Association of a State Prescribing Limits Policy with Opioid Prescribing and Long-term Use: an Interrupted Time Series Analysis

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BACKGROUND: Prescription opioids were a major initial driver of the opioid crisis. States have attempted to reduce overprescribing by enacting policies that limit opioid prescriptions, but the impacts of such policies on new prescribing and subsequent transitions to long-term use are not fully understood.

OBJECTIVE: To examine the association of implementation of a state prescribing limits policy with opioid prescribing and transitions to long-term opioid use.

DESIGN: Interrupted time series analyses assessing trends in new opioid prescriptions and long-term use before and after policy implementation.

PATIENTS: A total of 130,591 New Jersey Medicaid enrollees ages 18–64 who received an initial opioid prescription from January 2014 to December 2019.

INTERVENTIONS: New Jersey's opioid prescribing limit policy implemented in March 2017.

MAIN MEASURES: Total new opioid prescriptions, percentage of new prescriptions with >5 days' supply, and transition to long-term opioid use, defined as having opioid supply on day 90 after the initial prescription.

KEY RESULTS: Policy implementation was associated with a significant monthly increase in new opioid prescriptions of 0.86 per 10,000 enrollees, halving the pre-policy decline in the prescribing rate. Among new opioid prescriptions, the percentage with >5 days' supply decreased by about 1 percentage point (−0.76 percentage points, 95% CI −0.89, −0.62) following policy implementation. However, policy implementation was associated with a significant monthly increase in the rate of initial prescriptions with supply on day 90 (9.95 per 10,000 new prescriptions, 95% CI 4.80, 15.11) that reversed the downward pre-implementation trend.

CONCLUSIONS: The New Jersey policy was associated with a reduction in initial prescriptions with >5 days' supply, but not with an overall decline in new opioid prescriptions or in the rate at which initial prescriptions led to long-term use. Given their only modest benefits, policymakers and clinicians should carefully weigh potential unintended consequences of strict prescribing limits.

KEY WORDS: Opioid prescribing; Long-term opioid use; Prescribing limits; Health policy.

INTRODUCTION

Prescription opioids are widely viewed as a main initial driver of the opioid overdose epidemic.[1] Although rates of progression to opioid use disorder (OUD) among those who initiate prescribed opioids are low,[2,3] a range of policies have emerged to restrict opioid prescribing.[4,5] These policies aim to lessen exposure to opioids and prevent progression from use for short-term pain relief to long-term, chronic use, which has been criticized as risky and potentially ineffective.[6–9] In March 2017, New Jersey implemented restrictions that limit initial opioid prescriptions for acute pain to a 5-day supply of the lowest effective dose.[10,11] For subsequent prescriptions, the policy also requires providers to discuss prescription opioid risks and alternative treatments; develop and periodically review pain management contracts; assess development of dependence; use the state PDMP; and decrease opioid prescribing or transition to alternative pain management strategies.[11]

Prior research has shown mixed findings on the association of opioid prescribing policies with prescribing practices and related outcomes. While some studies found associations between prescribing restrictions and reductions in initial days' supply,[12–17] others showed no or limited effects on other prescription characteristics, including dosage,[13,18] opioids distributed,[13,19] proportion of patients receiving opioid prescriptions, and average prescription duration and dose.[20] Effects vary across states and outcomes; for example, two studies found that prescription limits were associated with shorter initial prescription duration in Massachusetts but not Connecticut, and lower opioid dose in Connecticut but not Massachusetts.[14,21] This heterogeneity highlights the need for evidence that accounts for unique policy provisions and the timing and context of implementation. Furthermore, prior research has largely focused on initial prescriptions without examining the association of prescribing limits with longer-term

outcomes that are critical to evaluate policy implications. To address these gaps, this study examines the impact of NJ's legislation on prescribing and outcomes among Medicaid beneficiaries, a population with high pain prevalence and elevated rates of opioid prescribing. The aims were to assess the impact of the NJ policy on (1) rates of initial opioid prescriptions; (2) the proportion of initial prescriptions with 5 or more days' supply; and (3) transitions to long-term prescribed opioid use.

METHODS

Data and Sample

We analyzed de-identified NJ Medicaid claims data from January 2013 to March 2020 among individuals aged 18–64 who were not dually eligible for Medicare. We examined initial opioid prescriptions from January 2014 through December 2019, prior to the onset of pandemic-related health care disruptions. We restricted the sample to individuals with continuous Medicaid enrollment for 365 days prior to opioid prescriptions to identify initial prescriptions as defined in the legislation, which apply to patients with no opioid prescriptions in the prior year. For the long-term use outcome only, we required continuous enrollment for 90 days following the initial prescription. As specified in the policy exemptions, we excluded enrollees receiving hospice or palliative care, long-term care facility residents, and those with active cancer treatment (i.e., diagnoses for cancers commonly treated with opioids) in the 180 days prior to the initial prescription and in the 90 days after initial prescription for the long-term use outcome.

Pharmacy claims were linked with the First Databank MedKnowledge database[22] by National Drug Codes to identify opioid prescriptions, excluding drugs for OUD treatment (Appendix Table A1). We used days' supply on pharmacy claims to identify initial prescription duration and assess transitions to long-term use.

Outcomes

To assess the direct impact of the policy requirement to limit initial opioid prescriptions to 5 days' supply, we calculated the monthly rate of new opioid prescriptions per 10,000 enrollees, overall and stratified by ≤5 or >5 days' supply, and the percentage of new prescriptions with >5 days' supply. We assessed the policy impact on transitions to long-term use, defined as the monthly rate per 10,000 new prescriptions with opioid supply on day 90 after the initial prescription, overall and stratified by ≤5 or >5 days' supply. This measure aligned with the CDC definition of long-term use as 3 or more months[7] and with the NJ law's requirement to review opioid prescribing every 3 months.[11] We attributed the outcome to the month of the initial prescription. In a sensitivity analysis, we tested an alternative measure of long-term use, calculated

as the monthly rate per 10,000 initial prescriptions that resulted in 80%+ days' supply in the first 90 days after the initial prescription.

Analysis

To evaluate policy effects, we used interrupted time series models to compare trends in opioid prescribing and transitions to long-term use after the policy was implemented to the pre-policy period.

To assess outliers, autocorrelation, and seasonality, we first plotted the unadjusted outcomes over time and their autocorrelation and partial autocorrelation functions. We performed Augmented Dickey-Fuller and KPSS tests to evaluate stationarity and accounted for autocorrelation and seasonality using auto-regressive integrated moving average (ARIMA) models. Models also adjusted for demographics by including monthly indicators of mean age, percentage of White, non-Hispanic patients, and percentage of female patients. We used the Census Bureau's X-13-ARIMA-SEATS program[23] integrated into the *seasonal* R package[24] to automatically detect the best-fitting ARIMA model (Appendix Table A2). To confirm the absence of additional autocorrelation in final models, we plotted and examined model residuals and performed Ljung-Box tests.[25]

Using ARIMA-adjusted time series, we performed segmented regression with terms to estimate outcome trends over time (months), outcome levels in the pre-policy (January 2014–February 2017) and post-policy (March 2017–December 2019) periods, and an interaction of these terms to obtain estimates of the changes attributable to policy implementation, including immediate changes at the time of implementation and changes in outcome trends over time after implementation. For long-term use analyses, we excluded the 3 months before policy implementation because the 90-day follow-up period crossed the pre- and post-policy period.

We performed sensitivity analyses to assess robustness of findings to alternate specifications. For all outcomes, we estimated models with 12-month policy implementation lags to assess potential delays in effects, which categorized data between March 2017 and March 2018 in the pre-policy period. For new prescription rates and the percentage of new prescriptions with >5 days' supply, we performed controlled interrupted time series analyses[26–28] to assess trends for opioid relative to benzodiazepine and stimulant prescriptions. We selected these comparison medications due to their status as controlled substances and assessed whether findings were specific to opioid medications and whether similar policy effects existed for medications not subject to the policy. Analyses were conducted using SAS Enterprise Guide Version 8.3 and R Version 4.1.0. All study procedures were reviewed and approved by the Rutgers University Institutional Review Board.

RESULTS

We identified 158,143 new opioid prescriptions meeting study criteria from January 2014 through December 2019. The number of unique enrollees was 130,591, of whom 25,038 had more than one initial opioid prescription during the study period. Enrollees had a median age of 42.1, 67.2% were female, 30.1% were non-Hispanic Black, 37.0% non-Hispanic White, 18.6% Hispanic, and 14.3% non-Hispanic Other race.

Association of prescribing limits with changes in initial opioid prescriptions

Table 1 and Figure 1 present estimates of the association between policy implementation and new opioid prescribing rates per 10,000 Medicaid enrollees. New prescriptions were decreasing at a monthly rate of −1.62 per 10,000 (95% CI −1.80, −1.45) before policy implementation. While new prescriptions per 10,000 Medicaid enrollees continued to decrease at a rate of −0.76 (95% CI −0.96, −0.55) after policy implementation, this represents an attenuation in the pre-policy trend of 0.86 new prescriptions per 10,000 (95% CI 0.60, 1.13). Stratified analyses showed that post-implementation trend increases were driven by new prescriptions with ≤5-days' supply, which increased by 0.67 (95% CI 0.57, 0.76) compared to an increase of 0.18 (95% CI 0.01, 0.36) for prescriptions with >5-days' supply. Lagged sensitivity analyses produced similar results to primary models (Appendix Table A3, Figure A1). Sensitivity analyses comparing trends in new opioid prescription rates to those of benzodiazepines and stimulants similarly showed a positive trend change for opioids relative to the other medications (Appendix Table A4, Figures A2-A3).

The percentage of initial opioid prescriptions with >5 days' supply increased at a modest rate in the pre-policy period (0.25%, 95% CI 0.16, 0.34), but implementation was associated with a significant trend decrease of −0.76% (95% CI −0.89, −0.62), resulting in a declining rate of opioid prescriptions with >5 days' supply in the period after policy implementation (−0.51, 95% CI −0.61, −0.40) (Table 2, Fig. 2). Sensitivity analyses comparing trends in the percentage of new opioid prescriptions with >5 days' supply to those of benzodiazepines and stimulants similarly found an association of the policy with a decreasing monthly trend for opioids relative to the other medications (Appendix Table A4, Figures A3-A4).

Association of prescribing limits with transitions to long-term receipt of prescribed opioids

Table 3 and Figure 3 show estimates of the policy's association with the number of new prescriptions per 10,000 that progress to long-term receipt of opioids, defined as supply on day 90 after the initial prescription. The policy was associated with a significant monthly increase in prescriptions progressing to long-term use of 9.95 per 10,000 (95% CI 4.80, 15.11), reversing the pre-policy trend (−5.29, 95% CI −8.85, −1.73) to a monthly increase of 4.66 per 10,000 new prescriptions (95% CI 0.94, 8.38). These trends resulted in similar rates of approximately 1000 per 10,000 new prescriptions progressing to long-term use at the start (January 2014) and end of the observation period (December 2019). Stratified analyses showed that the policy was associated with an increase in the monthly rate of ≤5-day prescriptions progressing to long-term use of 10.05 per 10,000 new prescriptions (95% CI 5.71, 14.39) following a flat trend during the pre-policy period (1.00, 95% CI −1.81, 3.80), nearly doubling the number of new ≤5-day prescriptions resulting in long-term use from the pre-policy period (~500 per 10,000) to the end of the observation period (~1,000 per 10,000). Trends for new >5-day new prescriptions were similar to those for all new prescriptions.

Results of sensitivity analyses with a 12-month implementation lag were similar (Appendix Table A6, Figure A5). In the sensitivity analysis measuring long-term use as the monthly rate per 10,000 initial prescriptions with at least 80% days' supply in the first 90 days, there was no association of the policy with an immediate change in long-term use rates at implementation and the post-policy trend flattened (Appendix Table A7, Figure A6).

DISCUSSION

Analyses of opioid prescribing in NJ Medicaid showed that implementation of a state law limiting initial days' supply was associated with a reduction in the proportion of new prescriptions with >5 days' supply, but not with an overall decline in new opioid prescriptions. In fact, while initial opioid prescriptions were declining before policy implementation, the policy was associated with a small increase that slowed the prior rate of decline. While the findings align with the policy goal to limit the duration of initial prescriptions, overall changes were relatively modest and may not have had a meaningful impact on opioid prescribing trends.

Prior studies of prescribing limits have also generally shown an association with shorter initial prescription duration[12–15] but not overall prescribing trends.[13,18–20] One possible explanation for the policy's minimal effect on overall prescribing, as suggested by Sacks et al.,[13] is that it defined a "reference point" (i.e., 5 days) signaling a safe threshold for initial opioid prescriptions, contributing to increases in initial short duration prescriptions after policy implementation with no impact on the rate of higher-risk, longer duration prescriptions. In other contexts, including diabetes treatment[29,30] and childbirth,[31] clinical guidelines with defined thresholds have had significant impacts on service delivery and may have led to unintended consequences, including increased health care use.[32]

Table 1. Changes in Initial Opioid Prescriptions Per 10,000 Medicaid Enrollees Associated with Implementation of New Jersey Prescribing Limits Policy

	All initial prescriptions	Change	Initial prescriptions ≤5 days	Change	Initial prescriptions >5 days	Change
Pre-policy intercept (95% CI)	116.56 (112.67, 120.44)*	−3.01 (−8.57, 2.55)	45.46 (44.04, 46.90)*	1.13 (−0.91, 3.17)	70.48 (67.98, 72.99)*	−4.97 (−8.56, −1.38)†
Post-policy intercept (95% CI)	113.55 (105.77, 121.33)*		46.60 (43.74, 49.46)*		65.52 (60.50, 70.54)*	
Pre-policy trend (95% CI)	−1.62 (−1.80, −1.45)*	0.86 (0.60, 1.13)*	−0.79 (−0.85, −0.72)*	0.67 (0.57, 0.76)*	−0.81 (−0.92, −0.69)*	0.18 (0.01, 0.36)‡
Post-policy trend (95% CI)	−0.76 (−0.96, −0.55)*		−0.12 (−0.20, −0.04)†		−0.62 (−0.76, −0.49)*	

Note: *P <.001; †P < .01; ‡P < .05; pre-policy intercept is rate at the start of the study period; intercept change is the level shift in rate occurring at the time of policy implementation; post-policy intercept is rate in the month of policy implementation; pre-policy trend is the time trend in rates before policy implementation; trend change is the change in time trend from before to after policy implementation; post-policy trend is the time trend in rates after policy implementation.

This study extends findings of previous research on prescribing restrictions to downstream effects that are key to addressing the opioid epidemic. Policy implementation was associated with an immediate decline in new prescriptions resulting in long-term use, but increasing post-policy trends reversed this effect, resulting in no overall reduction in transitions to long-term use. We observed a lag in the trend reversal, which may be explained by policy elements related to long-term use (e.g., need for pain management contracts, requirement for periodic review of pain management plan) that deterred long-term prescribing immediately after implementation, with later increases in longer-term prescribing as providers became familiar with policy requirements. Trends also differed depending on initial days' supply. For initial >5-day prescriptions, there was a decreasing pre-policy trend that became marginally positive after about a 115% increase following implementation, but to a lesser degree than ≤5-day prescriptions, which increased by over 1000% and nearly doubled the rate of ≤5-day prescriptions that had supply on day 90 by the end of the study period. One explanation for this shift is that the law required prescribers to issue ≤5-day prescriptions for patients with longer-term pain management needs, who, before the law, would have likely been issued >5-day prescriptions. Few other studies have examined transition to long-term use after initial opioid prescriptions, but one study similarly found that prescribing limits policies were not associated with decreases in opioid prescriptions in the 90 and 270 days following the initial prescription.[13]

Since 2016, more than 39 states have implemented prescribing limits policies,[5] but growing evidence suggests these policies on their own had a minimal impact on opioid prescribing and, therefore, even less impact on the overall trajectory of the opioid crisis. While some estimates suggest that reductions in prescribing have averted many thousands of deaths,[33] these changes may be more attributable to pain management guidelines and broader education efforts targeting prescribers.[34–36] Indeed, prescribing guidelines issued by the CDC[7] are similar to but predate state policies, and may explain why policies implemented later have had limited additional benefit. It is possible that although short-term policy impacts are limited, there may be long-term benefits of codifying guidelines consistent with those from the CDC into law, improving evidence-based opioid prescribing.

Concerns have been raised that prescribing limits may have adverse consequences offsetting their benefits, particularly for patients who are not the intended targets of the policy. By design, prescribing limits do not account for heterogeneity in the pain management needs of individual patients,[37] and more-flexible guidelines accounting for patient circumstances and allowing for provider discretion may be needed. Qualitative studies with patients and providers have suggested that prescribing limits policies impose substantial requirements on prescribers that risk transforming pain management into an administrative task that reduces autonomy and interferes with shared clinician-patient decision making,[38,39] complicating individualized pain management. While the trend in overall new prescriptions was not reduced, qualitative reports indicate that some individual prescribers may have reduced or discontinued prescribing opioids irrespective of individual patient needs in response to increasing complexity of opioid analgesic prescribing.[40,41] The increased administrative burdens (e.g., requirements for regular review of pain management contracts), as well as concerns over enforcement by regulatory agencies, may disincentivize prescribers from using opioids to treat pain and result in undertreatment.[42,43] For patients with inadequate pain management, many of whom report substantial difficulty obtaining needed medication,[38,44] policy restrictions could contribute to transitions to more dangerous illicit opioids.[43,45] Prescribing limitations may also prompt some prescribers to prematurely discontinue opioid treatment, which has been linked with catastrophic outcomes including suicide and overdose.[46–49] Additional research is needed to better understand whether the modest benefits of laws that limit opioid prescribing outweigh the potential unintended consequences, including spillover effects for chronic pain patients and others who could benefit from treatment beyond legal limits. Data is lacking on the impact of prescribing policies on patient satisfaction and quality of life, appropriate prescriber application of policy provisions, practice changes due to administrative burdens and concerns over sanctions,
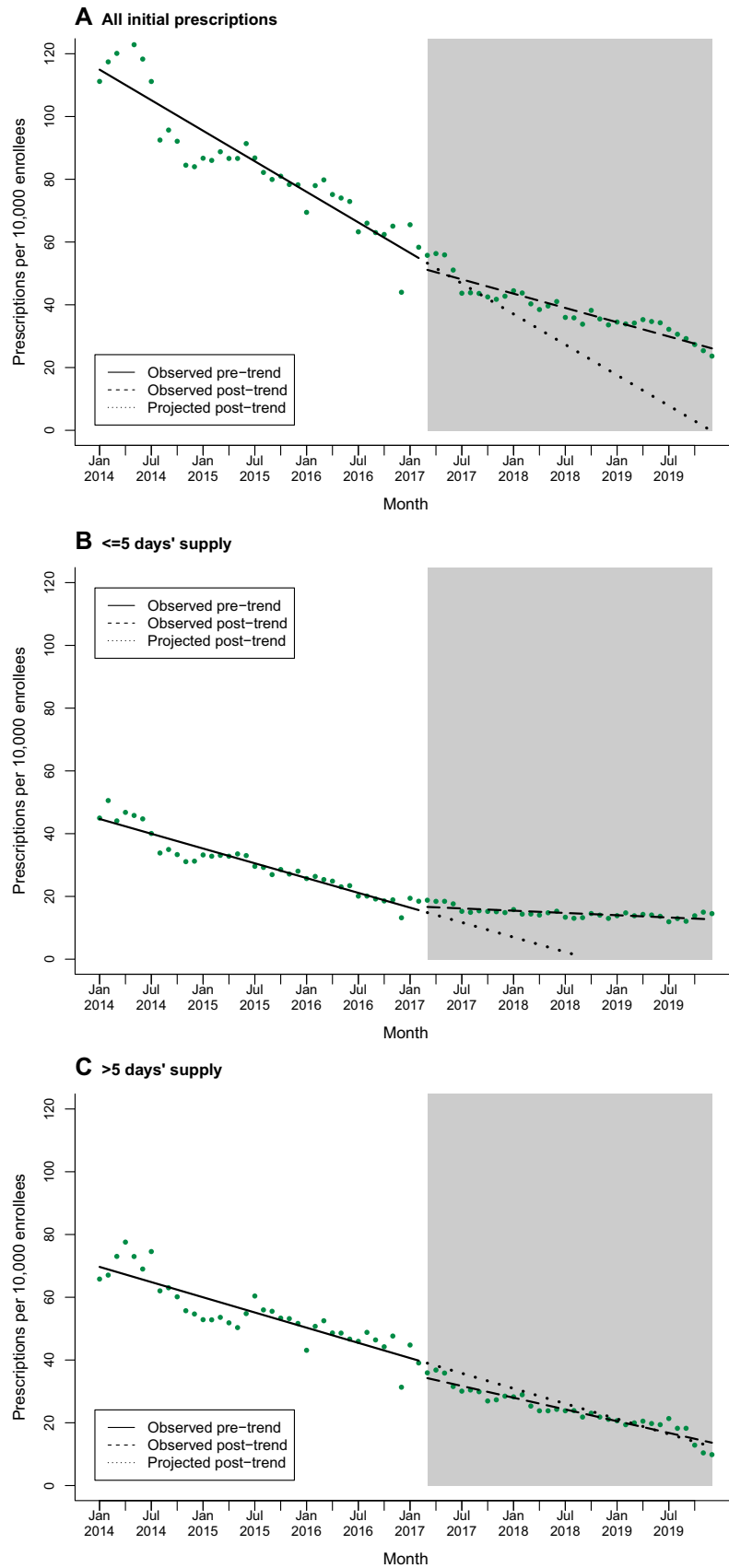
Fig. 1 Changes in initial opioid prescriptions associated with implementation of New Jersey prescribing limits policy. Points represent ARIMA-adjusted monthly observations. Shaded area is the period after the policy was implemented.

Table 2. Change in Percentage of Initial Opioid Prescriptions with >5 Days' Supply Associated with Implementation of New Jersey Prescribing Limits Policy

	Percentage with >5 days' supply	Change
Pre-policy intercept (95% CI)	60.10 (58.06, 62.14)[*]	0.01 (−2.92, 2.93)
Post-policy intercept (95% CI)	60.11 (56.02, 64.20)[*]	
Pre-policy trend (95% CI)	0.25 (0.16, 0.34)[*]	−0.76 (−0.89, −0.62)[*]
Post-policy trend (95% CI)	−0.51 (−0.61, −0.40)[*]	

Note: [*]*P* <.001; *pre-policy intercept is rate at the start of the study period; intercept change is the level shift in rate occurring at the time of policy implementation; post-policy intercept is rate in the month of policy implementation; pre-policy trend is the time trend in rates before policy implementation; trend change is the change in time trend from before to after policy implementation; post-policy trend is the time trend in rates after policy implementation.*

and treatment delays or premature discontinuation. Future research might also examine the role of pharmaceutical manufacturers and others with financial interests in designing prescribing limits policies, given their prior influence on opioid-related policies[50] and the possibility that support of prescribing limitations could limit their liability in future court filings. Opioid prescribing guidelines, including those issued by the CDC, have often been characterized as excessively rigid and misapplied.[51] These concerns and recent evidence on safe and effective pain management have prompted the CDC to update its 2016 opioid prescribing guidelines, with less emphasis on defined prescriptions limits and more flexibility for clinicians and patients to determine the best course of treatment.[52]

Although well-designed prescribing policies may be important for combatting the opioid crisis, the evidence to date indicates they are largely insufficient. Additional research is
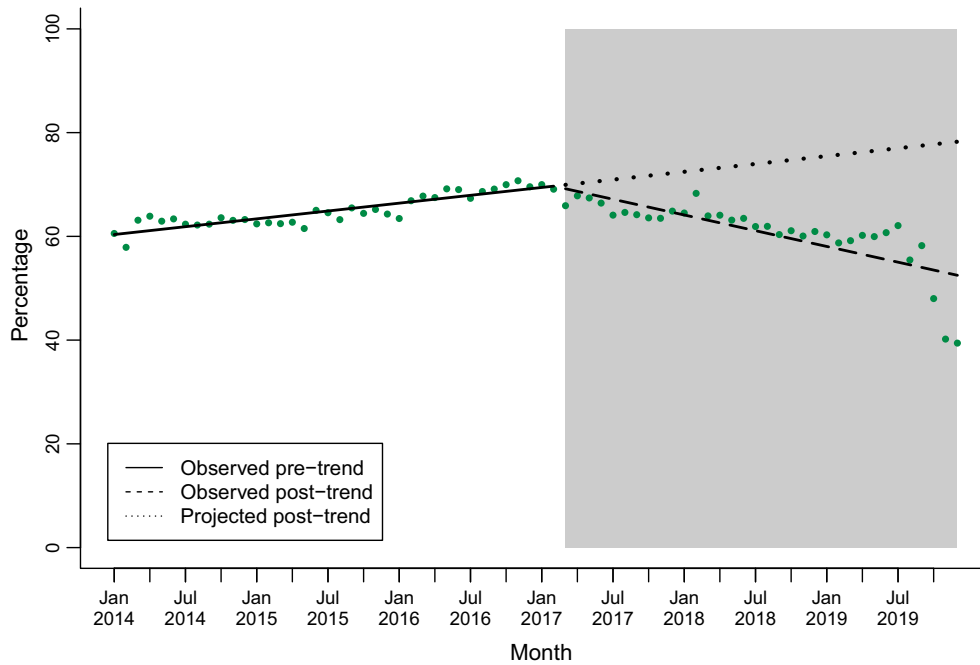

Fig. 2 Change in percentage of initial opioid prescriptions with >5 days' supply associated with implementation of New Jersey prescribing limits policy. Points represent ARIMA-adjusted monthly observations. Shaded area is the period after the policy was implemented.

Table 3. Association of Implementation of New Jersey Prescribing Limits Policy with Initial Opioid Prescriptions Leading to Long-term Use, Defined as Opioid Supply on Day 90

	Total initial prescriptions	Change	Initial prescriptions ≤5 days	Change	Initial prescriptions >5 days	Change
Pre-policy intercept (95% CI)	981.01 (907.46, 1054.54)[*]	−71.80 (−181.10, 37.51)	542.47 (479.73, 605.20)[*]	−144.84 (−234.60, −55.09)[†]	1268.86 (1157.85, 1379.88)[*]	−4.49 (−169.49, 160.51)
Post-policy intercept (95% CI)	909.21 (754.59, 1063.82)[*]		397.63 (272.03, 523.22)[*]		1264.40 (1030.97, 1497.77)[*]	
Pre-policy trend (95% CI)	−5.29 (−8.85, −1.73)[†]	9.95 (4.80, 15.11)[*]	1.00 (−1.81, 3.80)	10.05 (5.71, 14.39)[*]	−10.79 (−16.17, −5.41)[*]	12.56 (4.79, 20.34)[†]
Post-policy trend (95% CI)	4.66 (0.94, 8.38)[‡]		11.05 (7.73, 14.36)[*]		1.78 (−3.84, 7.39)	

Note: Rates shown per 10,000 initial prescriptions. [*]*P* <.001; [†]*P* < .01; [‡]*P* < .05; *pre-policy intercept is rate at the start of the study period; intercept change is the level shift in rate occurring at the time of policy implementation; post-policy intercept is rate in the month of policy implementation; pre-policy trend is the time trend in rates before policy implementation; trend change is the change in time trend from before to after policy implementation; post-policy trend is the time trend in rates after policy implementation.*
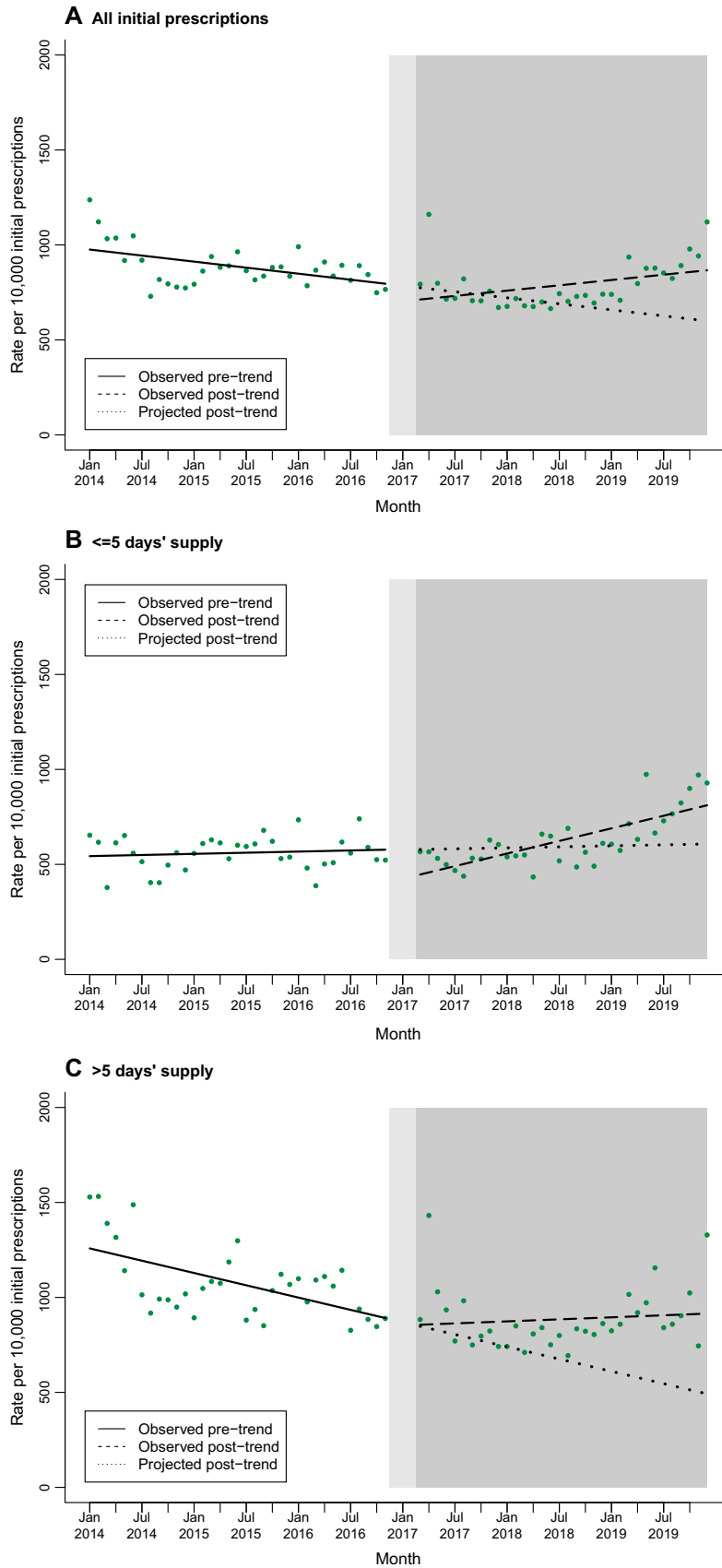
A **All initial prescriptions**

B **<=5 days' supply**

C **>5 days' supply**

Fig. 3 Association of implementation of New Jersey prescribing limits policy with initial opioid prescriptions leading to long-term use, defined as opioid supply on day 90. Points represent ARIMA-adjusted monthly observations. Light shaded area is the 3-month washout period before policy implementation. Dark shaded area is the period after the policy was implemented.

needed to inform and refine policies in conjunction with comprehensive solutions that focus on treatment for OUD and harm reduction strategies with demonstrated effectiveness, such as increased access to medications and other evidence-based OUD treatments, naloxone distribution, and syringe exchange programs.[43,53] Policies and interventions targeting upstream social determinants of addiction, such as stigma/discrimination and socioeconomic conditions, are likely also needed as part of a comprehensive approach.[54]

Limitations

Results from this study of NJ Medicaid enrollees may not generalize to populations with different or no insurance coverage, or to other state contexts and policies. Because diagnoses for acute and chronic pain often overlap, some individuals to whom the policy does not apply may have been included in analyses, which could reduce the magnitude of estimated policy effects. However, findings are consistent with studies of prescribing for acute pain associated with surgical procedures.[21,37] Although interrupted time series is widely used in policy evaluations and sensitivity analyses including comparison medications showed similar results, additional confounding due to contemporaneous events or co-interventions cannot be entirely ruled out under this study design.

Conclusion

The New Jersey policy was associated with a reduction in initial prescriptions with >5 days' supply, but not with an overall decline in new opioid prescriptions or in the rate at which initial prescriptions led to long-term use. The impacts of the policy on opioid prescribing, and consequently its downstream effects on the overall trajectory of the opioid crisis, are likely limited. With only modest benefits at best, future research is needed to build evidence regarding potential unintended consequences, including inadequate pain treatment and greater administrative burdens on providers and patients.

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Declarations:

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