Changes in Cardiovascular Care Provision After the Affordable Care Act

Joseph A. Ladapo, MD, PhD; and Dave A. Chokshi, MD, MSc

ABSTRACT

OBJECTIVES: Physicians are gatekeepers to preventive care recommended by the US Preventive Services Task Force (USPSTF). We aimed to determine whether the Affordable Care Act (ACA) was associated with changes in physicians' provision of preventive cardiovascular services, focusing primarily on patients with employer-sponsored health plans.

STUDY DESIGN: Quasi-experimental, difference-in-differences (DID) approach.

METHODS: We analyzed National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey data from 2006 to 2013. Using a quasi-experimental DID approach with multivariate logistic models, we compared trends in preventive cardiovascular services delivered during physician visits among target and control populations prior to the ACA's provisions.

RESULTS: The ACA was associated with an increase in use of diabetes screening (3.9% in 2006-2010 [third quarter] to 7.6% in 2010 [fourth quarter]-2013; DID, +3.5 per 100 visits; 95% CI, 1.1-5.9), tobacco use screening in adults (64.4% in 2006-2010 to 74.5% in 2010-2013; DID, +11.6 per 100 visits; 95% CI, 4.8-18.3), aspirin therapy in men (11.1% in 2006-2010 to 13.5% in 2010-2013; DID, +2.9 per 100 visits; 95% CI, 1.1-4.6), and hypertension screening (73.2% in 2006-2010 to 76.4% in 2010-2013; DID, +9.9 per 100 visits; 95% CI, 2.8-16.9).

CONCLUSIONS: Provision of cardiovascular preventive care increased for some USPSTF-recommended services following enactment of the ACA, with evidence of a sex disparity in aspirin use. Other complementary policy approaches may further enhance uptake of evidence-based clinical preventive services.

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Coronary heart disease (CHD) and stroke are leading causes of death in the United States,[1] and physicians play a central role in treating modifiable risk factors among patients seeking clinical care. The Affordable Care Act (ACA) is designed to reduce barriers to preventive care, including preventive cardiovascular care, by eliminating marginal cost sharing on high-value screening tests identified by the US Preventive Services Task Force (USPSTF).[2] The design of this particular provision of the ACA is unique, however, because it is unlike other policies and programs for cardiovascular disease (CVD) reduction that directly target the behavior of patients or healthcare providers—such as cigarette taxes, calorie postings on menus, or Medicare's recently launched physician incentive program for preventive cardiovascular care.[3,4]

The ACA's economic incentives for USPSTF services indirectly target physicians' provision of preventive care by reducing patients' out-of-pocket costs. Because physicians are gatekeepers to these services, directly assessing their patterns of preventive care provision in response to the ACA is critical to informing the design of future policies for clinical prevention. For example, policy approaches to increasing the population prevalence of a preventive cardiovascular test or therapy may differ depending on whether the service is provided during 5%, 15%, or 50% of clinical visits in which a physician sees a potentially eligible patient. Data on physicians' provision of preventive services may also be more persuasive to physicians than the population prevalence of preventive service penetration, since the former more directly reflects physicians' decision making.

To help inform future policies for preventive care in CVD, we used nationally representative data from the National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) and examined physicians' early response to the ACA. We primarily focused on physician visits for patients enrolled in private insurance plans because these plans insure the majority of the US population.

METHODS

Study Design

We used a quasi-experimental, difference-in-differences (DID) approach to examine the impact of the ACA on physicians' provision of preventive cardiovascular care. The DID approach measures changes in an outcome associated with a policy change, after accounting for secular trends in that outcome, as reflected in a control group that is not exposed to the policy change.[5] In this study, physician visits with insured patients in the target population were defined according to criteria proposed by the USPSTF, and the control group was composed of physician visits with patients who were: a) insured but ineligible for the preventive service by USPSTF guidelines (eg, patients close to but not meeting an age threshold for a screening test) or b) self-pay/uninsured and eligible for the preventive service. We selected these control groups because we hypothesized that physicians' provision of preventive cardiovascular care in these encounters would likely capture temporal trends unrelated to the ACA,[6,7] and we formally tested this hypothesis by comparing trends among the target and control populations in preventive cardiovascular services prior to the ACA's provisions (evidence of a difference in slopes would suggest a difference in trends prior to the ACA). These tests showed no significant differences among our target and control groups for any of the preventive cardiovascular services we evaluated, which supports our selection of control groups.

TAKEAWAY POINTS

Provision of cardiovascular preventive care increased for some US Preventive Services Task Force (USPSTF)-recommended services following the Affordable Care Act (ACA), with evidence of a sex disparity in aspirin use.

- This study was the first to analyze changes in use of cardiovascular preventive care after the ACA by directly assessing physician decision making.
- The ACA's cost-sharing provisions are an effective way to increase uptake of clinical preventive services.
- Levels of service provision were still lower than those recommended by the USPSTF.
- Sex disparity in aspirin use underscores concerns about poorer-quality cardiovascular care in women.
- Other complementary policy approaches may further enhance uptake of evidence-based clinical preventive services.

Data

We analyzed data collected in the NAMCS and NHAMCS from 2006 to 2013. The National Center for Health Statistics (NCHS) and the CDC conduct the NAMCS and NHAMCS annually on a nationally representative sample of visits to office-based physicians, hospital-based outpatient clinics, and emergency departments in the United States.[8] Data are collected on patients' symptoms, comorbidities, and demographic characteristics; physicians' diagnoses; medications ordered or provided; and medical services provided. The NAMCS and NHAMCS intake materials allow physicians and staff to record up to 3 reasons for each visit and 3 diagnoses related to the visit, in addition to capturing several other major comorbid diagnoses (coded by NCHS staff using the *International Classification of Diseases, Ninth Revision, Clinical Modification*).

Data on outpatient hospital departments and community health centers from the NHAMCS were unavailable from 2012 to 2013, but the majority of ambulatory care is performed in office-based visits and captured by the NAMCS (93% of visits during 2006-2011 occurred in the office rather than hospital outpatient departments, and 99% of office visits occurred outside of community health centers). However, we adjusted for the absence of these 2 care sites in our regression analyses and used the 2006 to 2011 ratio of total visits to nonhospital outpatient/non–community health center visits to adjust the 2012 and 2013 estimates of care provision.[9] Our analyses included only preventive care visits (including screening and general exams), routine visits for chronic problems, or visits to primary care physicians (including physicians in family practice, internal medicine, and obstetrics/gynecology) or to a patient's primary care clinic, because we viewed these visit types as reasonable opportunities for the provision of preventive cardiovascular care.

From 2006 to 2013, the physician and hospital/outpatient clinic response rates in the NAMCS and NHAMCS ranged from 54% to 65% and 84% to 90%, respectively, and item nonresponse rates were generally 5% or less in both surveys.

Study Population and Primary Measures

We evaluated 11 preventive cardiovascular services for adult patients (≥18 years) that received A or B ratings from the USPSTF prior to the ACA's implementation. Our target populations were primarily defined as patients who were privately insured unless otherwise stated, although we did not exclude patients concurrently enrolled in public plans as the ACA expanded preventive cardiovascular benefits in Medicare and Medicaid. Including these public plans therefore provides a more accurate assessment of the ACA's overall effects. In addition, we evaluated tobacco screening and cessation treatment among pregnant women enrolled in Medicaid because of the importance of this particular policy and its unique treatment in the ACA as a provision applicable to all Medicaid plans rather than only Medicaid expansion plans. We excluded physician visits by patients who had previously been diagnosed with the condition that was subject to screening (eg, visits by patients with diabetes were excluded from our analysis of glycated hemoglobin [A1C] use for diabetes screening). In our analysis of tobacco use screening, all adults were included, irrespective of their prior tobacco use.

The preventive cardiovascular services we evaluated were: a) use of A1C to screen patients with hypertension for type 2 diabetes[10];

b) obesity management with counseling about diet/nutrition, exercise, or weight reduction[11]; c) measuring blood pressure in adults without diagnosed hypertension[12]; d) lipid testing among men 35 years or older or in high-risk men aged 20 to 34 years (high-risk defined by USPSTF as history of diabetes, previous CHD or atherosclerosis, family history of CVD, tobacco use, hypertension, or obesity by body mass index ≥30 kg/m^2)[13]; e) lipid testing among women age 45 or older or high-risk women aged 20 to 44 years (high-risk defined similarly in women and men)[13]; f) aspirin therapy to prevent myocardial infarction in men aged 45 to 79 years[14]; g) aspirin therapy to prevent stroke in women aged 55 to 79 years[14]; h) tobacco use screening among pregnant women enrolled in Medicaid[15,16]; i) tobacco use screening among adults enrolled in private plans[15]; j) smoking cessation advice/counseling in pregnant smokers enrolled in Medicaid[15,16]; and k) smoking cessation advice/counseling in smokers enrolled in private plans.[15]

In our control groups, we examined physicians' provision of these same preventive cardiovascular services in visits with: a) asymptomatic adults with normal blood pressure, b) self-pay/uninsured obese adults, c) self-pay/uninsured adults without diagnosed hypertension, d) low-risk men aged 20 to 34 years, e) low-risk women aged 20 to 44 years, f) men aged 30 to 44 years, g) women aged 45 to 54 years, h) nonpregnant women enrolled in Medicaid, i) self-pay/uninsured adults, j) nonpregnant female smokers enrolled in Medicaid, and k) self-pay/uninsured smokers.

We hypothesized that these were plausible control groups because they likely captured temporal trends in physicians' preventive cardiovascular care but would not be directly affected by the ACA during our study timeframe because patients either did not meet USPSTF guideline criteria or did not have an eligible insurance plan. To identify our control groups, we also considered their clinical similarity to patients in the target population. When possible, we used age to distinguish between the target and control populations (eg, men 45 years or older were eligible for aspirin therapy whereas men younger than this age were generally not) because selection based on age was used in prior DID evaluations of the ACA.[17] When it was not appropriate to use an age cutoff (eg, A1C screening is based on presence or absence of hypertension among adults and is not age-specific; Medicaid tobacco use screening targeted pregnant women rather than nonpregnant women), we distinguished our target and control patients by the presence or absence of a relevant comorbidity or risk factor. When neither of these options were available or appropriate, we identified clinically similar patients and distinguished the target and control cohorts by whether they were enrolled in private plans (and therefore eligible for the provision) or were considered self-pay/uninsured (and therefore ineligible for the provision). Examples of this included measuring blood pressure in adults without diagnosed hypertension (applying age eligibility criteria was not appropriate, nor was using a control group composed of patients with diagnosed hypertension, since these patients have an established diagnosis and would no longer be eligible for screening). The validity of our control population selections was assessed in comparisons of time trends between target and control populations during the pre-ACA period, and there were no significant differences, a finding that supports our hypothesis.

All ACA provisions took effect on September 23, 2010, for privately insured patients, but we used a start date of October 1 due to data availability. For pregnant women in Medicaid, ACA tobacco coverage was required as of October 1, 2010.

Other Measures

To further account for patient and clinical characteristics that may be associated with physicians' use of preventive cardiovascular services, we extracted information on patient age, sex, race/ethnicity, US Census region (Northeast, Midwest, South, and West), urban or rural setting, and important comorbidities (identified using visit diagnoses and reasons for visit) known to increase the risk of adverse cardiovascular events (hypertension, coronary artery disease, diabetes, chronic kidney disease, and chronic obstructive pulmonary disease).[18] To account for a possible increase in the complexity of self-pay/uninsured patients after the ACA took effect, we adjusted for a measure of continuity of care, as defined by whether a patient was an established patient or a new patient in the physician's practice.[19,20]

Statistical Analysis

All analyses accounted for the complex sampling design of the NAMCS and NHAMCS.[21] We estimated simple and multivariate DID logistic regressions and estimated the predicted probability of a preventive cardiovascular service (as a dummy variable) to examine the impact of the ACA on the physicians' care patterns (see **eAppendix** [eAppendix available at **ajmc.com**). Our models were generally implemented as:

$$\textit{Preventive cardiovascular service} = \beta_0 + \beta_1 \textit{ Target population visit} + \beta_2 \textit{ Post ACA} + \beta_3 \textit{ Target population visit} \times \textit{Post ACA}$$

where *Preventive cardiovascular service*, *Target population visit*, and *Post ACA* are indicator variables and *Post ACA* specifically captures the period from October 1, 2010, to December 31, 2013.

The coefficient on the interaction term between *Target population visit* and *Post ACA* estimates the impact of interest. Specifically, this coefficient captures the differences among preventive cardiovascular service rates between target population visits and control population visits in the time period before the ACA's implementation and compares them with the differences after the policy change; the coefficient therefore represents the independent relationship between the ACA and physicians' preventive cardiovascular service rates. We tested for differences in pre-2010 testing trends among target population visits and control population visits by estimating multivariate logistic regressions limited to the period between January 1, 2006, and September 30, 2010, and including an interaction variable between time and our indicator for target population visits. The coefficient for this variable was not significant for any of the preventive cardiovascular services we examined. Multivariate logistic regression models also adjusted for patients' clinical risk factors and demographic characteristics, insurance, geographic region, and urban/rural setting. Analyses were performed using Stata version 14 (StataCorp LLC; College Station, Texas).

Sensitivity Analysis

Because of the concern that self-pay/uninsured patients may be sicker (or healthier overall; see Decker et al,[22] for example) in the post-ACA period than in the period before the law took effect[23] and that such differences could bias our results, we assessed changes in the overall cardiovascular risk of patients with private insurance versus patients who are self-pay/uninsured. Specifically, we computed the atherosclerotic cardiovascular disease (ASCVD) scores for privately insured patients and self-pay/uninsured patients from 2006 to 2013 and constructed linear regression models to test for an interaction between the post-ACA period and self-pay/uninsured status.[24] Lipid levels and blood pressure were not uniformly available in our data, so we imputed these values with age- and sex-adjusted population values in the United States (see **eAppendix Table 1**).[25,26] These models included covariates similar to those of our primary models, but patients with CHD were omitted (3.9% of overall population) because the ASCVD is only applicable to patients without CHD. We did not find evidence of an interaction ($P = .45$ for interaction), indicating that the overall cardiovascular risk level of the self-pay/uninsured cohort was not significantly different over time.

RESULTS

Annual Number and Prevalence of Preventive Cardiovascular Services

We present overall trends in physicians' use of preventive cardiovascular services during clinic visits for diabetes screening, obesity therapy, hypertension screening, cholesterol screening, aspirin therapy, tobacco use, and smoking cessation treatment in **Figure 1**. Characteristics of the population are reported in **eAppendix Table 2**. The rates of most preventive cardiovascular services tended to be flat or to trend modestly upward for physician visits with target and control patients, although rates of obesity treatment and smoking cessation advice/counseling tended to trend downward.

Changes in Preventive Cardiovascular Services Post ACA

Using our DID regression models, we found that in the period after the ACA's provisions took effect for preventive cardiovascular services, there was no significant change in the use of obesity treatment (47.2% in 2006-2010 [third quarter] to 40.3% in 2010 [fourth quarter]-2013; DID, –1.3 per 100 visits; 95% CI, –21.9 to 19.4), cholesterol screening in men (10.3% in 2006-2010 to 8.9% in 2010-2013; DID, +0.4 per 100 visits; 95% CI, –2.2 to 3.0), cholesterol screening in women (8.4% in 2006-2010 to 7.9% in 2010-2013; DID, +0.4 per 100 visits; 95% CI, –1.3 to 2.0), aspirin therapy in women (8.8% in 2006-2010 to 10.0% in 2010-2013; DID, +0.4 per 100 visits; 95% CI, –1.3 to 2.0), tobacco use screening in pregnant women (67.7% in 2006-2010 to 70.3% in 2010-2013; DID, +2.5 per 100 visits; 95% CI, –5.4 to 10.5), smoking cessation advice in pregnant smokers (17.6% in 2006-2010 to 13.3% in 2010-2013; DID, –7.2 per 100 visits; 95% CI, –17.7 to 3.2), or smoking cessation advice in adult smokers (23.0% in 2006-2010 to 17.8% in 2010-2013; DID, +0.8 per 100 visits; 95% CI, –6.2 to 7.7) (**Table**).

The ACA's 2010 provisions were associated with an increase in the use of diabetes screening (3.9% in 2006-2010 to 7.6% in 2010-2013; DID, +3.5 per 100 visits; 95% CI, 1.1-5.9), tobacco use screening in adults (64.4% in 2006-2010 to 74.5% in 2010-2013; DID, +11.6 per 100 visits; 95% CI, 4.8-18.3), aspirin therapy in men (11.1% in 2006-2010 to 13.5% in 2010-2013; DID, +2.9 per 100 visits; 95% CI, 1.1-4.6), and hypertension screening (73.2% in 2006-2010 to 76.4% in 2010-2013; DID, +9.9 per 100 visits; 95% CI, 2.8-16.9).

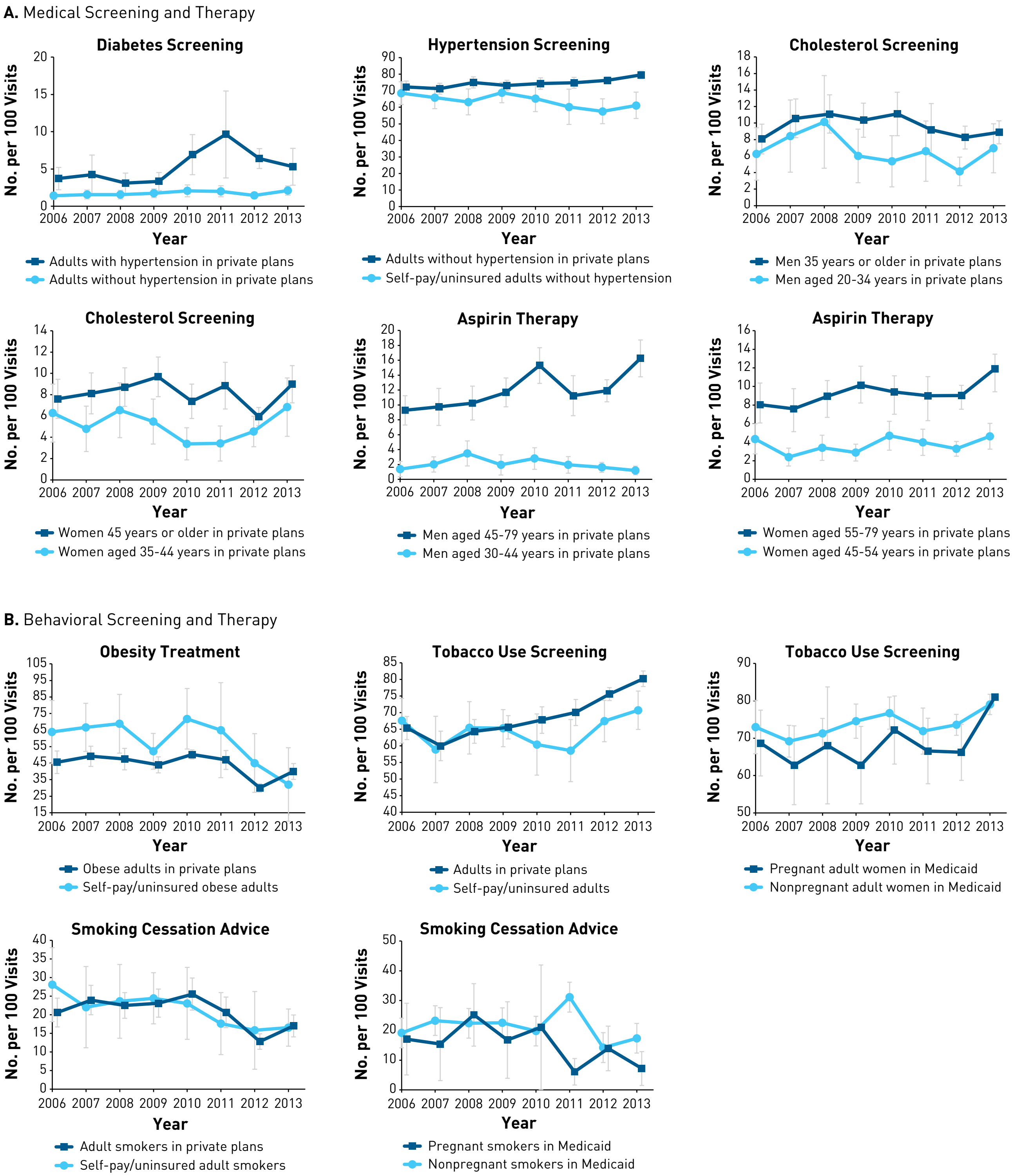
We performed sensitivity analyses for cholesterol screening and aspirin therapy that used a self-pay/uninsured cohort of similar age and sex to address any confounding potentially related to age differences in our primary analyses. This analysis was not possible for aspirin therapy in men because pre-ACA trends differed between these 2 groups. These sensitivity analyses yielded similar results to our main analyses, showing no significant change in cholesterol screening in men (DID, +2.2 per 100 visits; 95% CI, –1.9 to 6.2), cholesterol screening in women (DID, +0.4 per 100 visits; 95% CI, –4.0 to 4.7), or aspirin therapy in women (DID, +1.7 per 100 visits; 95% CI, –0.4 to 3.8).

Using the Benjamini-Hochberg procedure to adjust for multiple testing, where P values are sorted in ascending order and critical limits are estimated for each P value based on its rank, total number of statistical tests, and false discovery rate (0.05), we found that changes in tobacco use, hypertension, and diabetes screening remained significant, whereas the change in aspirin therapy among men was no longer significant.

DISCUSSION

Our results indicate that physicians' provision of cardiovascular preventive care increased for USPSTF-recommended services following enactment of the ACA, based primarily on findings in patients with employer-sponsored health plans. Out of 11 services examined, 4 (diabetes screening, tobacco use screening, aspirin therapy among men, and hypertension screening) were found to

FIGURE 1. Rate of USPSTF Preventive Cardiovascular Care in US Ambulatory Visits, 2006-2013[a,b]



No. indicates number; SE, standard error; USPSTF, US Preventive Services Task Force.

[a]In some years, data did not meet statistical reliability standards (sample size ≥30, relative SE ≤30%) due to small sample sizes, and estimates for these years may be inaccurate (2006, 2007, 2010, and 2011 for aspirin therapy in the male control group; 2012 to 2013 for smoking cessation advice in pregnant women; 2006 and 2009 to 2012 for cholesterol screening in male control group). All rates displayed in the figures are weighted, accounting for the complex sampling design of the surveys, and unadjusted.

[b]Each figure compares populations targeted for preventive services by USPSTF guidelines with control patients not eligible for these services.

TABLE. Rate of USPSTF Preventive Cardiovascular Care in the United States and Net Change (DID estimate) in Utilization Rate Post Affordable Care Act

		Rate per 100 Visits[a]			Rate per 100 Visits[a]		Unadjusted Impact			Adjusted Impact		
USPSTF Service	Target Population[b]	Pre-ACA	Post ACA	Control Population[c]	Pre-ACA	Post ACA	Net Change Post ACA[d]	95% CI	*P*	Net Change Post ACA[d]	95% CI	*P*
Diabetes and obesity												
Diabetes screening	Adults with hypertension in private plans	3.9	7.6	Adults without hypertension in private plans	1.6	1.9	3.5	1.1-5.9	.01	2.9	0.8-5.0	.008
Obesity treatment	Obese adults in private plans	47.2	40.3	Self-pay/uninsured obese adults	64.4	58.6	−1.3	−21.9 to 19.4	.93	−1.8	−20.4 to 16.8	.88
Hypertension and dyslipidemia												
Hypertension screening	Adults without hypertension in private plans	73.2	76.4	Self-pay/uninsured adults without hypertension	66.3	60.3	9.9	2.8-16.9	<.001	9.3	2.4-16.1	.004
Cholesterol screening	Men ≥35 years in private plans	10.3	8.9	Men aged 20-34 years in private plans	7.5	5.7	0.4	−2.2 to 3	.53	0.4	−2.4 to 3.3	.60
Cholesterol screening	Women ≥45 years in private plans	8.4	7.9	Women aged 35-44 years in private plans	5.5	4.6	0.4	−1.3 to 2	.48	0.4	−1.4 to 2.2	.55
Aspirin for CHD and stroke prevention												
Aspirin therapy	Men aged 45-79 years in private plans	11.1	13.5	Men aged 30-44 years in private plans	2.3	1.7	2.9	1.1-4.6	.02	2.7	1.0-4.4	.03
Aspirin therapy	Women aged 55-79 years in private plans	8.8	10.0	Women aged 45-54 years in private plans	3.4	4.1	0.4	−1.1 to 1.9	.69	0.3	−1.2 to 1.7	.73
Tobacco use[e]												
Tobacco use screening	Pregnant adult women in Medicaid	67.7	70.3	Nonpregnant adult women in Medicaid	72.9	74.5	2.5	−5.4 to 10.5	.56	2.8	−5.2 to 10.7	.53
Tobacco use screening	Adults in private plans	64.4	74.5	Self-pay/uninsured adults	63.9	63.4	11.6	4.8-18.3	<.001	11.4	4.8-18.1	<.001
Smoking cessation advice	Pregnant smokers in Medicaid	17.6	13.3	Nonpregnant smokers in Medicaid	20.9	23.2	−7.2	−17.7 to 3.2	.22	−6.3	−16.9 to 4.4	.30
Smoking cessation advice	Adult smokers in private plans	23.0	17.8	Self-pay/uninsured adult smokers	24.0	18.3	0.8	−6.2 to 7.7	.84	0.5	−6.4 to 7.4	.94

ACA indicates Affordable Care Act; CHD, coronary heart disease; DID, difference-in-differences; USPSTF, US Preventive Services Task Force.
[a]The period prior to the ACA is January 1, 2006, to September 22, 2010; the period after the ACA is September 23, 2010, to December 31, 2013.
[b]Target populations include only patients with private insurance plans unless otherwise stated.
[c]Control populations include only patients with private insurance plans and exclude patients jointly enrolled in Medicare or Medicaid, unless otherwise stated.
[d]Net changes incorporate pre-ACA and post-ACA preventive service rates in visits for both target and control populations and reflect DID estimates per 100 visits.
[e]Medicaid coverage for smoking cessation services in pregnant women began on October 1, 2010. The nonpregnant control group excludes patients jointly enrolled in Medicaid and either private insurance plans or Medicare.

be used more frequently by physicians. Our findings also indicate that overall, physician visits for preventive cardiovascular care were increasing prior to the ACA—and this trend continued following its passage. The sex disparity for aspirin use underscores wider concerns about disparities in cardiovascular care among women versus men.[27]

To our knowledge, this study is the first to analyze changes in use of cardiovascular preventive care after the ACA using physician visit–level data. The physician focus in our analysis allows a more direct assessment of clinical decision making in response to policy changes encoded in the ACA, such as elimination of marginal cost sharing for USPSTF-recommended preventive services.

Comparing our results with those in prior studies using patient-level data (eg, from the Medical Expenditure Panel Survey), we found similarly mixed, although generally modest, effects on uptake of USPSTF-recommended preventive services after the ACA.[28-30] This may reflect the limited consequences that eliminating patient cost sharing has on physician decision making. In March 2014, only about 43% of the population reported awareness that the ACA eliminated out-of-pocket expenses for preventive services.[31] The fact that overall physician visits for preventive cardiovascular services increased during the timeframe studied (2006-2013) may mean that other factors were more important in influencing physician uptake. For example, a growing emphasis on cardiovascular prevention through insurance payer policies and professional society guidelines may have been more significant than ACA provisions.

With respect to the increase in certain preventive services (diabetes screening, tobacco use screening, aspirin therapy among men, and hypertension screening), it is difficult to pinpoint the mechanism of effect, particularly because they are services that could be delivered within the context of a routine primary care visit. Patients may not have experienced cost sharing for these services even before the ACA—other than their co-payment for the office visit itself, which would not be affected by the ACA preventive services provisions. The causes of these temporal trends require further investigation with more granular data on cost sharing at the visit level.

Our study supports the argument that the ACA's cost-sharing provisions are an effective way to increase uptake of clinical preventive services, although overall levels of service provision were still lower than those recommended by the USPSTF and these gaps increase the population risk of CVD. Our findings are in contrast to some earlier evaluations of the ACA that found minimal or no effects on preventive care. However, the absolute effects of the ACA's preventive cardiovascular care provisions were often modest. Physician decision making may be more sensitive to more proximal factors such as educational interventions, enhanced reimbursement for preventive services, or ease of operational processes, such as referrals for smoking cessation advice or point-of-care A1C testing. For services delivered during a preponderance of clinic visits, such as hypertension screening or tobacco use screening, strategies may differ and revolve around implementation of practice-level processes that ensure near-universal screening. For those offered during a lower proportion of visits, such as aspirin therapy or diabetes screening, clinical decision support (eg, electronic health record defaults) may be more effective.

Limitations

Our study has several limitations. We were unable to account for the presence of grandfathered plans exempt from some ACA provisions, patient or physician awareness of ACA provisions, or the effects of insurer medical loss ratio regulations that may have increased overall preventive service provision. Our findings may therefore underestimate (or overestimate, particularly in the cases of hypertension and tobacco use screening, where control populations were self-pay/uninsured) the effect of the policy change on physicians' provision of preventive cardiovascular services. In addition, diffusion of high-deductible insurance plans may have exerted indiscriminate downward pressure on appropriate and inappropriate preventive care, a finding that was demonstrated in the RAND health insurance experiment.[32] Related to this, if private plans or state Medicaid programs that were otherwise exempt from the ACA's provisions chose to reduce cost sharing on preventive cardiovascular services in response to a changing climate of health reform, these shifts would cause us to understate the ACA's effects. We also performed multiple statistical tests, and our findings should be interpreted in this context. Further, we did not have data on patients' incomes, and some research suggests that patients from lower income groups—and the physicians who care for them—may be more sensitive to the elimination of marginal cost sharing than patients from higher income groups.

CONCLUSIONS

Physicians' provision of cardiovascular preventive care increased for some USPSTF-recommended services following enactment of the ACA. The results of our direct assessment of physicians' clinical decision making in response to policy changes encoded in the ACA support the notion that cost-sharing provisions are an effective way to increase uptake of evidence-based clinical preventive services, although substantial gaps in preventive care persist. The sex disparity in aspirin use also underscores wider concerns about poorer-quality cardiovascular care in women versus men. Other interventions, including those with an educational, reimbursement-based, or practice-level focus, may be complementary approaches to influencing physician decision making and reducing the population burden of CVD. ■

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Author Affiliations: Division of General Internal Medicine, David Geffen School of Medicine at UCLA (JAL), Los Angeles, CA; NYC Health + Hospitals and Departments of Population Health and Medicine, New York University School of Medicine (DAC), New York, NY.

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Address Correspondence to: Joseph A. Ladapo, MD, PhD, David Geffen School of Medicine at UCLA, 911 Broxton Ave, Los Angeles, CA 90024. E-mail: jladapo@mednet.ucla.edu.

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eAppendix

Statistical Analysis

All analyses accounted for the complex sampling design of the NAMCS and NHAMCS. Independent variables were chosen based on our past work in cardiovascular testing,[1] with a focus on factors known to increase the risk of adverse cardiovascular events (hypertension, coronary artery disease, diabetes, chronic kidney disease, and chronic obstructive pulmonary disease [COPD]).[2] We used simple and multivariate logistic regressions, and our multivariable logistic regression models also adjusted for patients' clinical risk factors and demographic characteristics, and region. Our regression models for preventive cardiovascular care generally took the form:

$$\begin{aligned}\text{Logit}(\textit{Preventive\_CV\_care}_{it}) = {} & \beta_0 + \beta_1\, \textit{Target\_population\_visit}_i + \beta_2\, \textit{Post-Affordable\_Care\_Act}_t \\ & + \beta_3\, \textit{Affordable\_Care\_Act's\_Impact}_{it} + \beta_4\, \textit{Hospital\_outpatient\_department}_{it} \\ & + \beta_5\, \textit{Community\_health\_center}_{it} + \beta_6\, \textit{Female}_{it} + \beta_7\, \textit{Black}_{it} + \beta_8\, \textit{Hisp}_{it} \\ & + \beta_9\, \textit{Race\_other\_unknown}_{it} + \beta_{10}\, \textit{Midwest}_{it} + \beta_{11}\, \textit{South}_{it} + \beta_{12}\, \textit{West}_{it} \\ & + \beta_{13}\, \textit{Rural}_{it} + \beta_{14}\, \textit{Patient\_seen\_before}_{it} + \beta_{15}\, \textit{Htn\_diag}_{it} + \beta_{16}\, \textit{CAD\_diag}_{it} \\ & + \beta_{17}\, \textit{Diabetes\_diag}_{it} + \beta_{18}\, \textit{CKD\_diag}_{it} + \beta_{19}\, \textit{COPD\_diag}_{it} + \varepsilon_{it}\end{aligned}$$

Preventive_CV_care is an indicator for whether a preventive cardiovascular service was ordered/performed (1=yes, 0=no; all indicator variables were similarly coded). *Target_population_visit* is also an indicator and equals 1 for visits by patients meeting the criteria that defined our target population for each test; *Post-Affordable_Care_Act* is a binary variable for the time period after September 23, 2010 (in our models, we used a cut-point of October 1, 2010 because of data constraints); and *Affordable_Care_Act's_Impact* is an interaction term between *Target_population_visit* and *Post-Affordable_Care_Act*. The coefficient of interest is β_3 because it captures the Affordable Care Act's impact on preventive cardiovascular care among patients in the target population, compared to patients in a control group (non-target population). We expect β_3 to be greater than 0 if the policy change increased preventive cardiovascular care.

We also adjust for *Hospital_outpatient_department* and *Community_health_center* in our simple and multivariate logistic regressions to account for the absence of data on outpatient hospital departments and community health centers in 2013. In addition, when reporting rates of preventive cardiovascular care in 2013, we used the ratio of total visits to total non-hospital outpatient/non-community health center visits (restricted to office-based care) from 2006-2011 to adjust 2013 estimates of care provision. The range of this ratio was 0.99-1.03 for the various preventive cardiovascular services ($Rate_{2013,\ adjusted} = N\_visits\_total_{2006\text{-}2011} / N\_visits\_office\_only_{2006\text{-}2011} \times Rate_{2013,\ unadjusted}$), and we used a Taylor series expansion and the delta method[3] to estimate standard errors and construct 95% confidence intervals for these adjusted rates.

Female is an indicator for female gender, *Black* is an indicator for black race, *Hisp* is an indicator for Hispanic race, *Race_other_unknown* is an indicator for unknown or other race, *Other_unk_insurance* is an indicator for other or unknown health insurance, *Rural* is an indicator for a rural setting, *Patient_seen_before* is an indicator for continuity of care and is defined by whether a patient was an established patient or a new patient in the physician's practice, *Htn_diag* is an indicator for a diagnosis of hypertension, *CAD_diag* is an indicator for a diagnosis of coronary artery disease (CAD), *Diabetes_diag* is an indicator for a diagnosis of diabetes, *CKD_diag* is an indicator for a diagnosis of chronic kidney disease (CKD), *COPD_diag* is an indicator for a diagnosis of chronic obstructive pulmonary disease (COPD). Comorbidity variables were omitted from the regression models as needed (e.g., *CAD_diag* was omitted from models assessing the use of aspirin for primary prevention in men and women, etc). The *i* and *t* index a specific patient visit and time (year). The unadjusted model included only the terms *Target_population_visit*, *Post-Affordable_Care_Act*, *Affordable_Care_Act's_Impact*, *Hospital_outpatient_department*, and *Community_health_center*.

We also estimated a similar multivariate differences-in-differences linear regression model to assess changes in the overall cardiovascular risk of patients with private insurance versus patients who are self-pay/uninsured in the period before the Affordable Care Act compared to the period afterward. These models used a similar set of covariates but the outcome measure was atherosclerotic cardiovascular disease (ASCVD) score (rather than provision of a preventive cardiovascular service). As reported, the interaction term did not have a statistically significant coefficient (P=0.45).

eAppendix Table 1. Age- and Sex-Specific Mean Serum Total Cholesterol, HDL-C, LDL, Systolic Blood Pressure, and Diastolic Blood Pressure Among Adults: United States, National Health and Nutrition Examination Survey, 2007-2010 for Lipids; 2001–2008 for Blood Pressure[4,5]

Sex	Age	Total chol, mg/dL	HDL, mg/dL	LDL, mg/dL	Triglyc, mg/dL	SBP, mm Hg (no HTN)	DBP, mm Hg (no HTN)	SBP, mm Hg (treated HTN)	DBP, mm Hg (treated HTN)	SBP, mm Hg (untreated HTN)	DBP, mm Hg (untreated HTN)
Male	20-29 yrs	181	47.4	110	105	117	68	127	79	140	87
Male	30-39 yrs	199	45	120	123	117	68	127	79	140	87
Male	40-49 yrs	207	46.5	125	127	119	74	129	79	145	88
Male	50-59 yrs	203	47.3	125	126	119	74	129	79	145	88
Male	60-69 yrs	188	48.3	108	121	121	67	135	69	154	76
Male	≥70 yrs	178	49.2	103	111	121	67	135	69	154	76
Female	20-29 yrs	178	55.7	101	87	109	67	123	76	140	90
Female	30-39 yrs	190	55.5	113	89	109	67	123	76	140	90
Female	40-49 yrs	203	59.3	117	95	115	72	129	76	149	86
Female	50-59 yrs	213	58.7	128	118	115	72	129	76	149	86
Female	60-69 yrs	211	58.8	122	120	122	66	141	67	159	72
Female	≥70 yrs	203	58.7	116	125	122	66	141	67	159	72

Chol indicates cholesterol; HDL, high-density lipoprotein; LDL, low-density lipoprotein; Triglyc, triglycerides; DBP, diastolic blood pressure; SBP, systolic blood pressure; HTN, hypertension; yrs, years.

eAppendix Table 2. Demographic Characteristics of Target and Control Populations in USPSTF Preventive Cardiovascular Care Evaluation (pre-Affordable Care Act, 2006-2010)

Characteristic	Unweighted Visits, n	Annual Weighted Visits, n	Percent, % (Or Mean)	Standard Error
Diabetes screening (Target population)				
Age, yrs.	24,829	118,300,000	62	0
Female	13,635	65,800,000	56	1
Non-Hispanic white	15,012	67,200,000	57	1
Rural	3,497	15,300,000	13	2
Diabetes screening (Control population)				
Age, yrs.	95,294	414,700,000	34	0
Female	57,978	254,500,000	61	0
Non-Hispanic white	53,247	219,100,000	53	1
Rural	10,421	41,900,000	10	1
Obesity treatment (Target population)				
Age, yrs.	9,642	42,000,000	52	0
Female	6,317	27,100,000	64	1
Non-Hispanic white	5,729	23,600,000	56	2
Rural	1,165	5,200,000	12	2
Obesity treatment (Control population)				
Age, yrs.	1,865	4,400,000	44	1
Female	1,385	3,200,000	74	2
Non-Hispanic white	824	2,100,000	49	5
Rural	161	500,000	11	4
Hypertension screening (Target population)				
Age, yrs.	87,968	370,100,000	48	0
Female	55,849	238,700,000	65	0
Non-Hispanic white	50,710	198,800,000	54	1
Rural	10,777	41,500,000	11	2
Hypertension screening (Control population)				
Age, yrs.	17,052	36,000,000	41	0
Female	10,633	22,400,000	62	1
Non-Hispanic white	7,096	17,200,000	48	2
Rural				
Cholesterol screening (Men; Target population)				
Age, yrs.	33,409	136,100,000	57	0
Female	-	-	-	-
Non-Hispanic white	19,628	74,000,000	54	1
Rural	4,192	16,400,000	12	2
Cholesterol screening (Men; Control population)				
Age, yrs.	3,939	16,100,000	27	0
Female	-	-	-	-
Non-Hispanic white	2,144	8,200,000	51	2
Rural	397	1,400,000	9	1
Cholesterol screening (Women; Target population)				

Age, yrs.	39,921	172,500,000	60	0
Female	39,921	172,500,000	100	-
Non-Hispanic white	23,506	94,500,000	55	1
Rural	5,236	21,800,000	13	2
Cholesterol screening (Women; Control population)				
Age, yrs.	7,472	32,300,000	39	0
Female	7,472	32,300,000	100	-
Non-Hispanic white	4,115	16,600,000	52	2
Rural	708	2,600,000	8	1
Aspirin therapy (Men; Target population)				
Age, yrs.	27,263	118,400,000	60	0
Female	-	-	-	-
Non-Hispanic white	16,299	66,100,000	56	1
Rural	3,638	14,400,000	12	2
Aspirin therapy (Men; Control population)				
Age, yrs.	8,488	36,500,000	38	0
Female	-	-	-	-
Non-Hispanic white	4,723	18,700,000	51	1
Rural	963	3,900,000	11	1
Aspirin therapy (Women; Target population)				
Age, yrs.	23,349	108,400,000	65	0
Female	23,349	108,400,000	100	-
Non-Hispanic white	14,095	61,200,000	57	1
Rural	3,340	14,600,000	13	2
Aspirin therapy (Women; Control population)				
Age, yrs.	14,203	62,700,000	50	0
Female	14,203	62,700,000	100	-
Non-Hispanic white	8,259	33,900,000	54	1
Rural	1,749	6,700,000	11	1
Tobacco use screening (Pregnant; Target population)				
Age, yrs.	9,733	13,000,000	25	0
Female	9,733	13,000,000	100	-
Non-Hispanic white	2,614	4,200,000	32	2
Rural	590	2,100,000	16	3
Tobacco use screening (Non-pregnant; Control population)				
Age, yrs.	35,573	66,800,000	26	1
Female	35,573	66,800,000	100	-
Non-Hispanic white	10,892	24,000,000	36	1
Rural	3,359	11,900,000	18	2
Tobacco use screening (Target population)				
Age, yrs.	121,787	528,700,000	53	0
Female	74,103	325,100,000	62	0
Non-Hispanic white	70,920	287,800,000	54	1
Rural	15,490	62,100,000	12	2
Tobacco use screening (Control population)				
Age, yrs.	32,193	52,900,000	44	0
Female	21,842	36,100,000	68	1
Non-Hispanic white	10,668	20,800,000	39	2

Rural	3,030	9,500,000	18	3
Smoking cessation advice (Pregnant; Target population)				
Age, yrs.	1,088	1,700,000	25	0
Female	1,088	1,700,000	100	-
Non-Hispanic white	602	1,000,000	61	4
Rural	136	500,000	32	5
Smoking cessation advice (Non-pregnant; Control population)				
Age, yrs.	4,582	8,000,000	40	1
Female	4,582	8,000,000	100	-
Non-Hispanic white	2,122	4,400,000	55	2
Rural	700	2,200,000	27	4
Smoking cessation advice (Target population)				
Age, yrs.	12,975	53,100,000	49	0
Female	6,931	28,500,000	54	1
Non-Hispanic white	8,012	30,800,000	58	1
Rural	1,945	8,300,000	16	2
Smoking cessation advice (Control population)				
Age, yrs.	4,262	7,800,000	41	0
Female	2,185	3,900,000	50	2
Non-Hispanic white	2,077	3,900,000	50	3
Rural	342	1,000,000	13	2

eAppendix References

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