



Catastrophic expenditures in California trauma patients after the Affordable Care Act: reduced financial risk and racial disparities

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ABSTRACT

Background: Hospital charges due to major injury can result in high out-of-pocket expenses for patients. We analyzed the effect of the Affordable Care Act (ACA) on catastrophic health expenditures (CHE) among trauma patients.

Methods: We identified trauma patients aged 19–64 admitted to a safety-net Level 1 trauma center in California from 2007 to 2017. Out-of-pocket expenditures and income were calculated using hospital charges, insurance status, and ZIP code. CHE was defined using the World Health Organization definition of out-of-pocket spending exceeding 40% of inflation-adjusted income minus food and housing expenditures. Multivariable logistic regression was performed to assess odds of CHE post-ACA (2014–2017) vs. pre-ACA (2007–2013).

Results: Of 7519 trauma patients, 20.6% experienced CHE, including 89.0% of uninsured patients. There was a 74% decrease in odds of CHE post-ACA (aOR: 0.26, 95% CI: 0.22–0.30), with greater decreases among Black (aOR: 0.09, 95% CI: 0.04–0.18) and Hispanic (aOR: 0.23, 95% CI: 0.19–0.29) patients.

Conclusions: ACA implementation was associated with markedly decreased odds of catastrophic expenditures and decreased racial disparities in financial protection among trauma patients in our study.

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Introduction

Health care expenditures are a leading cause of bankruptcy and financial hardship for families in the United States, and pose a significant barrier to accessing timely and safe medical care.^{1–3} In 2019, one in four US adults reported that their household had trouble paying medical bills in the past year, and 51% reported that a household member had delayed needed care due to its cost.⁴ Patients are also facing rising out-of-pocket costs: the percentage of workers whose employer-sponsored insurance plan included a deductible increased from 55% in 2006 to 82% in 2019, and the average deductible increased from \$584 to \$1655 over this time period.⁵ In particular, traumatic injuries are inherently unpredictable, have the potential to require expensive and complex care,^{6,7} and disproportionately impact patients who are poor, uninsured,

and members of racial and ethnic minorities.^{8–11} Uninsured patients are uniquely vulnerable to the out-of-pocket expenditures associated with trauma, with recent research showing that 71% of uninsured trauma patients in the US are at risk of incurring catastrophic health expenditures (CHEs).¹² Unlike other types of medical illness, trauma is unlikely to be influenced by improved access to primary and preventive care, and is thus likely to remain a significant source of financial risk to patients despite ongoing efforts to improve access.^{13,14}

The Patient Protection and Affordable Care Act (ACA) of 2010 sought to address the crisis of high and rising health care expenditures in the US by reducing uninsurance and underinsurance. The principal components of the ACA related to increasing insurance coverage included (1) federal funding for states to expand eligibility for the Medicaid program for low-income individuals; (2) the Dependent Coverage Provision, which allowed young adults ages 19 to 25 to remain covered by their parents' health insurance; (3) subsidies to assist individuals to purchase health insurance through state or federal marketplaces; and (4) a requirement that each individual obtain health insurance.¹⁵ The Dependent Coverage

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Provision took effect in September 2010, and the other major provisions of the ACA in January 2014.

The implementation of the ACA in 2014 was associated with increased insurance coverage,^{15,16} reduced self-reported inability to afford medical care,¹⁷ and reduced out-of-pocket expenditures for all medical care, especially for low-income Americans.¹⁸ However, relatively few studies have evaluated the impact of the ACA on out-of-pocket expenditures and financial burden among trauma patients.^{14,19} Patients with traumatic injuries may face different financial risks than the general population following ACA implementation, given the high and unpredictable costs associated with trauma care. In order to improve our understanding of the impact of the ACA on out-of-pocket expenditures for trauma, we examined trauma admissions at a single hospital before and after ACA implementation and determined the risk of CHE based on estimated out-of-pocket expenditures and household income data. We chose a public safety-net hospital with an urban underserved patient population, in a state (California) that fully implemented all components of the ACA, in order to evaluate the full effect of the law in one of its primary target populations.

Material and methods

Study population

We identified all trauma admissions (defined as admissions with major or minor trauma activations or trauma consults) at an urban, county-operated Level 1 trauma center in northern California from January 1, 2007 to December 31, 2017. We omitted all admissions outside the ages of 19–64 (nonelderly adults), as children and the elderly were likely to have been covered by Medicaid, the Children's Health Insurance Program (CHIP), or Medicare both before and after ACA implementation, and were thus likely unaffected by this policy intervention.

Data sources

We obtained data on patient age, sex, race, ethnicity, ZIP code of residence, year of admission, diagnosis, Injury Severity Score (ISS), primary payer, and total hospital charges from the hospital's trauma database. Median household income by 5-digit ZIP code tabulation area was obtained from the U.S. Census Bureau American Community Surveys, 2007–2017,²⁰ and annual expenditures on food and housing by income bracket were obtained from the U.S. Bureau of Labor Statistics Consumer Expenditure Survey, 2017.²¹ All values were converted to 2017 dollars using the Consumer Price Index,²² using the index for January of each calendar year.

Data analysis

The unit of analysis was the hospital admission. We estimated patient income based on the median household income of his or her ZIP-code for the 5-year period ending in the year of admission. As earlier income data were not available, all admissions during 2007–2011 were assigned the income for that 5-year period. Post-subsistence income was then calculated by subtracting expenditures on food and housing from household income. We defined CHE as out-of-pocket (OOP) expenditures exceeding 40% of post-subsistence income, a threshold established by the World Health Organization that has been used in prior studies.^{12,23}

OOP expenditures were estimated based on each patient's total hospital charges and insurance status using an approach that has been described in prior research.¹⁹ OOP spending was defined as the full hospital charge for uninsured patients. As Medicaid prohibits patient cost-sharing for emergency care and limits total OOP

costs to no more than 5% of household income, OOP expenditures were set to zero for patients with Medicaid coverage.²⁴ Similarly, OOP costs were zeroed for patients with county/local government, military/other government, or other (worker's compensation, auto, home) insurance coverage. For patients with Medicare, OOP spending was set at the national average for Medicare-Medicaid dual-eligible patients, or \$2652 in 2017 dollars.²⁵ Finally, for privately insured patients, OOP spending was calculated based on estimated deductibles, cost-sharing, and OOP maximums obtained from the Kaiser Family Foundation/Health Research and Educational Trust Annual Employer Health Benefits Survey, 2007 to 2017 (see [Supplement Table 1](#) for detailed methodology).²⁶

Unadjusted comparisons between pre-ACA implementation (2007–2013) and post-ACA implementation (2014–2017) admissions were performed using a Wilcoxon rank-sum test for continuous variables (given the skewed distribution of several variables, such as ISS) and Pearson's chi-squared test for categorical variables. Multivariable logistic regression was performed to determine the adjusted odds ratio of CHE post-ACA implementation vs. pre-ACA implementation, controlling for the covariates of age, sex, race/ethnicity, and ISS. Stata/SE 16.0 (College Station, TX) was used for all data analysis. Ethical approval was obtained from the Santa Clara Valley Medical Center Institutional Review Board.

Sensitivity analyses

To test the robustness of our findings, we conducted several sensitivity analyses in which we varied study parameters. First, to evaluate the effect of allowing for a washout period, we excluded all observations from 2014, the first year of full ACA implementation. Second, to exclude potential effects from the 2008 financial crisis, we excluded all observations from 2007 to 2009. Third, to account for potential unpaid or forgiven medical bills, we capped out-of-pocket spending for uninsured patients at twice the federal family out-of-pocket maximum for private insurance. Finally, to control for underlying secular trends, we conducted an interrupted time series analysis of changes in CHE risk for both the full cohort and subgroups stratified by race/ethnicity.

Results

Of 14,408 trauma admissions over the 11-year study period of 2007–2017, 5503 were excluded due to age under 19 or over 64, 529 due to missing primary payer, 283 due to missing hospital charges, and 574 due to missing ZIP code or ZIP code median income. In total, 7519 nonelderly adult trauma admissions with complete charge, primary payer, and median household income data were included in the final analytic sample. [Table 1](#) shows the unadjusted characteristics of trauma admissions in the pre-ACA (2007–2013) and post-ACA (2014–2017) periods. Both median hospital charges and median household income were modestly higher in the post-ACA period, after adjusting for inflation. Males comprised about three quarters of trauma patients in both the pre- and post-ACA periods, and there were small differences in race/ethnicity and age between the two time periods. Notably, nearly one quarter of our study population was aged 19 to 25 and nearly half was aged 35 or below, illustrating the disproportionate impact of traumatic injury on young adults. There was a marked decrease in self-pay/uninsured patients in the post-ACA period compared to pre-ACA (7.5% vs 30.2%) and an increase in Medicaid patients (35.4% vs 8.7%) ($p < 0.001$ for overall change in type of insurance coverage). Changes in source of insurance coverage over time are shown in [Fig. 1](#). There was no difference between the two periods in ISS category ($p = 0.39$), or in ISS analyzed as a continuous variable using the Wilcoxon rank-sum test ($p = 0.13$, data not shown).

Table 1
Trauma admissions pre- and post-ACA implementation (n = 7519).

	Pre-ACA implementation (2007–2013)	%	Post-ACA implementation (2014–2017)	%
Number of admissions^a	4496	59.8	3023	40.2
Median hospital charges^b	\$45,561	–	\$51,802	–
Median household income^b	\$84,467	–	\$87,103	–
Characteristics				
Sex				
Male	3358	74.7	2209	73.1
Female	1138	25.3	814	26.9
Race/Ethnicity				
Non-Hispanic White	2123	47.2	1377	45.6
Hispanic	1568	34.9	1031	34.1
Asian	363	8.1	307	10.2
Non-Hispanic Black	185	4.1	158	5.2
Pacific Islander	14	0.3	12	0.4
Native American	7	0.2	5	0.2
Other	155	3.5	99	3.3
Unknown	81	1.8	34	1.1
Age				
19–25	1091	24.3	595	19.7
26–35	1031	22.9	685	22.7
36–45	836	18.6	520	17.2
46–55	936	20.8	650	21.5
56–64	602	13.4	573	19.0
Primary Payer				
Private Insurance	2023	45.0	1288	42.6
Medicaid	392	8.7	1071	35.4
Self-Pay/Uninsured	1357	30.2	226	7.5
Medicare	218	4.9	166	5.5
County/Local Govt	188	4.2	124	4.1
Military/Other Govt	13	0.3	17	0.6
Other ^c	305	6.8	131	4.3
Injury Severity Score				
< 9	1889	42.0	1258	41.6
9–15	1508	33.5	1001	33.1
16–24	613	13.6	393	13.0
> 24	380	8.5	292	9.7
Unknown	106	2.4	79	2.6

Notes.^a = These are row percentages; the remainder of the table shows column percentages.^b = 2017 dollars.^c = Other includes worker's compensation, auto, home, third-party insurance.

Overall, 20.6% of nonelderly adult trauma patients were exposed to CHE. The proportion of patients exposed to CHE declined from 28.3% in the pre-ACA period to 9.2% in the post-ACA period. Changes in the proportion of patients exposed to CHE over time are shown in Fig. 2. A decline in rate of CHE was also seen in subgroup analyses by race/ethnicity, although the magnitude of decline varied based on pre-ACA rates of CHE (Fig. 3). Among uninsured patients, 89.0% were exposed to CHE, including 88.7% in the pre-ACA period and 90.7% in the post-ACA period.

Table 2 shows the results of our multivariable logistic regression examining the association between ACA implementation and CHE, controlling for sex, race/ethnicity, age, and ISS. In the full sample, ACA implementation was associated with a 74% decrease in odds of CHE (adjusted odds ratio [aOR] 0.26, 95% confidence interval [CI]: 0.22 to 0.30). Results for several subgroup analyses are also shown. Subgroups experiencing notably large decreases in odds of CHE included Black patients (aOR 0.09, 95% CI: 0.04 to 0.18), Hispanic patients (aOR 0.23, 95% CI: 0.19 to 0.29), and patients aged 26 to 35 (aOR 0.21, 95% CI: 0.16, 0.28), although decreases were seen across all subgroups. The racial disparity in likelihood of CHE between non-Hispanic White and Black patients decreased from 22.9% pre-ACA to –0.8% post-ACA, and the disparity between non-Hispanic White and Hispanic patients decreased from 16.3% pre-ACA to 4.8% post-ACA.

Lastly, we performed a more detailed subgroup analysis of patients ages 19–25 (Supplement Table. 2), who became eligible to

remain on their parents' health insurance beginning in September 2010 with implementation of the ACA's Dependent Coverage Provision (DCP). The uninsured rate in this subgroup fell from 41.4% in the pre-DCP period (2007–2010) to 30.2% in the DCP-only transition period (2011–2013) to 9.1% in the post-ACA period (2014–2017). There were corresponding increases in Medicaid coverage (8.8% to 13.9% to 37.0%) and, less evenly, private insurance coverage (43.2% to 39.4% to 47.1%) over the three time periods. In a multivariable logistic regression controlling for sex, race/ethnicity, and ISS, implementation of the DCP was associated with a 29% decrease in odds of CHE (aOR 0.71, 95% CI: 0.54 to 0.93), while full ACA implementation was associated with an 80% decrease in odds of CHE (aOR 0.20, 95% CI: 0.15 to 0.27).

Sensitivity analyses

Excluding admissions from the first year of full ACA implementation (2014), excluding admissions potentially affected by the 2008 financial crisis (2007–2009), and capping out-of-pocket spending for uninsured patients at twice the federal family out-of-pocket maximum for private insurance did not qualitatively affect our results (Supplement Table. 3). Our interrupted time series analysis demonstrated an association between ACA implementation and decreases in CHE risk in the full cohort, as well as among non-Hispanic White, Hispanic, and Black trauma patients, controlling for underlying secular trends (Supplement Table. 4).

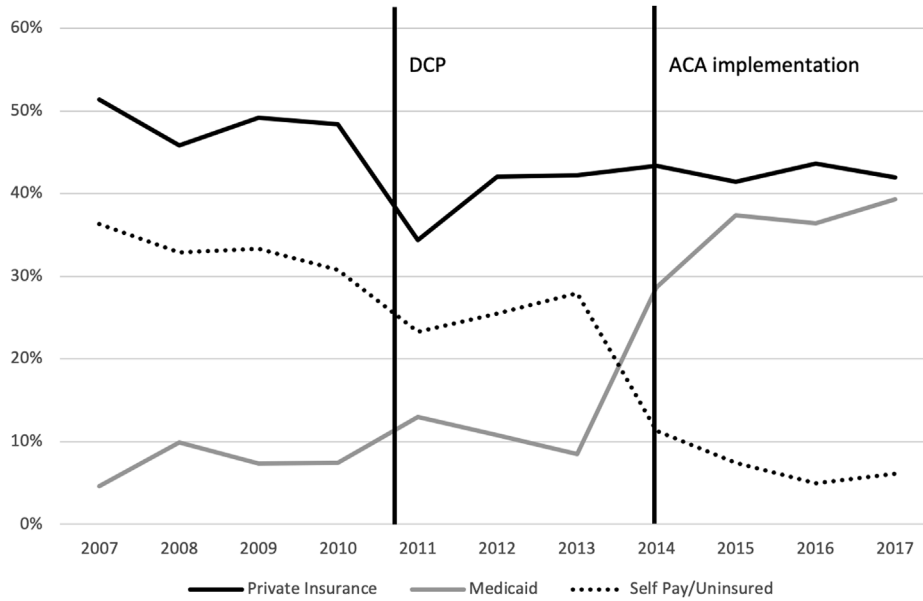


Fig. 1. Primary source of insurance coverage by year among trauma patients aged 19 to 64. For clarity, only the three most common sources of insurance coverage are shown. (DCP = Dependent Coverage Provision, ACA = Affordable Care Act)

Discussion

In this retrospective study based on data from an urban, public safety-net hospital in California, our analysis suggests that implementation of the Affordable Care Act in 2014 was associated with a 74% decrease in the odds of catastrophic health expenditures among nonelderly adult trauma patients, controlling for changes in age, sex, race/ethnicity, and injury severity. We hypothesize that this decrease was primarily associated with the observed decline in the proportion of uninsured patients, and the concomitant marked rise in the proportion of patients insured by Medicaid. These trends are consistent with the policy aims of the ACA as well as the population served by the study hospital, which includes a significant

number of low-income and nonwhite patients and experienced a more than 30% uninsured rate in the pre-ACA period. While declining, rates of CHE remain high, with 9.2% of all trauma patients and 90.7% of uninsured trauma patients exposed to catastrophic expenditures even after ACA implementation.

Our results are consistent with the findings of previous studies, which have demonstrated that ACA implementation was associated with lower out-of-pocket expenditures by patients for all types of medical care, especially among low-income individuals.¹⁸ We find a larger-magnitude decrease in the likelihood of catastrophic expenditures than previous research (74% in our study vs about 20% in the lowest-income group of the previous study), likely due in large part to the fact that out-of-pocket expenditures in trauma are larger

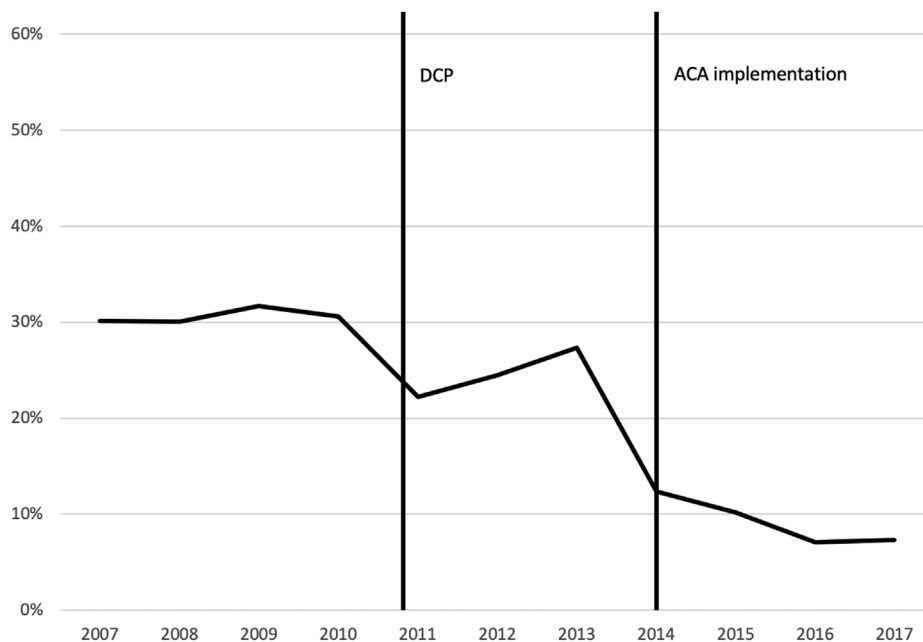


Fig. 2. Proportion of trauma patients aged 19 to 64 at risk for catastrophic health expenditures, by year. (DCP = Dependent Coverage Provision, ACA = Affordable Care Act)

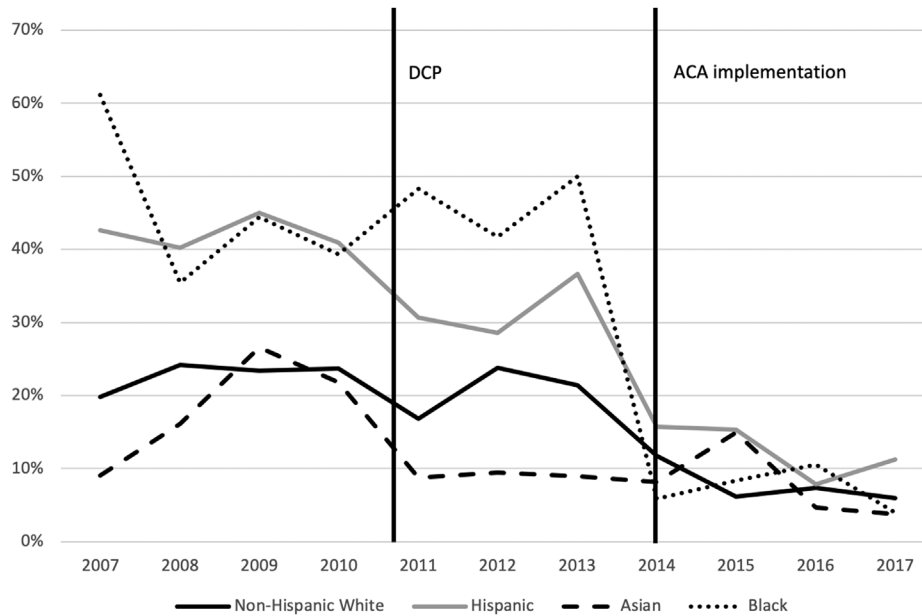


Fig. 3. Proportion of trauma patients aged 19 to 64 at risk for catastrophic health expenditures by year, by race/ethnicity. (DCP = Dependent Coverage Provision, ACA = Affordable Care Act)

and more unpredictable than those for other types of medical care.

We also find that among Black and Hispanic patients, as well as young adults aged 26 to 35, ACA implementation was associated with even greater decreases in odds of catastrophic expenditures than the general trauma population, and that racial disparities in likelihood of CHE among non-Hispanic White, Black, and Hispanic patients decreased markedly with ACA implementation. This suggests that ACA implementation was associated not only with general improvements in financial protection for trauma patients in our safety-net institution, but also improved health equity. These findings lay the groundwork for future research to better

understand how the ACA has interacted with well-documented racial and ethnic disparities in trauma care.

Lastly, in our subgroup analysis of 19–25 year-old trauma patients, we found that implementation of the main provisions of the ACA in January 2014 was associated with a substantially greater reduction in odds of catastrophic expenditures (80% vs 29%) than implementation of the ACA’s Dependent Coverage Provision in September 2010. This suggests that the ACA’s principal components – the expansion of Medicaid eligibility (which was adopted in our state) and the availability of premium and cost-sharing subsidies on the ACA health insurance exchanges – conferred greater financial

Table 2

Adjusted association between ACA implementation and odds of catastrophic expenditures in all trauma patients aged 19–64 and selected subgroups (n = 7519).

	Sample size	CHE Risk Pre-ACA	CHE Risk Post-ACA	Adjusted OR (95% CI)
Full sample	7519	28.3%	9.2%	0.26** (0.22, 0.30)
Subgroups				
Sex				
Male	5567	31.0%	10.5%	0.26** (0.22, 0.30)
Female	1952	20.1%	5.9%	0.24** (0.17, 0.33)
Race/Ethnicity				
Non-Hispanic White	3500	22.0%	7.8%	0.31** (0.25, 0.39)
Hispanic	2599	38.3%	12.6%	0.23** (0.19, 0.29)
Asian	670	15.2%	7.5%	0.44** (0.26, 0.75)
Non-Hispanic Black	343	44.9%	7.0%	0.09** (0.04, 0.18)
Other	292	22.2%	6.0%	0.22** (0.09, 0.51)
Unknown	115	30.9%	2.9%	0.05** (0.01, 0.40)
Age				
19–25	1686	35.1%	11.4%	0.23** (0.17, 0.31)
26–35	1716	33.0%	10.1%	0.21** (0.16, 0.28)
36–45	1356	28.1%	11.4%	0.30** (0.22, 0.41)
46–55	1586	24.0%	7.4%	0.25** (0.18, 0.35)
56–64	1175	14.6%	6.1%	0.37** (0.24, 0.56)
Injury Severity Score				
< 9	3147	28.5%	8.1%	0.22** (0.17, 0.28)
9–15	2509	29.0%	9.5%	0.25** (0.20, 0.32)
16–24	1006	25.6%	12.7%	0.42** (0.30, 0.61)
> 24	672	30.8%	9.9%	0.25** (0.16, 0.40)
Unknown	185	19.8%	3.8%	0.08** (0.02, 0.32)

** = p < 0.01.

Note: Each subgroup analysis is adjusted for all covariates (sex, race/ethnicity, age, ISS) other than the variable used to stratify.

protection than the DCP. Improved financial risk protection in this age group is important given its high rate of trauma, with nearly a quarter of our study population falling into this age range. Young adults are also particularly at risk for prolonged harm from trauma-related CHE due to their relative financial insecurity and damage to their future earning potential.^{27,28} Our findings are consistent with prior research, which showed that the ACA Medicaid expansions led to about a fourfold greater decrease in uninsured rate among adults ages 19 to 25 than the DCP, and that insurance coverage gains under the DCP were concentrated among higher-income, non-Hispanic White patients who represent a minority of safety-net hospital trauma patients.²⁹

Limitations

Our study has several limitations. First, as it is a retrospective, observational study, we cannot demonstrate causality, only association, between ACA implementation and reduced odds of catastrophic expenditures due to trauma. Although there may be other unmeasured confounders that are not accounted for in our analysis, we attempt to control for the confounding effect of age, race/ethnicity, sex, and injury severity using our multivariable regression model. Our unadjusted comparison also demonstrated no significant difference in injury severity from the pre-ACA to the post-ACA period. Second, as a single-institution study based on an urban safety-net patient population in California, our findings may not be generalizable to other settings. Third, as our analysis estimates risk of CHE based on hospital charges and insurance status, rather than payments ultimately made by patients, we are unable to account for unpaid medical bills or charges that were waived or reduced by the hospital as charity care. Finally, as our estimates of patients' out-of-pocket spending do not include insurance premiums, post-discharge care, and lost wages for patients and their caregivers, our study likely provides a conservative estimate of the rate of catastrophic expenditures.

Conclusions

We demonstrate that implementation of the ACA in 2014 was associated with a 74% decrease in odds of catastrophic expenditures among trauma patients at a public safety-net hospital, and with decreased racial and ethnic disparities in likelihood of catastrophic spending. However, catastrophic expenditures due to trauma continue to be common even in the post-ACA era. In the context of ongoing debates over the future of the ACA, these findings suggest that efforts to expand insurance coverage, address underinsurance, and reduce out-of-pocket expenses remain important to improving financial protection for trauma patients and vulnerable populations.

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Disclosures

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

Ethics approval

Ethics approval, including waiver of informed consent for this analysis of de-identified data, was obtained from the Santa Clara Valley Medical Center Institutional Review Board.

Declaration of competing interest

The authors have no disclosures and report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2020.04.012>.

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