



## Healthcare

## Bariatric surgery among vulnerable populations: The effect of the Affordable Care Act's Medicaid expansion



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## ABSTRACT

**Background:** Obesity disproportionately affects vulnerable populations. Bariatric surgery is an effective long-term treatment for obesity-related complications; however, bariatric surgical rates are lower among racial minorities and low-income and publicly insured patients. The Affordable Care Act's Medicaid expansion improved access to health insurance, but its impact on bariatric surgical disparities has not been evaluated. We sought to determine the impact of the Affordable Care Act's Medicaid expansion on disparate utilization rates of bariatric surgery.

**Methods:** A total of 47,974 nonelderly adult bariatric surgical patients (ages 18–64 years) were identified in 2 Medicaid-expansion states (Kentucky and Maryland) versus 2 nonexpansion control states (Florida and North Carolina) between 2012 and 2015 using the Healthcare Cost and Utilization Project's State Inpatient Database. Poisson interrupted time series were conducted to determine the adjusted incidence rates of bariatric surgery by insurance (Medicaid/uninsured versus privately insured), income (high income versus low income), and race (African American versus white). The difference in the counts of bariatric surgery were then calculated to measure the gap in bariatric surgery rates.

**Results:** The adjusted incidence rate of bariatric surgery among Medicaid or uninsured and low-income patients increased by 15.8% and 5.1% per quarter, respectively, after the Affordable Care Act in expansion states ( $P < .001$ ). No marginal change was seen in privately insured and high-income patients in expansion states. The adjusted incidence rates increased among African American and white patients, but these rates did not change significantly before and after the Affordable Care Act in expansion states.

**Conclusion:** The gap in bariatric surgery rates by insurance and income was reduced after the Affordable Care Act's Medicaid expansion, but racial disparities persisted. Future research should track these trends and identify factors to reduce racial disparity in bariatric surgery.

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## Introduction

Obesity affects more than 93 million adults in the United States.<sup>1</sup> This widespread epidemic disproportionately affects vulnerable populations.<sup>2,3</sup> Bariatric surgery is globally recognized

as the most effective treatment for obesity and obesity-related complications.<sup>4–7</sup> However, <1% of patients who clinically qualify for bariatric surgery receive surgical care.<sup>8</sup> Furthermore, there is well-documented inequity in utilization rates of bariatric surgery by insurance status, income, and race. Eligible Medicaid-insured, low-income persons and African American patients who qualify for bariatric surgery are significantly less likely to receive surgical care as compared with privately insured, high-income persons and white patients, respectively.<sup>9–15</sup> The Affordable Care Act's (ACA's) Medicaid expansion extended Medicaid eligibility to include all persons who have incomes <138% of the federal poverty line.<sup>16</sup> This policy has increased access to health insurance for millions of non-elderly, low-income adults

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(ages 18–64 years).<sup>17</sup> Furthermore, the ACA improved access to obesity screening for all patients.<sup>18</sup>

However, the impact of the ACA's Medicaid expansion on utilization rates of bariatric surgery has not been evaluated. Specifically, it has not been determined whether a decrease in the uninsured population in ACA's Medicaid expansion states translates to an increase in the utilization rates of bariatric surgery in vulnerable populations. Although some research has reported changes in bariatric surgery trends for 2010 to 2014, no research has examined the impact of the ACA's Medicaid expansion on disparities in obesity treatment by insurance status, income, and race.<sup>19,20</sup> Changes in the utilization rates of bariatric surgery among vulnerable populations in expansion states after implementation of the ACA's Medicaid expansion have not been assessed. These policy implications are critical in understanding whether the ACA's Medicaid expansion was effective in providing equitable obesity care to marginalized populations who are most negatively affected by obesity.

This study aims to determine whether the ACA's Medicaid expansion has increased utilization rates of bariatric surgery for the (1) Medicaid or uninsured population, (2) the low-income population, and (3) the racial minority population. We will compare the number of bariatric surgeries performed in expansion states versus nonexpansion states by insurance status, income, and race pre-ACA and post-ACA expansion. We hypothesize that there will be a preferential increase in the number of bariatric surgeries performed for Medicaid or uninsured populations, low-income persons, and racial minorities in expansion states versus nonexpansion states. These findings are important to identify remaining disparities in obesity treatment to provide equal access to high-quality obesity care for all patients.

## Methods

### Data and state selection

Research has examined utilization trends of surgical procedures after the implementation of the ACA's Medicaid expansion. This analysis follows the methodology of evaluations by Crocker et al.<sup>21</sup> and McDermott et al.,<sup>22</sup> who examined the ACA's Medicaid expansion policy in relation to complex surgery utilization and regionalization. Data were constructed from the State Inpatient Database (SID) provided by the Agency for Health Research and Quality's Healthcare Cost Utilization Project (HCUP) from 2012 to 2015. SID data was merged from the American Hospital Association's Yearly Survey to include information for individual hospitals using an American Hospital Association linkage file provided with SID. Regional information from the Health Resources and Services Administration Area Health Resource File was also linked to data from SID. The combination of these resources provided the information needed to allow for adequate control for factors associated with utilization at patient, hospital, and county levels. The study period chosen included 2 years before and 2 years after the ACA's Medicaid expansion went into effect on January 1, 2014. Owing to the changes in diagnosis and procedure coding from International Classification of Diseases 9th edition (ICD-9) to International Classification of Diseases 10th edition (ICD-10) in October of 2015, and in conjunction with published results showing that volume and utilization counts are sensitive to the classification change, the fourth quarter of 2015 was excluded from our analysis.<sup>23</sup> Institutional review board of MedStar Health Research Institute approved this study with waived consent.

States selected for analysis included 2 Medicaid-expansion states (Kentucky and Maryland) and 2 nonexpansion states (Florida and North Carolina). In addition to the geographic similarities

and variations discussed elsewhere,<sup>21,22</sup> these 4 states had similar policies related to Medicaid compensation for bariatric surgical procedures and had similar adult obesity rates during our study period.<sup>24,25</sup> Together, our sample represented about 7% of the nation's bariatric surgeries.<sup>26</sup>

### Cohort and independent variables

To identify patients who had gastric surgery indicated for weight loss, patients were first selected by the inclusion of a diagnosis code of morbid obesity (ICD-9 278.01) or obesity not otherwise specified (ICD-9 278.00), or had a discharge group of "weight loss surgery" (DRG 288). We identified 1,011,743 patients who were under age 65 years and not insured by Medicare. ICD-9 Clinical Modification (ICD-9-CM) codes were then used to identify all adult patients who underwent a bariatric surgical procedure. The ICD-9-CM primary procedure codes for bariatric surgery included were gastric bypass (44.3, 44.31, 44.39), laparoscopic sleeve gastrectomy (43.82, 43.89, which is also inclusive of duodenal switch), laparoscopic gastric band (44.95), laparoscopic gastroplasty (44.68, 44.96), laparoscopic gastroenterostomy (44.38), or open partial gastrectomy (43.81). These codes are based on the methodology of Kuo et al.<sup>27</sup> and have been reviewed by an expert bariatric surgeon (T.R.S.). The final sample included 47,974 adult patients (aged 18–64 years) who had bariatric surgery between 2012 and the third quarter of 2015.

### Outcome and statistical analysis

A quasi-experimental design was used to analyze the number of bariatric surgeries by insurance type, income, and race in both Medicaid-expansion states and nonexpansion control states from 2012 to the third quarter of 2015. Utilization was defined as the total number of bariatric procedures provided and completed in a 3-month period, defined as 1-calendar quarter. To analyze utilization, Poisson interrupted time series (ITS) were used to estimate adjusted incidence rates of bariatric surgery overall and by insurance type (Medicaid versus privately insured versus uninsured), income (highest income quartile versus lowest income quartile), and race (African American versus white). Utilization was computed by tabulated bariatric surgeries by quarter-year time period; ACA Medicaid expansion; and with insurance status, race, income, and sex and categorized bed size as controls. After tabulation, within-strata summaries were computed for Elixhauser comorbidity score, age, primary care provider/1,000 population ratio, specialist/1,000 population ratio, percentage of local population that is urban, and population size. A linear spline was constructed, starting in the first quarter of 2014 to estimate the change in slope, and an *intervention* indicator was made for time periods of the first quarter of 2014 and after to estimate a change in intercept. The models were also fit with interactions with an ACA indicator for differences between Medicaid-expansion states and nonexpansion states and with indicators for insurance status, income, and race in 3 separate models.

These models were used to test whether there was a preferential or disparate change in utilization of bariatric surgeries within vulnerable populations (privately insured versus Medicaid or uninsured, high income versus low income, whites versus African Americans). Combined effects were estimated using the *multcomp* package (The R Foundation) to interpret the three-way interactions with time, splined time, and the intercept change. All models were controlled for sex, age, Elixhauser morbidity, local primary care physician and specialist density, local population size, percent of local population that is urban, number of beds in the hospital, race, income, and insurance. In addition, locally estimated scatterplot

**Table 1**  
Patient characteristics of bariatric surgical recipients in nonexpansion and expansion states, 2012 to 2015

	Overall	Nonexpansion states n = 33,583	Expansion states n = 14,391	P value
Age (y, mean)	43.23	43.38	42.88	< .001
Sex				< .001
Male	19.8%	20.3%	18.6%	
Female	80.2%	79.7%	81.4%	
Race				< .001
White	64.7%	61.8%	71.6%	
Black	23.1%	22.3%	25%	
Hispanic	9.9%	13.4%	1.5%	
Asian	0.3%	0.2%	0.4%	
AI/AN	0.4%	0.5%	0.1%	
Other	1.7%	1.8%	1.3%	
Insurance				< .001
Medicaid	11.4%	8.9%	17.2%	
Private	81.9%	82.5%	80.6%	
Uninsured	6.7%	8.6%	2.2%	
Median income quarter				< .001
1 (low)	24.4%	21.7%	30.8%	
2	24.2%	24.6%	23.4%	
3	26%	26.4%	25.2%	
4 (high)	25.3%	27.4%	20.6%	
Elixhauser (mean)	1.76	1.63	2.07	< .001
LOS (mean)	2.06	2.08	2.01	.016
Year (%)				< .001
2012	23.2%	24.4%	20.4%	
2013	21.3%	19.3%	26%	
2014	30.8%	31.2%	29.8%	
2015	24.7%	25.1%	23.8%	
Total beds (mean)	522.13	592.74	357.36	< .001
Bed size (%)				< .001
< 100	3.99%	3.67%	4.79%	
100–399	45.23%	38.16%	61.72%	
400+	50.78%	58.18%	33.49%	
Population (mean)	762,457.03	888,765.54	467,921.47	< .001
Median age (y, mean)	36.99	37.11	36.7	< .001
% White (mean)	66.72	67.8	64.21	< .001
% Urban (mean)	86.74	87.49	84.99	< .001
% No insurance (mean)	19.02	21.41	13.46	< .001
PCP per 1,000 (mean)	0.92	0.91	0.94	< .001

AI/AN, American Indian/Alaska Native; LOS, length of stay; PCP, primary care physician.

smoothing curves based on adjusted values were used to illustrate the trends in the gap in utilization of bariatric surgery between the groups of interest. Data importing and manipulation were performed in SAS 9.4 (SAS Institute, Cary, NC, USA), and data analyses were performed in R 3.4.<sup>28,29</sup>

## Results

### Cohort information in Medicaid expansion versus non-expansion states

Table 1 presents the cohort of bariatric surgical patients in Medicaid-expansion states versus nonexpansion states. Of all the captured bariatric surgeries, 70% were conducted in ACA non-expansion states. The majority of the cohort was female (80.2%), white (64.7%), and privately insured (81.9%). SID classifies patients' income by the quartile of the median income of their ZIP code within each state and year without disclosing threshold values. As such, the cohort was evenly dispersed between income thresholds. In unadjusted analysis, there was an increase in the utilization of bariatric surgeries after 2014 (11,138 in 2012, 10,203 in 2013, 14,773 in 2014, and 15,813 projected in 2015;  $P < .001$ ). Comparing ACA-expansion states versus nonexpansion states, bariatric surgical populations from nonexpansion states tended to be older (43.38 vs

42.88 y), male (20% vs 18%), Hispanic (13.4% vs 1.5%), and from higher income areas (27.4% vs 20.6%). The  $P$  value for all was  $< .001$ . Meanwhile, the proportion of bariatric surgical procedures among Medicaid patients in expansion states was approximately double that of nonexpansion states (17.2% vs 8.9%). The proportion of bariatric surgical patients from the lowest income quartile was also higher in expansion states (30.8% vs 21.7%). Furthermore, in non-expansion states, the majority of bariatric procedures were performed in large hospitals with more than 400 beds (58.2%), and in expansion states the majority were performed in moderately sized hospitals of 100 to 399 beds (61.7%).

### Trends and disparities by insurance status

As illustrated in Figure 1 and reported in Table II, Poisson ITS indicated that, in expansion states, the combined Medicaid-insured and uninsured populations had a significant and substantial increase in the adjusted incidence rate of bariatric procedures after 2014 by 15.8% per quarter (incidence rate ratio [IRR] 1.158, 95% confidence interval [CI] 1.130–1.187) compared with only a 5% increase in the utilization rate in the same population in non-expansion states (95% CI 1.033–1.068). Before 2014, the incidence of bariatric procedures among combined Medicaid and uninsured patients was falling by 3% per quarter (IRR 0.989, 95% CI

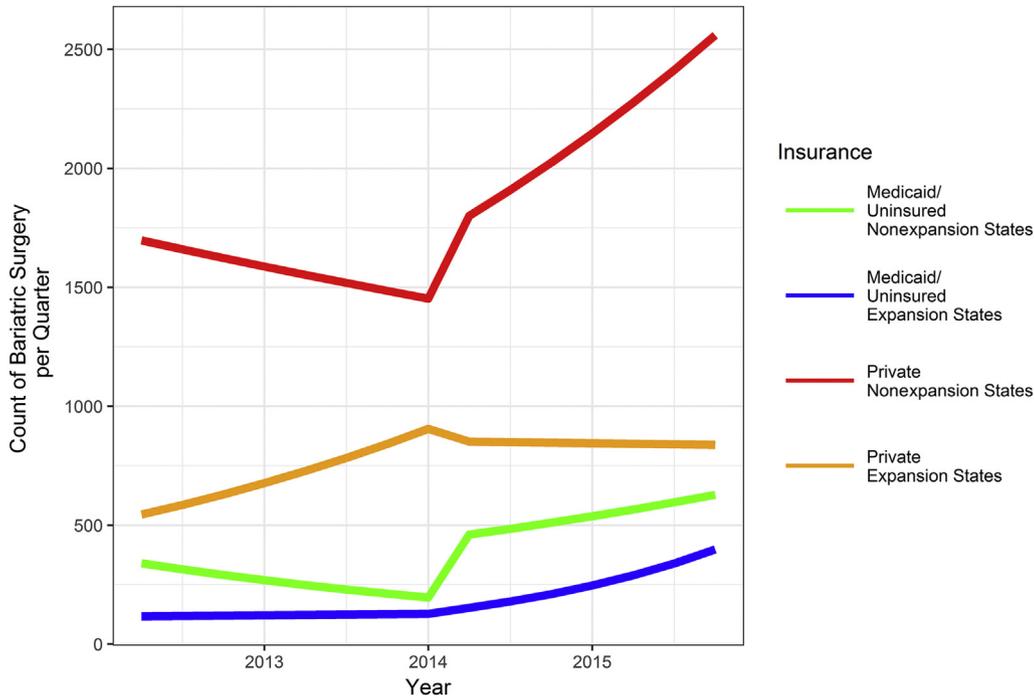


Fig 1. Estimated utilization of bariatric surgery based on Poisson interrupted time series with insurance interactions.

Table II

Trend estimate stratified by insurance in expansion and non-expansion states before and after expansion. Linear combinations of main effects and interactions as estimated by the its model

		Pre-ACA	Post-ACA
Nonexpansion states	Medicaid + uninsured	0.936 [0.918,0.954]	1.051 [1.033,1.068]
	Private	0.980 [0.973,0.988]	1.063 [1.054,1.072]
Expansion states	Medicaid + uninsured	0.989 [0.962,1.017]	1.158 [1.130,1.187]
	Private	1.043 [1.031,1.056]	0.995 [0.982,1.008]

0.962–1.017). The privately insured bariatric surgical population was growing at a rate of 4% per quarter before 2014 (IRR 1.043, 95% CI 1.031–1.056). After the ACA’s Medicaid expansion, the population of privately insured bariatric surgical patients in ACA’s expansion states held constant (IRR 0.95, 95% CI 0.982–1.008). In nonexpansion states, the privately insured bariatric surgical population grew at an increasing rate of 6.3% per quarter in non-expansion states after 2014 (IRR 1.063, 95% CI 1.054–1.072), which is statistically similar to the rate of utilization increase in the Medicaid and uninsured populations.

Figure 2 illustrates the gap between the incidence of the privately insured and combined Medicaid-insured and uninsured populations. In expansion states, the gap widened until the ACA’s Medicaid expansion was implemented in 2014. After the implementation of the ACA’s Medicaid expansion, the gap began to decrease. In nonexpansion states, the opposite trend was seen: The gap slowly decreases until 2014, after which the gap expands.

Trends and disparities by income

Figure 3 shows that, in expansion states, the incidence rate of bariatric surgery for low-income populations is consistently higher

than high-income populations, resulting in a negative gap. As shown in Table III, before 2014, in expansion states, the rate of increase for bariatric surgery within populations from low-income areas was insignificant (IRR 1.012, 95%CI 0.99–1.03). Post-ACA expansion, the IRR of bariatric surgery in low-income populations increased significantly, by 5.1% per quarter (IRR 1.051, 95% CI 1.030–1.073). In contrast, pre-ACA expansion, high-income bariatric surgical populations had a growth rate of 7.5% per quarter (IRR 1.080, 95% CI 1.054–1.106). After 2014, the utilization of bariatric surgery stabilized for those from high-income areas in expansion states (IRR 1.003). Simultaneously, the marginal rate of bariatric surgery remained parallel between high-income and low-income groups within nonexpansion states pre-ACA and post-ACA Medicaid expansion.

The gap in bariatric surgery utilization between the patients from the highest income areas and those from the lowest income areas is illustrated in Fig 4. In expansion states, patients from low-income areas consistently have higher utilization rates of bariatric surgery, therefore yielding a negative gap. This negative gap steadily widened as utilization among the wealthier population stabilized after 2014. In nonexpansion states, the gap between populations from high-income versus low-income areas was unchanged throughout the study period.

Trends and disparities by race

Table IV shows that there was no statistical impact on racial disparities after the ACA Medicaid Expansion, as Figure 5 depicts. In expansion states, before 2014, the incidence of bariatric surgery within the white population was increasing by 4.6% per quarter (IRR 1.059, 95% CI 1.049–1.069), and after 2014, utilization rates increased by 3.3% per quarter (IRR 1.039, 95% CI 1.025–1.053). In contrast, the African American bariatric surgical population remained stable in expansion states before 2014 (IRR 1.008, 95% CI 0.987–1.030) and after 2014 (IRR 0.999, 95% CI 0.977–1.022). In nonexpansion states, before 2014, both white and African American

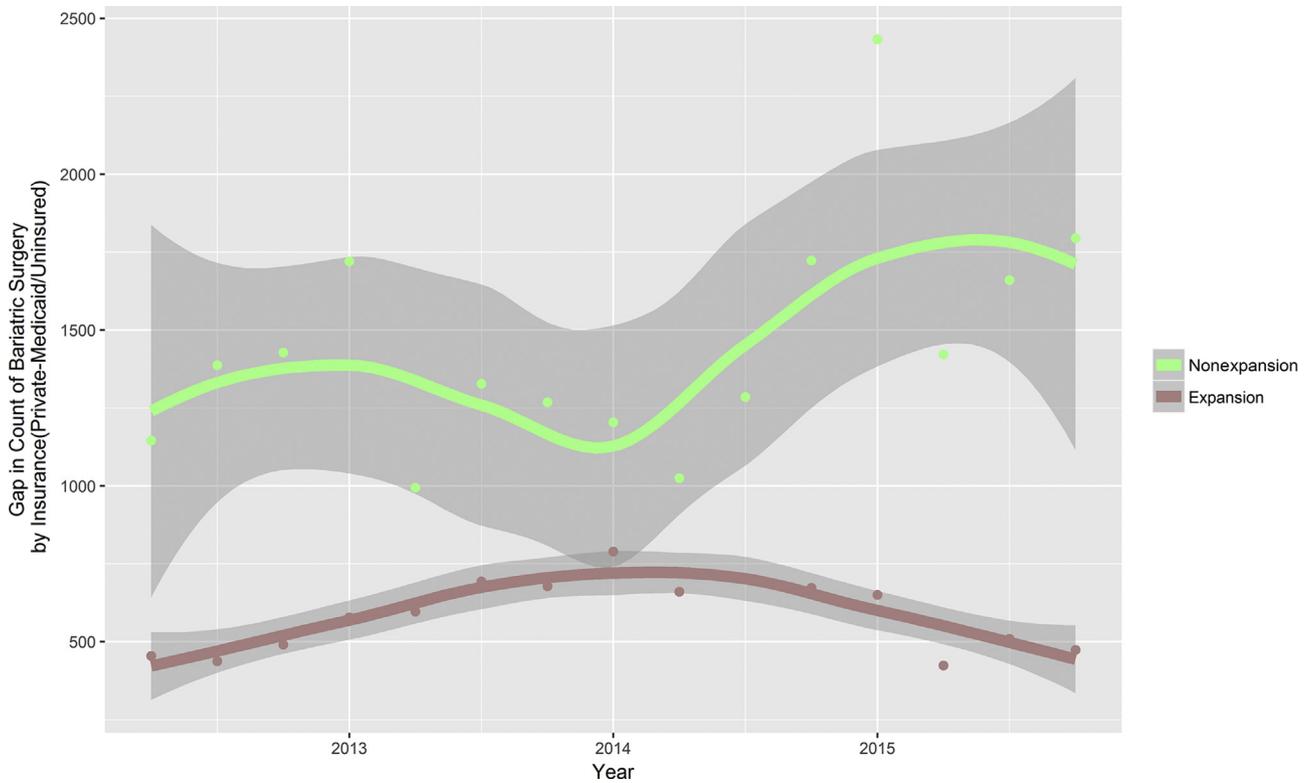


Fig 2. Locally estimated scatterplot smoothing fit of gap in bariatric utilization between privately insured and Medicaid-insured populations.

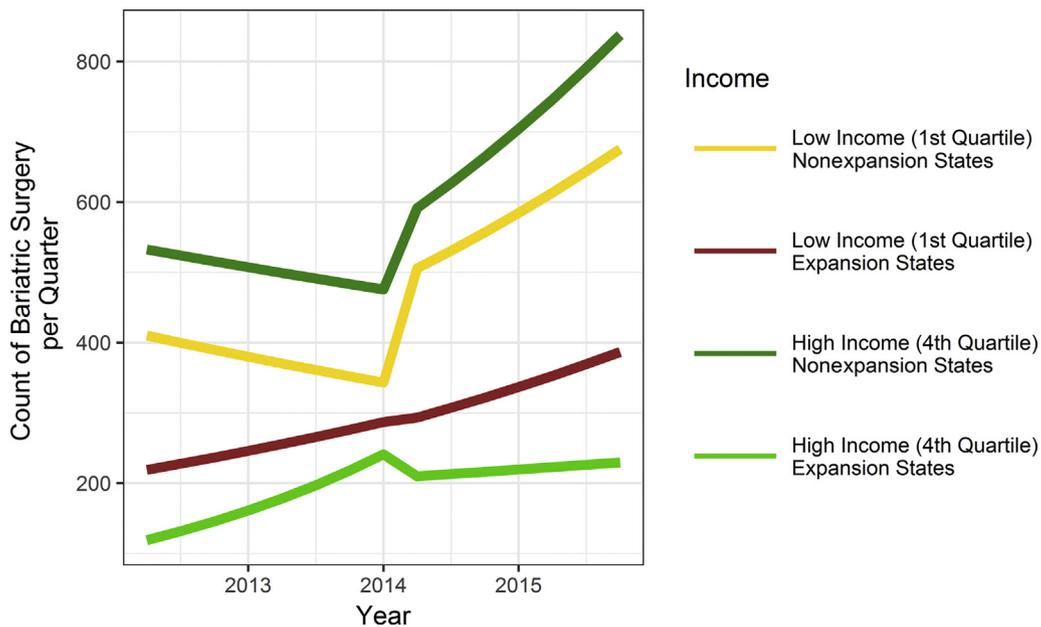


Fig 3. Estimated utilization of bariatric surgery based on Poisson interrupted time series with income interactions.

patients had slowly decreasing utilization rates (white patients IRR 0.980; African American patients IRR 0.976,  $P < .05$  for both). After 2014, both white and African American patients saw a statistically equivalent increase in utilization (white patients IRR 1.047; African American patients IRR 1.077,  $P < .05$  for both).

Figure 6 demonstrates that the gap in bariatric surgery utilization between whites and African Americans steadily grew after the ACA’s expansion in expansion states because of the unchanged

marginal IRR’s. The growth rate in the racial gap in bariatric surgery was even greater after 2014 in nonexpansion states.

**Discussion**

In this multistate evaluation of the impact of the ACA Medicaid expansion on utilization of bariatric surgery in vulnerable populations, a reduction in the gap in bariatric surgery rates by

**Table III**

Trend estimate stratified by income in expansion and non-expansion states before and after expansion. Linear combinations of main effects and interactions as estimated by the its model

		Pre-ACA	Post-ACA
Nonexpansion states	Low (first quarter)	0.976 [0.961,0.992]	1.050 [1.034,1.067]
	High (fourth quarter)	0.994 [0.981,1.008]	1.056 [1.041,1.071]
Expansion states	Low (first quarter)	1.012 [992,1.031]	1.051 [1.030,1.073]
	High (fourth quarter)	1.080 [1.054,1.106]	1.003 [0.978,1.029]

insurance status and income was observed. However, racial disparities persisted in expansion states. These findings illustrate that disparities in utilization rates of bariatric surgery decreased after the ACA Medicaid expansion, but racial disparities were unchanged.

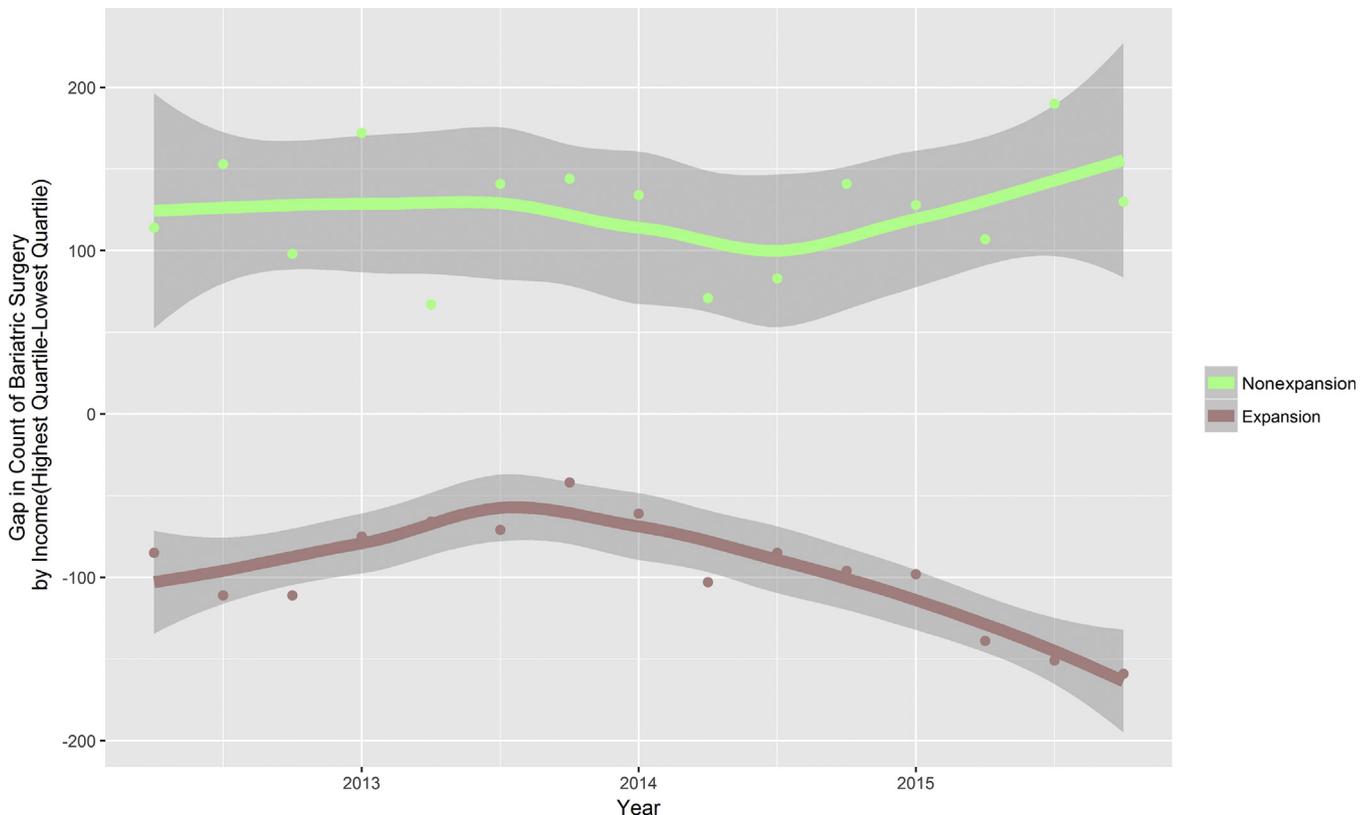
Insurance status is one of the main socioeconomic factors that affects a patient’s decision on whether to pursue bariatric surgery.<sup>30</sup> The ACA Medicaid expansion increased access to medical insurance for millions of Americans.<sup>17</sup> However, medical insurance coverage is not always equal for surgical procedures such as bariatric surgery. The Centers for Medicare & Medicaid Services has determined that patients qualify for bariatric surgery if they have a body mass index  $\geq 35$ , have a comorbidity related to obesity, and have been unsuccessful using medical treatment for obesity.<sup>31</sup> Each individual state also determines standard qualifications that each Medicaid-insured patient must fulfill to be preapproved for bariatric surgery.<sup>32,33</sup> These preapprovals may include a required 6- to 12-month weight-loss program before receiving bariatric

surgery.<sup>34</sup> Therefore, Medicaid populations also often have longer wait times for bariatric surgical procedures.<sup>34</sup>

Despite the complex qualification criteria for patients with public insurance, the Medicaid expansion successfully decreased the gap in bariatric surgery by insurance status in expansion states. The opposite trend was seen in nonexpansion states. The gap in utilization of bariatric surgery, based on insurance status, expanded after the ACA Medicaid expansion. These findings demonstrate that increased access to medical insurance for uninsured populations helped ensure that these populations pursued this effective surgical form of obesity treatment. Earlier research has reported similar findings that increased medical insurance has increased the number of discretionary surgical procedures in nonprivately insured populations.<sup>21</sup> Other research also demonstrates a similar reduction in disparities in access to obesity treatment for Medicaid-insured patients. For example, a recent study showed a decrease in the gap in access to diabetes drugs for Medicaid-insured patients in expansion states.<sup>35</sup> These findings could also partially be attributable to increased access to screening and management of obesity across all populations with insurance from evidence-based screening guidelines promoted by the United States Preventive Services Task Force.<sup>36</sup>

After the ACA’s implementation, there was also an increase in the utilization rates of bariatric surgery among privately insured patients in nonexpansion states. Specifically, there was an increase of 6% per quarter of utilization of bariatric surgery after the ACA’s institution in nonexpansion states. This trend in nonexpansion states has been noted in earlier research and is explained by an overall increased usage of ACA marketplace exchange programs in nonexpansion states as compared with expansion states.<sup>21</sup>

Similar to the preferential increase in the utilization rate of bariatric surgery by Medicaid-insured and uninsured patients,



**Fig 4.** Locally estimated scatterplot smoothing fit of gap in bariatric utilization between high-income and low-income populations.

**Table IV**

Trend estimate stratified by race in expansion and non-expansion states before and after expansion. Linear combinations of main effects and interactions as estimated by the ITS model

		Pre-ACA	Post-ACA
Nonexpansion states	White	0.980 [0.972,0.982]	1.047 [1.034,1.060]
	African American	0.976 [0.962,0.992]	1.077 [1.060,1.095]
Expansion states	White	1.059 [1.049,1.069]	1.039 [1.025,1.053]
	African American	1.008 [0.987,1.030]	0.999 [0.977,1.022]

there was also a preferential increase in the utilization rates of bariatric surgery among low-income versus high-income persons in expansion states. This preferential increase resulted in a decreased gap in utilization rates of bariatric surgery by income. It is notable that our results showed a higher utilization rate of bariatric surgery among patients from low-income versus high-income areas in expansion states pre-ACA and post-ACA expansion. Based on the differences in morbid obesity rates based on income and the clinical qualifications for bariatric surgery, higher utilization rates of bariatric surgery would be expected for all patients from low-income versus high-income areas. However, these results do not follow the published trend that there is a higher utilization rate of bariatric surgery among patients from high-income versus low-income areas.<sup>9,11,12</sup> Some more recent findings suggest that this income disparity may be lessening over time because of the changes in the utilization rate of bariatric surgery.<sup>36,37</sup> Our results, however, still show a higher utilization rate of bariatric surgery among high-income versus low-income patients in nonexpansion states. To our knowledge, our results are the first to show a higher rate of bariatric surgery among low-income patients versus high-income patients in expansion states. These results suggest that the socioeconomic barriers of receiving bariatric surgical care for low-income patients may be lessened in expansion states.

Although there were improved utilization rates of bariatric surgeries for Medicaid-insured and low-income persons after the ACA Medicaid expansion, this preferential impact was not apparent for racial minorities. Specifically, there was no change in the trend of the utilization rates of bariatric surgery among whites and African Americans pre-ACA and post-ACA expansion in expansion states. The utilization rates of bariatric surgery steadily increased for both races during this time period. Some earlier research states that the differences in bariatric surgical rates between whites and African Americans were partially due to differences in insurance status.<sup>13</sup> Our current evaluation supports this. African American populations have higher rates of Medicaid insurance pre-ACA and post-ACA as compared with white patients (African American Medicaid rate 11.4% pre-ACA, 14.6% post-ACA; white Medicaid rate 6.1% pre-ACA, 10.7% post-ACA). Even with increased access to Medicaid insurance in African American populations after the ACA expansion, racial disparities persisted. These findings also suggest that there may be other sociocultural and upstream healthcare barriers that inhibit racial minorities from using bariatric surgery. Some of these barriers may include lower referral rates for bariatric surgery among African Americans.<sup>38</sup> Further research has found that some African Americans perceive bariatric surgery as a last option to treat obesity, and these patients also lose less weight on average than whites post-bariatric surgery.<sup>39,40</sup> These sociocultural barriers to healthcare may not have been directly influenced by an increased access to medical insurance owing to the ACA Medicaid expansion.

This current study has the following limitations. First, this policy analysis is retrospective in nature. Therefore, it is possible that confounding variables affected our results. However, we attempted to control this by choosing states within close proximity to account for changes in disease prevalence. In addition, we controlled for demographic differences in the ITS model. Second, these results provide an early look into the effect of the ACA Medicaid expansion on bariatric surgery. Our study period reflects the 2-y period after the ACA Medicaid expansion was implemented. Further research is needed to capture long-term effects of the ACA Medicaid expansion on health disparities in obesity treatment. Third, the cohort of bariatric surgical patients in

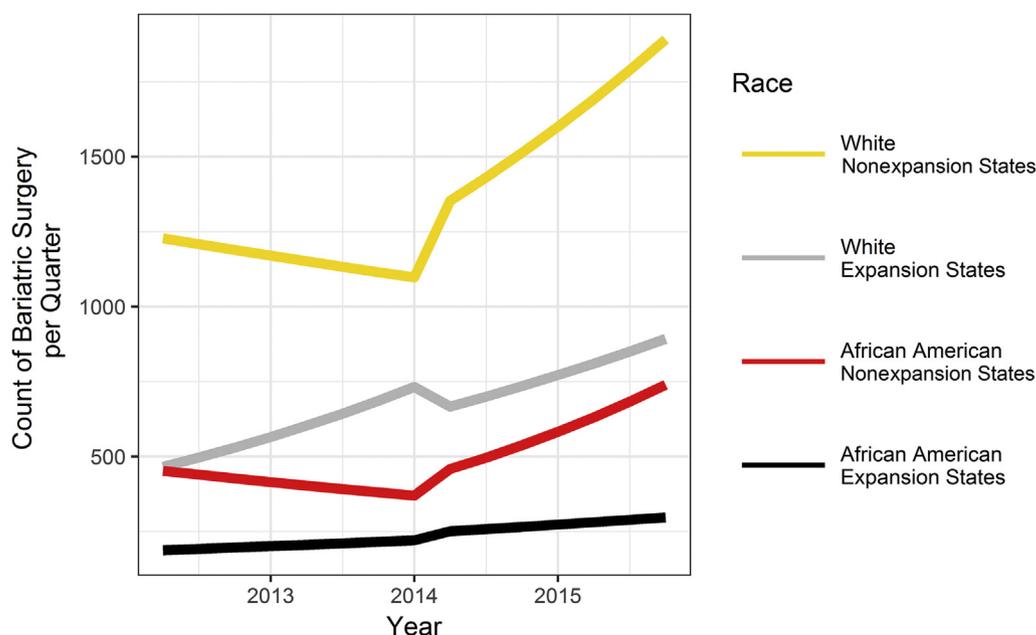


Fig 5. Estimated utilization of bariatric surgery based on Poisson interrupted time series with race interactions.

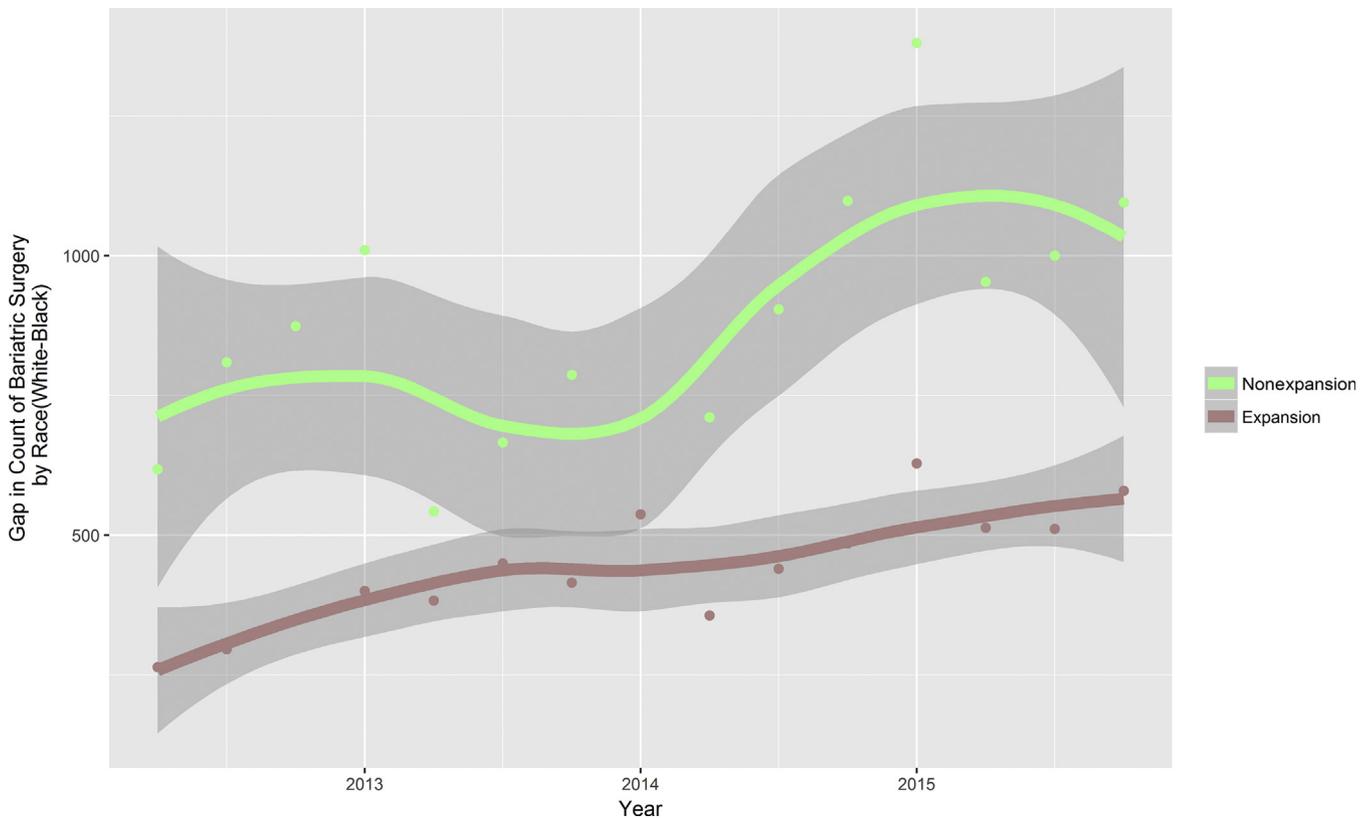


Fig 6. Locally estimated scatterplot smoothing fit of gap in bariatric utilization between white and African American populations.

nonexpansion states was larger than in expansion states because of differences in overall population size. However, our select states represent a diverse population and are representative of the average prevalence of obesity in the United States. Fourth, our data represent the overall utilization of bariatric surgery. Our methodology is not designed to directly measure access to bariatric surgery that is based on eligibility for bariatric surgery. Instead, our data provide evidence and understanding of the overall changes in utilization of bariatric surgical care among vulnerable populations. Fifth, our data did not exclude patients with gastric cancer. However, only 25 patients of 47,974 patients were identified with a diagnosis of gastric cancer, and removal of these patients did not significantly change the results. Sixth, there are some state-to-state level variations in bariatric surgical patient criteria for Medicaid coverage.<sup>33</sup> Our quasi-experimental design should account for all state-to-state level variations. Last, our data are from the HCUP SID. The HCUP SID data do not include information on outpatient bariatric surgical procedures. However, because almost 90% of bariatric surgeries performed are inpatient procedures, these data are generalizable to the majority of bariatric surgical care.<sup>20</sup>

Despite these limitations, this original evaluation provides early insights into the impact of the ACA Medicaid expansion on utilization rates of bariatric surgery in vulnerable populations. These results compare pre-ACA and post-ACA Medicaid expansion across diverse states that represent the overall population of the United States. This study provides one of the first evaluations of the impact of major healthcare policy on utilization of obesity treatment for vulnerable populations that are highly affected by obesity as a chronic disease.

This research provides key understandings into the early effects of the ACA Medicaid expansion on insurance, income, and racial

disparities in utilization rates of bariatric surgery. Because obesity disproportionately affects vulnerable populations, these results are crucial to further understanding the impact of national policy on health-related outcomes for the most vulnerable populations in the United States.<sup>2,3</sup> Future research should be conducted that examines long-term trends in bariatric surgery utilization owing to the ACA Medicaid expansion and also assesses the impact of the expansion in additional states. Efforts should also be directed to explain the persistence of the racial gap by identifying health system and sociocultural factors associated with this healthcare disparity. A geospatial evaluation of disparities in the utilization rates of bariatric surgery may also be helpful to public health workers and healthcare providers in targeting areas for clinical outreach to lessen ongoing health disparities in utilization rates of bariatric surgery by race.

In conclusion, the gap in bariatric surgery rates by insurance status and income was reduced after the ACA Medicaid expansion, but racial disparities persisted. Future research should follow these trends and focus on identifying other factors that can help reduce disparity in utilization rates of bariatric surgery for minority patients.

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#### Conflict of interest/Disclosure

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

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.surg.2019.05.005>.

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