.92- 1.17)	0.566
Uninsured	1.12 (0.72- 1.76)	0.611	1.38 (0.86- 2.23)	0.187	1.08 (0.90- 1.30)	0.401
Urban or rural setting						
Urban	1.00		1.00		1.00	
Rural	0.97 (0.76- 1.25)	0.825	0.87 (0.63- 1.20)	0.410	0.89 (0.72- 1.09)	0.257
U.S. region						
Northeast	1.00		1.00		1.00	
Midwest	1.11 (0.91- 1.36)	0.286	1.20 (0.95- 1.51)	0.127	1.12 (0.98- 1.27)	0.096
South	0.91 (0.73- 1.15)	0.443	1.03 (0.79- 1.34)	0.819	0.98 (0.86- 1.12)	0.774
West	1.00 (0.79- 1.27)	0.981	1.01 (0.76- 1.34)	0.956	1.09 (0.97- 1.23)	0.147
Physician specialty						

General medicine/Internist	1.00				1.00				1.00		
Cardiologist	1.34	(1.15-	1.56)	<0.001	1.36	(1.10-	1.68)	0.005	1.16	(1.01-	1.33)	0.032
Chronic Conditions												
Obese/overweight	1.09	(0.94-	1.26)	0.253	1.08	(0.91-	1.27)	0.389	1.16	(1.09-	1.24)	<0.001
Dyslipidemia	1.00	(1.00-	1.00)	.	1.98	(1.60-	2.44)	<0.001	1.04	(0.96-	1.12)	0.318
Diabetes	1.19	(1.08-	1.31)	<0.001	1.00	(1.00-	1.00)	.	1.02	(0.96-	1.09)	0.529
Hypertension	1.23	(1.04-	1.45)	0.013	1.10	(0.88-	1.38)	0.387	1.00	(1.00-	1.00)	.
Smoker	0.99	(0.87-	1.13)	0.908	1.04	(0.88-	1.23)	0.633	1.02	(0.95-	1.10)	0.615
Good continuity of care	1.15	(0.91-	1.46)	0.244	0.88	(0.70-	1.12)	0.302	1.12	(0.98-	1.29)	0.091
Time trend	0.99	(0.91-	1.07)	0.813	1.08	(0.97-	1.20)	0.185	0.95	(0.90-	1.00)	0.070

RR, relative risk; CI, confidence interval;

Reference groups are male sex, White race/ethnicity, <45 years-old, private insurance, and urban setting. Other independent variables included in regression models are: obesity, smoker, dyslipidemia, diabetes, hypertension, CVD, and a year-based time trend

Note: All analyses account for the complex sampling design of the NAMCS

*Medications for smoking cessation include nicotine replacement therapy, varenicline, and bupropion

Table S7. Adjusted Relative Risk of Preventive Cardiovascular Lifestyle Counseling in Adults 40-79 Years-old Seeing Physicians in U.S. Ambulatory Care Visits, 2014-2016 (sensitivity analysis with sample limited to physicians who identify as the patient's primary care doctor).

	Diet/exercise Counseling for Obesity				Smoking Cessation Advice/Therapy			
Characteristics	Adj. RR (95% CI)			P value	Adj. RR (95% CI)			P value
Prescribed an opioid	0.91	(0.74-	1.11)	0.337	1.07	(0.71-	1.60)	0.752
Sex								
Men	1.00				1.00			
Female	1.10	(0.91-	1.33)	0.332	1.06	(0.81-	1.38)	0.672
Race/ethnicity								
White	1.00				1.00			
Non-Hispanic black	1.11	(0.86-	1.44)	0.428	1.29	(0.79-	2.12)	0.311
Hispanic	1.39	(1.08-	1.78)	0.009	0.46	(0.25-	0.85)	0.013
Other/unknown	1.15	(0.87-	1.53)	0.327	1.14	(0.77-	1.71)	0.513
Age, yrs								
40-49	1.00				1.00			
50-59	0.91	(0.72-	1.16)	0.462	1.26	(0.88-	1.81)	0.204
60-69	0.80	(0.65-	0.99)	0.044	0.97	(0.64-	1.47)	0.875
70-79	0.8	(0.6-	1.1)	0.157	0.7	(0.4-	1.2)	0.159
Insurance								
Private								
Medicare	1.06	(0.85-	1.30)	0.621	1.38	(0.98-	1.94)	0.065
Medicaid	0.68	(0.47-	0.98)	0.041	0.85	(0.49-	1.47)	0.551
Other/unknown	1.00	(0.76-	1.30)	0.981	1.09	(0.60-	1.99)	0.778
Uninsured	0.94	(0.49-	1.77)	0.838	0.63	(0.25-	1.58)	0.325
Urban or rural setting								
Urban	1.00				1.00			
Rural	0.78	(0.50-	1.24)	0.297	0.91	(0.53-	1.57)	0.745
U.S. region								
Northeast	1.00				1.00			
Midwest	1.19	(0.86-	1.63)	0.294	0.62	(0.38-	1.01)	0.054
South	1.42	(1.02-	1.98)	0.038	0.77	(0.47-	1.26)	0.297
West	0.96	(0.61-	1.49)	0.852	0.77	(0.47-	1.27)	0.300
Physician specialty								
General medicine/Internist	1.00				1.00			

Cardiologist	0.96	(0.47-	1.99)	0.923	0.65	(0.28-	1.51)	0.320
Chronic Conditions								
Obese/overweight	1.00	(1.00-	1.00)	.	0.94	(0.63-	1.41)	0.758
Dyslipidemia	1.18	(0.97-	1.43)	0.091	1.13	(0.81-	1.58)	0.455
Diabetes	1.13	(0.97-	1.33)	0.117	0.80	(0.54-	1.19)	0.280
Hypertension	1.12	(0.93-	1.33)	0.231	0.94	(0.71-	1.24)	0.646
Smoker	1.18	(0.97-	1.43)	0.100	1.00	(1.00-	1.00)	.
Good continuity of care	0.9	(0.7-	1.1)	0.361	0.7	(0.5-	1.0)	0.035
Time trend	1.2	(1.1-	1.4)	0.006	1.6	(1.4-	2.0)	<0.001

Table S8. Adjusted Relative Risk of Preventive Cardiovascular Medication Use in Adults 40-79 Years-old Seeing Physicians in U.S. Ambulatory Care Visits, 2014-2016 (sensitivity analysis with sample limited to patients without a diagnosis of cancer).

	Statin for Dyslipidemia			Statin for Diabetes			Antihypertensive for Hypertension		
Characteristics	Adj. RR (95% CI)		P value	Adj. RR (95% CI)		P value	Adj. RR (95% CI)		P value
Prescribed an opioid	1.07	(0.92- 1.24)	0.374	1.28	(1.08- 1.52)	0.005	1.14	(1.06- 1.22)	<0.001
Sex									
Men	1.00			1.00			1.00		
Female	0.86	(0.77- 0.97)	0.010	0.86	(0.74- 0.99)	0.033	0.96	(0.90- 1.02)	0.214
Race/ethnicity									
White	1.00			1.00			1.00		
Non-Hispanic black	0.97	(0.75- 1.26)	0.811	0.87	(0.66- 1.14)	0.310	1.00	(0.86- 1.16)	0.988
Hispanic	0.58	(0.43- 0.78)	<0.001	0.52	(0.33- 0.80)	0.004	0.94	(0.85- 1.04)	0.251
Other/unknown	1.01	(0.85- 1.19)	0.929	1.10	(0.91- 1.34)	0.333	1.04	(0.93- 1.15)	0.528
Age, yrs									
40-49	1.00			1.00			1.00		
50-59	1.09	(0.88- 1.36)	0.413	1.13	(0.86- 1.48)	0.394	0.98	(0.88- 1.10)	0.776
60-69	1.12	(0.90- 1.38)	0.310	1.02	(0.74- 1.41)	0.890	1.04	(0.94- 1.15)	0.402
70-79	1.13	(0.90- 1.43)	0.286	1.12	(0.82- 1.52)	0.486	1.05	(0.91- 1.21)	0.517
Insurance									
Private									
Medicare	0.99	(0.87- 1.13)	0.901	1.06	(0.88- 1.27)	0.566	1.00	(0.93- 1.07)	0.926
Medicaid	0.95	(0.77- 1.17)	0.635	1.05	(0.81- 1.36)	0.707	0.92	(0.82- 1.03)	0.146
Other/unknown	0.96	(0.76- 1.22)	0.756	1.01	(0.72- 1.40)	0.976	1.04	(0.94- 1.16)	0.446
Uninsured	1.13	(0.74- 1.74)	0.564	1.34	(0.81- 2.21)	0.259	1.06	(0.89- 1.27)	0.488
Urban or rural setting									
Urban	1.00			1.00			1.00		
Rural	0.99	(0.78- 1.26)	0.958	0.87	(0.63- 1.20)	0.410	0.88	(0.72- 1.07)	0.207
U.S. region									
Northeast	1.00			1.00			1.00		
Midwest	1.27	(1.03- 1.57)	0.027	1.40	(1.08- 1.83)	0.012	1.13	(1.00- 1.28)	0.043
South	1.05	(0.83- 1.33)	0.692	1.18	(0.88- 1.58)	0.258	1.00	(0.88- 1.13)	0.944
West	1.08	(0.85- 1.37)	0.524	1.16	(0.86- 1.57)	0.334	1.08	(0.95- 1.22)	0.227
Physician specialty									

General medicine/Internist	1.00				1.00				1.00			
Cardiologist	1.17	(0.98-	1.40)	0.091	1.08	(0.87-	1.35)	0.492	1.11	(0.99-	1.24)	0.070
Chronic Conditions												
Obese/overweight	1.09	(0.95-	1.25)	0.227	1.07	(0.91-	1.25)	0.432	1.16	(1.10-	1.24)	<0.001
Dyslipidemia	1.00	(1.00-	1.00)	.	1.97	(1.60-	2.43)	<0.001	1.04	(0.97-	1.11)	0.296
Diabetes	1.17	(1.06-	1.29)	0.002	1.00	(1.00-	1.00)	.	1.01	(0.95-	1.08)	0.765
Hypertension	1.36	(1.13-	1.65)	0.001	1.24	(0.98-	1.56)	0.076	1.00	(1.00-	1.00)	.
Smoker	1.03	(0.92-	1.16)	0.596	1.08	(0.92-	1.26)	0.349	1.03	(0.96-	1.10)	0.459
Good continuity of care	1.20	(0.98-	1.47)	0.071	1.08	(0.85-	1.36)	0.539	1.19	(1.07-	1.32)	0.001
Time trend	1.00	(0.92-	1.08)	0.913	1.08	(0.97-	1.21)	0.150	0.94	(0.89-	0.99)	0.024

RR, relative risk; CI, confidence interval;

Reference groups are male sex, White race/ethnicity, <45 years-old, private insurance, and urban setting. Other independent variables included in regression models are: obesity, smoker, dyslipidemia, diabetes, hypertension, CVD, and a year-based time trend

Note: All analyses account for the complex sampling design of the NAMCS

*Medications for smoking cessation include nicotine replacement therapy, varenicline, and bupropion

Table S9. Adjusted Relative Risk of Preventive Cardiovascular Lifestyle Counseling in Adults 40-79 Years-old Seeing Physicians in U.S. Ambulatory Care Visits, 2014-2016 (sensitivity analysis with sample limited to patients without a diagnosis of cancer).

	Diet/exercise Counseling for Obesity				Smoking Cessation Advice/Therapy			
Characteristics	Adj. RR (95% CI)			P value	Adj. RR (95% CI)			P value
Prescribed an opioid	0.89	(0.73-	1.09)	0.254	1.09	(0.73-	1.64)	0.679
Sex								
Men	1.00				1.00			
Female	1.10	(0.92-	1.31)	0.300	0.99	(0.77-	1.29)	0.965
Race/ethnicity								
White	1.00				1.00			
Non-Hispanic black	1.25	(0.99-	1.57)	0.061	1.37	(0.85-	2.20)	0.197
Hispanic	1.37	(1.08-	1.75)	0.009	0.41	(0.22-	0.76)	0.004
Other/unknown	1.20	(0.92-	1.56)	0.169	1.06	(0.72-	1.58)	0.754
Age, yrs								
40-49	1.00				1.00			
50-59	0.98	(0.78-	1.24)	0.877	1.27	(0.89-	1.80)	0.183
60-69	0.87	(0.70-	1.07)	0.175	1.01	(0.67-	1.53)	0.960
70-79	0.8	(0.6-	1.1)	0.219	0.7	(0.4-	1.2)	0.151
Insurance								
Private								
Medicare	1.04	(0.86-	1.27)	0.666	1.38	(0.97-	1.95)	0.072
Medicaid	0.69	(0.47-	1.00)	0.051	0.86	(0.51-	1.45)	0.576
Other/unknown	0.92	(0.68-	1.24)	0.574	1.03	(0.58-	1.85)	0.912
Uninsured	0.74	(0.37-	1.46)	0.379	0.75	(0.35-	1.58)	0.447
Urban or rural setting								
Urban	1.00				1.00			
Rural	0.68	(0.44-	1.06)	0.090	0.88	(0.50-	1.56)	0.665
U.S. region								
Northeast	1.00				1.00			
Midwest	0.99	(0.73-	1.34)	0.966	0.76	(0.47-	1.24)	0.272
South	1.20	(0.90-	1.61)	0.220	0.92	(0.56-	1.49)	0.729
West	0.86	(0.59-	1.26)	0.448	0.74	(0.44-	1.25)	0.259
Physician specialty								
General medicine/Internist	1.00				1.00			

Cardiologist	0.79	(0.57-	1.09)	0.152	0.78	(0.48-	1.26)	0.311
Chronic Conditions								
Obese/overweight	1.00	(1.00-	1.00)	.	1.02	(0.69-	1.50)	0.921
Dyslipidemia	1.32	(1.10-	1.59)	0.003	1.09	(0.80-	1.49)	0.585
Diabetes	1.13	(0.97-	1.30)	0.111	0.82	(0.56-	1.19)	0.285
Hypertension	1.07	(0.90-	1.26)	0.463	0.94	(0.72-	1.24)	0.680
Smoker	1.16	(0.96-	1.40)	0.128	1.00	(1.00-	1.00)	.
Good continuity of care	1.0	(0.8-	1.2)	0.683	0.9	(0.7-	1.3)	0.653
Time trend	1.2	(1.1-	1.4)	0.003	1.6	(1.3-	1.9)	<0.001