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Impact of Sociodemographic and Hospital Factors on Inpatient Bilateral Reduction Mammaplasty: A National Inpatient Sample Analysis

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Background: Although reduction mammaplasty remains a common procedure in plastic surgery, its interaction with sociodemographic and economic disparities has remained relatively uncharacterized on a nationwide scale.

Methods: Patients who underwent reduction mammaplasty were identified within the 2016–2018 National Inpatient Sample databases. In addition to clinical comorbidities, sociodemographic characteristics, hospital-level variables, and postoperative outcomes of each patient were collected for analysis. Statistical analyses, including univariate comparison and multivariate logistic regression, were applied to the cohort to determine significant predictors of adverse outcomes, described as extended length of stay, higher financial cost, and postoperative complications.

Results: The final patient cohort included 414 patients who underwent inpatient reduction mammaplasty. The average age was 45.2 ± 14.5 years. The average length of stay was 1.6 ± 1.5 days, and the average hospital charge was \$53,873.81 ± \$36,014.50. Sixty (14.5%) patients experienced at least one postoperative complication. Black race and treatment within a nonmetropolitan or rural county predicted postoperative complications ($P < 0.01$). Black race, lower relative income, and concurrent abdominal contouring procedures also predicted occurrence of extended length of stay ($P < 0.01$). Hospital factors, including larger bed capacity and for-profit ownership, predicted high hospital charges ($P < 0.05$). Severity of comorbidities, measured by a clinical index, also predicted all three outcomes ($P < 0.001$).

Conclusion: In addition to well-described clinical variables, multiple sociodemographic and economic disparities affect outcomes in inpatient reduction mammaplasty. *(Plast Reconstr Surg Glob Open 2024; 12:e5682; doi: 10.1097/GOX.0000000000005682; Published online 22 March 2024.)*

INTRODUCTION

Reduction mammaplasty is a procedure within plastic surgery that has remained consistently common within recent decades; there were an estimated 115,895 reduction mammaplasties performed in 2020 alone in the United States, which reflects a slight increase from the estimate of 106,179 cases in 2007.[1,2] Breast reductions have been shown to produce significant improvements in quality of life and psychological well-being, and represent the most effective avenue of treatment for macromastia.[3–5] As a result, there is a strong motivation to address potential barriers to receiving this surgery, and to ensure patients are provided with the best care during the perioperative and postoperative periods.

Although previous studies have thoroughly described the postoperative outcome profiles of reduction mammaplasty,[6–8] the impact of socioeconomic and hospital-level factors on such outcomes, including length of stay and financial burden, remain relatively uncharacterized. The existing literature is also conflicting on this topic; applications of the BREAST-Q questionnaire in 2020 displayed associations of racial and economic factors, such as income, with satisfaction with provided information and

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physical well-being.[9] In contrast, a survey of the National Surgical Quality Improvement detected no evident racial disparities in reduction mammaplasty outcomes in the postoperative 30-day period.[10] Although these studies were focused in their approach either through the number of variables studied or the number of institutions included in their methodologies, a more expansive analysis of additional socioeconomic and hospital-level factors on a nationwide scale may assist in validating or extending the conclusions existing in the current literature. A previous analysis of pediatric reduction mammaplasties on this scale revealed significant racial and socioeconomic disparities in multiple outcomes, which further motivates an evaluation of adult reduction mammaplasties.[11] This study provides an insight into the impact of racial and social inequality on adult inpatient bilateral reduction mammaplasty procedures by evaluating a host of socioeconomic factors, including race and ethnicity, payer status, hospital bed size, and regional population density, and their associations with surgical outcomes, length of inpatient stay, and procedural financial burden.

Takeaways

Question: What is the role of sociodemographic disparities in outcomes after reduction mammaplasty?

Findings: Our study found several sociodemographic predictors of postoperative complications, extended lengths of stay, and high hospital charge after reduction mammaplasty. These predictors included variables like race, rural-urban density, and income.

Meaning: Multiple sociodemographic and economic disparities affect outcomes in inpatient breast reduction and can offer points of future intervention for more equitable care.

METHODS

A retrospective, observational cohort study was conducted within the 2016–2018 National Inpatient Sample (NIS) databases. The NIS was developed by the HCUP and is the largest publicly available inpatient database, representing a 20% stratified random sample of all discharges from U.S. community hospitals.[12] Patients were included in this study cohort if they were diagnosed with macromastia by International Classification of Disease, Tenth Revision (ICD-10) Clinical Modification (CM) code (N62: "breast hypertrophy") and if they were identified as female sex. Because the NIS databases in this study defined diagnoses and procedures via the ICD-10 coding system and not by Current Procedural Terminology (CPT) code, patients who underwent bilateral reduction mammaplasty in this cohort were identified by an additional ICD-10 Procedure Coding System (PCS) code (0HB0VZZ: "excision of bilateral breast, open approach"). Because this code is also indicated for other breast procedures, primarily mastectomy, the subsequent patient cohort was manually reviewed to include reduction mammaplasty cases without evidence of breast cancer. Additionally, patients who were undergoing other major procedures concurrently, such as hysterectomy, ileostomy, and treatment for disseminated cancer, were not included in the final cohort.

Cases with inadequate information on predictor variables or outcomes were excluded from the cohort. Breast reductions for male patients with gynecomastia were also excluded from this analysis to reduce procedural differences and potential confounding factors. Of note, as only in-patients are included in the NIS database, the reduction mammaplasty patients examined in this study were all treated on an inpatient basis.

The sociodemographic characteristics, hospital-level variables, and postoperative outcomes of all patients were collected. Comorbidities for each patient were aggregated into an adjusted Elixhauser Comorbidity Index, a well-validated measure of comorbidity severity that evaluates risk of hospital readmission.[13,14] Concurrent ICD-10 diagnoses and procedures that were described during each patient's stay were also collected. Given that abdominal contouring procedures, such as panniculectomy and liposuction, are procedures that are commonly conducted concurrently with reduction mammaplasty and could confound relationships with outcomes of interest,[15] such procedures were identified via ICD-10-PCS codes and then consolidated into a binary predictor variable. Outcome data were also collected for the patient cohort, including occurrence of extended length of stay (defined as greater than the 75th percentile of all lengths of stay in the cohort), high hospital charge (defined as greater than the 75th percentile of all charges in the cohort), and postoperative complications during the index admission. Surgical and medical complications were defined by a host of ICD-10-CM and ICD-10-PCS codes that were incorporated into previous literature and included both systemic events, including stroke, embolus and thrombosis, intestinal obstruction, and respiratory failure, as well as procedural outcomes, including dehiscence, hematoma, blood transfusion, and seroma.[16,17] (**See table, Supplemental Digital Content 1,** which displays ICD-10 CM and PCS codes used to identify postoperative complications. **http://links.lww.com/PRSGO/D126**.)

Statistical analysis for differences between patient groups was conducted with Fisher exact tests and chi-squared contingency tests for categorical variables, as well as two-sided Student *t* tests for numerical variables. Counts for categorical variables were expressed as *n* (%), and distributions for numerical variables were summarized as mean ± SD. All regression models were adjusted with discharge-level weights that were provided in the NIS database to provide a nationwide estimate of trends and cohort size. In multivariate analysis, only predictors that yielded significance of $P = 0.2$ or less in bivariate comparison were included into the model. Results of multivariate regression were described with regression coefficients, standard errors, odds ratios, and 95% odds ratio CIs. All analysis was conducted on Python Software (v3.9; Python Software Foundation).[18] Statistical relationships that resulted in a value of P less than 0.05 were considered statistically significant.

RESULTS

After exclusion of initial cases with missing information and patients of male sex, 1376 adult women were identified with the diagnosis of breast hypertrophy during their inpatient stays. Cases were similarly distributed across the three years used for data collection ($P = 1.00$). After filtering with ICD-10 codes, manual review, and exclusion of extraneous cases, such as patients who underwent mastectomy, 414 (30.1%) patients were included in the final cohort of reduction mammaplasty procedures. The average age was 45.2 ± 14.5 years. Each patient was recorded with an average of 7.4 ± 5.5 diagnoses, with the most common being essential hypertension (100, 24.2%), cervicalgia (77, 18.6%), dorsalgia (75, 18.1%), and obesity (73, 17.6%; Fig. 1). The average Elixhauser Comorbidity Index score was 3.9 ± 7.3 (Table 1). Within this cohort, 190 (45.9%) patients also underwent a total of 144 unique concurrent procedures, with the most common one being alteration of abdominal wall (29, 7.0%; Fig. 2).

Sixty (14.5%) patients experienced at least one postoperative complication. The most common complication was hematoma (20, 4.8%), followed by blood transfusion (14, 3.4%) and cardiovascular (eg, heart failure, atrial fibrillation, cardiomyopathy) (11, 2.7%) events. Patients who did not experience a postoperative complication were rated 4.7 less points in the Elixhauser Comorbidity Index ($P < 0.001$) on average when compared with patients who did experience complications. The patient cohort with postoperative complications also comprised a higher proportion of Black patients ($P = 0.014$; Table 2)

The average length of hospital stay in the patient cohort was 1.6 ± 1.5 days, and 56 (13.5%) patients experienced a stay over the 75th percentile of two days. Patients with an extended length of stay were rated an average of 6.5 points higher than other patients in the Elixhauser Comorbidity Index ($P < 0.001$) and also included a higher proportion of Black patients ($P = 0.012$). Extended length of stay also approached significant association with concurrent abdominal contouring procedures during surgery ($P = 0.099$; Table 3).

The average total hospital charge was $53,873.81 ± $36,014.50, and 102 (24.6%) patients received a hospital charge above the 75th percentile of $70,396.50. Patients with a high hospital charge were rated an average of 2.0 points higher in comorbidity severity ($P = 0.037$) and received a higher proportion of procedures in private, invest-owned hospitals ($P < 0.001$) when compared with other patients (Table 4).

Comorbidity severity, race, and rural-urban density were incorporated into logistic regression for risk of postoperative complication. Higher comorbidity index [odd ratio (OR): 1.07, 95% confidence interval (CI): 1.06–1.09, $P < 0.001$], Black race (OR: 2.17, 95% CI: 1.62–2.91, $P < 0.001$), and treatment within a nonmetropolitan or rural county (OR: 1.95, 95% CI: 1.28–2.96, $P = 0.0017$) were significant predictors of increased risk of postoperative complication. Notably, treatment in smaller metropolitan counties with a population greater than 50,000 predicted decreased risk of this outcome (OR: 0.51, 95% CI: 0.35–0.75, $P < 0.001$; (Table 5).

Age, comorbidity severity, race, zip code income quartile, and occurrence of concurrent abdominal contouring procedure were selected for a logistic model for risk of extended length of stay. Older age (OR: 1.01, 95% CI: 1.00–1.02, $P = 0.0078$), increased comorbidity severity (OR: 1.09, 95% CI: 1.08–1.11, $P < 0.001$) and Black race (OR: 1.72, 95% CI: 1.24–2.39, $P = 0.0011$) predicted higher risk of extended length of stay, whereas Hispanic race predicted decrease of such risk (OR: 0.24, 95% CI: 0.12–0.47, $P < 0.001$). Additionally, membership in the first (OR: 2.12, 95% CI: 1.40–3.21, $P < 0.001$) or second (OR: 2.42, 95% CI: 1.61–3.63, $P < 0.001$) quartiles of income predicted increased risk of extended length of stay when compared with membership in the fourth quartile. Concurrent abdominal contouring procedure also independently predicted extended length of stay (OR: 2.50, 95% CI: 1.71–3.64, $P < 0.001$; Table 6).

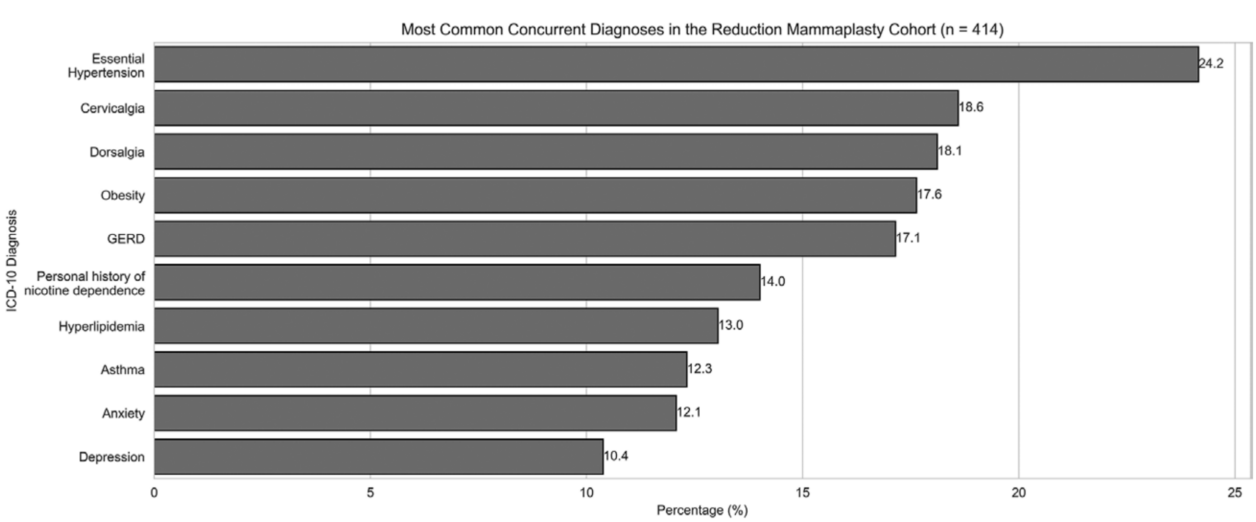

Fig. 1. The ten most common concurrent ICD-10 diagnoses in the reduction mammaplasty cohort.

Table 1. Patient Characteristics among Patients Who Underwent Reduction Mammaplasty, Mean (SD), *n* (%)

Variable	Patient Cohort (n = 414)	
Age (y)	45.2	(14.5)
Elixhauser Comorbidity Index score	3.9	(7.3)
Race		
White	212	(51.2%)
Black	111	(26.8%)
Hispanic	61	(14.7%)
Asian or Pacific Islander	7	(1.7%)
Native American	3	(0.7%)
Other	20	(4.8%)
Payer Status		
Medicare	78	(18.8%)
Medicaid	91	(22.0%)
Private insurance	192	(46.4%)
Selfpay	29	(7.0%)
Other	24	(5.8%)
Rural–urban Density		
"Central" metropolitan counties with >1,000,000 population	180	(43.5%)
"Fringe" metropolitan counties with >1,000,000 population	110	(26.6%)
Counties in metro areas of 250,000–999,999 population	63	(15.2%)
Counties in metro areas of 50,000–249,999 population	25	(6.0%)
Micropolitan counties	19	(4.6%)
Not metropolitan or micropolitan counties	17	(4.1%)
Zip Code Income Quartile		
First quartile	115	(27.8%)
Second quartile	97	(23.4%)
Third quartile	95	(22.9%)
Fourth quartile	107	(25.8%)
Hospital Bed Size		
Large	230	(55.6%)
Medium	95	(22.9%)
Small	89	(21.5%)
Hospital Control		
Nonfederal government	69	(16.7%)
Private, nonprofit	298	(72.0%)
Private, invest-owned	47	(11.4%)
Concurrent abdominal contouring	50	(12.1%)
Length of stay (d)	1.6	(1.5)
Total hospital charge (USD)	53873.81	(36014.50)
Occurrence of at least one complication	60	(14.5%)

Lastly, comorbidity severity, hospital bed size, and hospital control were incorporated into logistic regression for high hospital charge. Higher comorbidity index (OR: 1.04, 95% CI: 1.02–1.05, $P < 0.001$) and treatment at a private, invest-owned hospital (OR: 6.96, 95% CI: 5.02–9.65, $P < 0.001$) predicted high cost. In contrast, both small (OR: 0.31, 95% CI: 0.22–0.44, $P < 0.001$) and medium (OR: 0.73, 95% CI: 0.56–0.95, $P = 0.020$) hospital bed sizes predicted decreased risk of high cost when compared with large hospitals (Table 7).

DISCUSSION

Macromastia is a chronic condition with relatively high prevalence, as well as physical and economic burden, in the general population.[19] Surgical intervention via reduction mammaplasty has been shown to produce the greatest improvement in patients when compared with more conservative and nonsurgical treatments.[5] However, because of its cost and requirement for significant postoperative care, surgery is especially susceptible to the effects of socioeconomic disparities.[20–22] This study investigates the specific impact of such disparities in several postoperative metrics, and its findings suggest that significant barriers exist in multiple aspects of the patient experience during and after hospitalization.

The findings of this study described 414 inpatient reduction mammaplasty procedures, which correlate to approximately 2070 procedures nationwide when accounting for discharge-level weights, as the NIS records data from only 20% of all patients in member hospitals. This prevalence over a 3-year period is similar to those found in previous literature incorporating a large national database; for example, Webster et al detected 3608 inpatient reduction mammaplasty procedures in the National Surgical Quality Improvement Program over an 8-year period.[23] The age and racial composition of the patient cohort in this study generally reflected characteristics of previous studies that investigated breast reduction in a national scope.[24,25] At least one postoperative complication occurred in 14.5% of patients within the cohort; depending on the length of follow-up and definition of complication, the overall complication rate for reduction mammaplasty has been estimated to range from 6.2% to 32%, indicating consistency with the results of our study.[25–27]

All outcomes examined in this study were predicted by sociodemographic variables. Race was a significant indicator of outcomes; notably, Black race predicted a higher risk of both postoperative complication and extended length of stay. The influence of race on clinical outcomes in plastic surgery remains contested within subjects like breast reconstruction and cleft palate repair.[10,11,28,29] Massey et al described a predictive effect of racial minority status on symptom severity of macromastia in adolescent women.[30] This indicates that race may not directly predict postoperative complications but may instead be mediated by a more complex relationship with symptom severity before surgery. The relationship of race to length of stay in this study supports the consensus of findings from other studies, including the analysis of pediatric reduction mammaplasty by Soleimani et al that similarly described African American race as a predictor of a hospital stay greater than one day.[11] Hispanic race protected against extended length of stay; this finding has not been described as thoroughly in the literature. A study of patients with sepsis and acute respiratory failure also found that Hispanic and Asian/Pacific Islander racial identification predicted shorter lengths of stay and attributed this potentially to preexisting differences in comorbidity severity or insurance payer status.[31] In our study, Hispanic patients were indeed an average of 1.1 points lower in comorbidity severity when compared with non-Hispanic patients, although this difference was not statistically significant. Such a relationship may explain the differences in trend directions found in length of stay between Black and Hispanic patients.

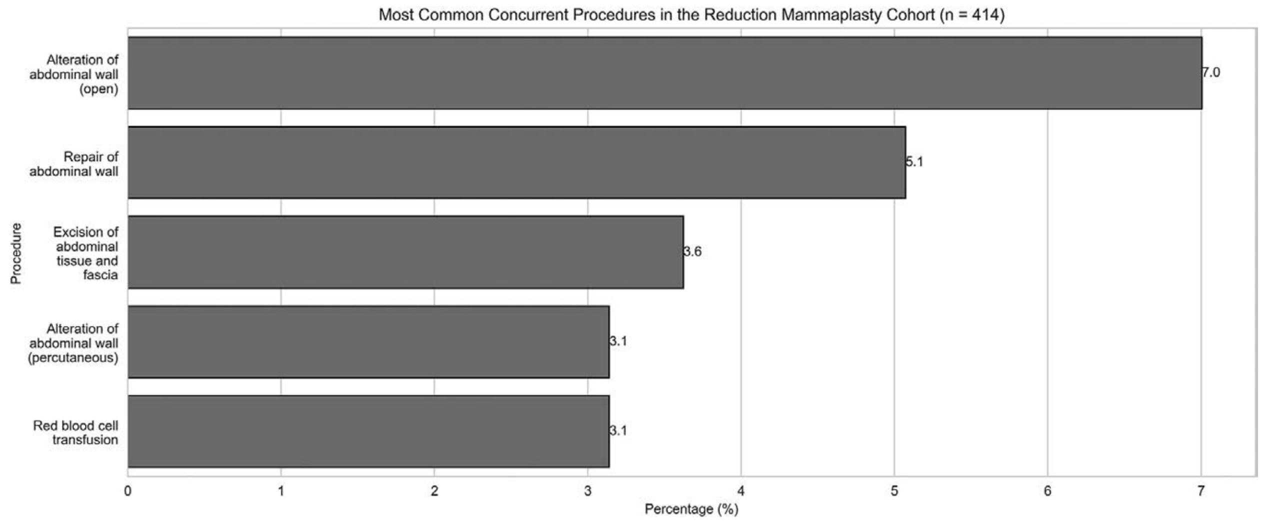

Fig. 2. The five most common concurrent ICD-10 procedures in the reduction mammaplasty cohort, excluding routine procedures.

Table 2. Comparison between Reduction Mammaplasty Procedures with and without Occurrence of Postoperative Complication, Mean (SD), *n* (%)

	Postoperative Complications (n = 60)		No Postoperative Complications (n = 354)		*P* Value
Age (y)	47.2	(12.7)	44.9	(14.8)	0.21
Elixhauser Comorbidity Index	7.9	(9.1)	3.2	(6.8)	<0.001***
Race					0.014*
White	26	(43.3%)	186	(52.5%)	
Black	26	(43.3%)	85	(24.0%)	
Hispanic	6	(10.0%)	55	(15.5%)	
Other	2	(3.3%)	28	(7.9%)	
Payer Status					0.26
Medicare	13	(21.7%)	65	(18.4%)	
Medicaid	15	(25.0%)	76	(21.5%)	
Private insurance	29	(48.3%)	163	(46.0%)	
Other	3	(5.0%)	50	(14.1%)	
Rural-urban Density					0.14
Metropolitan counties with >1,000,000 population	44	(73.3%)	246	(69.5%)	
Counties in metro areas of 50,000-999,999 population	8	(13.3%)	80	(22.6%)	
Nonmetropolitan or rural counties	8	(13.3%)	28	(7.9%)	
Zip Code Income Quartile					0.83
First quartile	18	(30.0%)	97	(27.4%)	
Second quartile	16	(26.7%)	81	(22.9%)	
Third quartile	12	(20.0%)	83	(23.4%)	
Fourth quartile	14	(23.3%)	93	(26.3%)	
Hospital Bed Size					0.65
Large	35	(58.3%)	195	(55.1%)	
Medium	11	(18.3%)	84	(23.7%)	
Small	14	(23.3%)	75	(21.2%)	
Hospital Control					0.50
Nonfederal government	7	(11.7%)	62	(17.5%)	
Private, nonprofit	45	(75.0%)	253	(71.5%)	
Private, invest-owned	8	(13.3%)	39	(11.0%)	
Concurrent abdominal contouring	9	(15.0%)	41	(11.6%)	0.59

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

Table 3. Comparison between Reduction Mammaplasty Procedures with and without Occurrence of Extended Length of Stay (>75th Percentile, or 2 d), Mean (SD), *n* (%)

	Extended Length of Stay (n = 56)		No Extended Length of Stay (n = 358)		*P*
Age (y)	48.6	(13.7)	44.7	(14.6)	0.056
Elixhauser Comorbidity Index	9.5	(10.5)	3.0	(6.3)	<0.001***
Race					0.012*
White	26	(46.4%)	186	(52.0%)	
Black	23	(41.1%)	88	(24.6%)	
Hispanic	2	(3.6%)	59	(16.5%)	
Other	5	(8.9%)	25	(7.0%)	
Payer Status					0.22
Medicare	16	(28.6%)	62	(17.3%)	
Medicaid	12	(21.4%)	79	(22.1%)	
Private insurance	21	(37.5%)	171	(47.8%)	
Other	7	(12.5%)	46	(12.8%)	
Rural–urban Density					0.37
Metropolitan counties with >1,000,000 population	42	(75.0%)	248	(69.3%)	
Counties in metro areas of 50,000-999,999 population	8	(14.3%)	80	(22.3%)	
Nonmetropolitan or rural counties	6	(10.7%)	30	(8.4%)	
Zip Code Income Quartile					0.12
First quartile	19	(33.9%)	96	(26.8%)	
Second quartile	18	(32.1%)	79	(22.1%)	
Third quartile	9	(16.1%)	86	(24.0%)	
Fourth quartile	10	(17.9%)	97	(27.1%)	
Hospital Bed Size					0.37
Large	34	(60.7%)	196	(54.7%)	
Medium	14	(25.0%)	81	(22.6%)	
Small	8	(14.3%)	81	(22.6%)	
Hospital Control					0.26
Nonfederal government	13	(23.2%)	56	(15.6%)	
Private, nonprofit	39	(69.6%)	259	(72.3%)	
Private, invest-owned	4	(7.1%)	43	(12.0%)	
Concurrent abdominal contouring	11	(19.6%)	39	(10.9%)	0.099

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

Income below the zip code median was also linked to extended lengths of stay after reduction mammaplasty. This trend has been supported in a diverse range of diagnoses and procedures, including hip fracture,[32] pediatric reduction mammaplasty,[11] and hip arthroplasty.[33] Previous studies have reasoned that patients with less financial resources may be less likely to consistently visit health care providers and more likely as a result to delay diagnosis or treatment. In this study, patients in the lower half of their zip code income distribution had an average comorbidity score of 4.0, which was only 0.3 points higher and not significantly different from wealthier patients with an average of 3.7 points. Given this information, such disparities in length of stay and eventually complications could be attributed to hospital-level factors as well; for example, patients with lower income may only have access to hospitals that have less experience in or capacity for reduction mammaplasty procedures.

Hospital-level factors, including bed size and ownership, were significant predictors only for high hospital charge. Although our model controlled for general comorbidity severity, hospitals with large bed capacities may also have been associated with the treatment of patients with more advanced progression of specifically macromastia and its associated symptoms, resulting in larger resource utilization and financial charges. Private for-profit hospitals were also a predictor of higher hospital charge; this trend is strongly supported by the profit-maximizing model of for-profit hospitals when compared with not-for-profit and government hospitals. This model has been associated with higher charges for the same Medicare diagnosis-related patient groups than other types of institutions.[34]

Rural-urban density displayed a diverging trend in prediction of postoperative complications, as smaller metropolitan counties protected against such risk and even smaller nonmetropolitan and rural counties exacerbated such risk when compared with the largest counties. The former medium-sized counties may show a lower risk of postoperative complication in comparison to the largest areas because the latter are more likely to host tertiary care centers that may accommodate patients with the most advanced progressions of macromastia. In contrast, the most rural counties may be associated with higher risk of complication because they may be

Table 4. Comparison between Reduction Mammaplasty Procedures with and without Occurrence of High Hospital Charge (>75th Percentile, or $70,396.50), Mean (SD), *n* (%)

	High Cost (n = 102)		No High Cost (n = 312)		*P* Value
Age (y)	46.2	(12.7)	44.9	(15.0)	0.40
Elixhauser Comorbidity Index	5.4	(8.9)	3.4	(6.7)	0.037*
Race					0.27
White	49	(48.0%)	163	(52.2%)	
Black	33	(32.4%)	78	(25.0%)	
Hispanic	16	(15.7%)	45	(14.4%)	
Other	4	(3.9%)	26	(8.3%)	
Payer Status					0.77
Medicare	21	(20.6%)	57	(18.3%)	
Medicaid	25	(24.5%)	66	(21.2%)	
Private insurance	43	(42.2%)	149	(47.8%)	
Other	13	(12.7%)	40	(12.8%)	
Rural–urban Density					0.28
Metropolitan counties with >1,000,000 population	77	(75.5%)	213	(68.3%)	
Counties in metro areas of 50,000-999,999 population	16	(15.7%)	72	(23.1%)	
Nonmetropolitan or rural counties	9	(8.8%)	27	(8.7%)	
Zip Code Income Quartile					0.47
First quartile	31	(30.4%)	84	(26.9%)	
Second quartile	27	(26.5%)	70	(22.4%)	
Third quartile	18	(17.6%)	77	(24.7%)	
Fourth quartile	26	(25.5%)	81	(26.0%)	
Hospital Bed Size					0.14
Large	63	(61.8%)	167	(53.5%)	
Medium	24	(23.5%)	71	(22.8%)	
Small	15	(14.7%)	74	(23.7%)	
Hospital Control					<0.001***
Nonfederal government	13	(12.7%)	56	(17.9%)	
Private, nonprofit	64	(62.7%)	234	(75.0%)	
Private, invest-owned	25	(24.5%)	22	(7.1%)	
Concurrent abdominal contouring	15	(14.7%)	35	(11.2%)	0.45

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

Table 5. Multivariate Binary Logistic Regression for Occurrence of Postoperative Complications

	Coefficient (SE)	Odds Ratio (95% CI)	*P*
Elixhauser Comorbidity Index	0.071 (0.008)	1.07 (1.06, 1.09)	<0.001***
Race (reference = White)			
Black	0.78 (0.15)	2.17 (1.62, 2.91)	<0.001***
Hispanic	-0.073 (0.22)	0.93 (0.60, 1.44)	0.74
Other	-0.67 (0.35)	0.51 (0.26, 1.01)	0.055
Rural–urban Density (reference = Metropolitan counties with >1,000,000 population)			
Counties in metro areas of 50,000-999,999 population	-0.67 (0.19)	0.51 (0.35, 0.75)	<0.001***
Nonmetropolitan or rural counties	0.67 (0.21)	1.95 (1.28, 2.96)	0.0017**

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

more closely associated with a limited availability of surgeons or less experience with reduction mammaplasty. The overall role of rural-urban density in postoperative complications has been unclear, as similar nationwide studies have depicted trends that differ depending on procedure, year, and anatomical region.[35–37] This relationship depicts the complex interactions between socioeconomic factors that must be considered in all health disparity analyses.

Notably, the severity of existing comorbidities, defined through the Elixhauser Comorbidity Index, were consistent clinical predictors of postoperative outcomes, and age was a significant predictor of extended length of stay. This demonstrates that clinical metrics remain critical in determining risk of adverse events and ensuring equitable care. However, it is also important to consider the interactions between sociodemographic characteristics and clinical manifestations; for example,

Table 6. Multivariate Binary Logistic Regression for Occurrence of Extended Length of Stay

	Coefficient (SE)	Odds Ratio (95% CI)	*P* Value
Age	0.014 (0.005)	1.01 (1.00, 1.02)	0.0078**
Elixhauser Comorbidity Index	0.089 (0.008)	1.09 (1.08, 1.11)	<0.001***
Race (reference = White)			
Black	0.54 (0.17)	1.72 (1.24, 2.39)	0.0011**
Hispanic	-1.43 (0.35)	0.24 (0.12, 0.47)	<0.001***
Other	0.45 (0.26)	1.57 (0.94, 2.62)	0.088
Zip Code Income Quartile (reference = fourth quartile)			
First quartile	0.75 (0.21)	2.12 (1.40, 3.21)	<0.001***
Second quartile	0.88 (0.21)	2.42 (1.61, 3.63)	<0.001***
Third quartile	-0.23 (0.24)	0.79 (0.50, 1.26)	0.33
Concurrent abdominal contouring	0.91 (0.19)	2.50 (1.71, 3.64)	<0.001***

**P* < 0.05.
***P* < 0.01.
****P* < 0.001.

Table 7. Multivariate Binary Logistic Regression for Occurrence of High Hospital Charge

	Coefficient (SE)	Odds Ratio (95% CI)	*P*
Elixhauser Comorbidity Index	0.037 (0.007)	1.04 (1.02, 1.05)	<0.001***
Hospital Bed Size (reference = large)			
Small	-1.16 (0.17)	0.31 (0.22, 0.44)	<0.001***
Medium	-0.31 (0.13)	0.73 (0.56, 0.95)	0.020*
Hospital Control (reference = private, nonprofit)			
Nonfederal government	-0.093 (0.16)	0.91 (0.67, 1.23)	0.55
Private, invest-owned	1.94 (0.17)	6.96 (5.02, 9.65)	<0.001***

**P* < 0.05.
***P* < 0.01.
****P* < 0.001.

the severity and prevalence of liver disease, one of the most heavily weighted components of the Elixhauser Comorbidity Index, has been associated with racial disparities in treatment and transplant.[38,39] This is due to the multifaceted interplay between medical conditions and socioeconomic gaps in multiple fields, including food security, access to prevention efforts, education, and geographic location.

The multiple socioeconomic disparities examined in this study are pervasive and not easily addressed in a systemic method; however, interventions to ensure health equity are necessary and implementable within health care systems. Hisam et al reviewed the existing literature about surgical disparities and suggested solutions that included condition-specific targeted interventions, surgical standardization, strengthening of provider-patient interactions, and promotion of cultural humility.[5] Targeted initiatives could be created to increase plastic surgeon density in rural areas and smaller hospitals to increase access to reduction mammaplasty procedures and decrease potential delay in treatment. These types of interventions may also decrease the risk of complications in these at-risk patients, and improve their overall outcomes. On an institutional scale, hospitals, especially those that are privately owned, could investigate pricing models for reduction mammaplasty that may alleviate financial burden for patients. In addition to these suggestions, more research regarding patient attitudes to treatment, access to treatment itself, and patient-provider relationships within plastic surgery is essential to appropriately design more effective interventions for health disparities.

This study had several limitations. Because the NIS records unique discharges rather than patients, it is possible that duplicate patients with separate admissions were included in our cohort. However, the prevalence of repeated reduction mammaplasty procedures has been noted to be rare in multiple institutional studies; as a result, this limitation is unlikely to affect the findings of this study given the magnitude of significance for predictor variables.[40–42] The indirect method of case identification with ICD-10 codes may have introduced procedure variability into the patient sample. The high prevalence of outpatient reduction mammaplasties indicates another limitation that restricts the generalizability of the findings of this study, which was conducted within an inpatient database.

Future studies of reduction mammaplasties could apply similar sociodemographic analyses to outpatient procedures in ambulatory surgery centers or private practices, as the payer composition and wealth distribution within these institutions have been shown to be markedly different from inpatient centers.[43] Additionally, future studies could also examine the impact of sociodemographic indicators on access to breast reduction itself for patients with macromastia. Such investigation is motivated by literature that has shown similar barriers of access in other plastic surgery procedures, such as breast reconstruction,[44] gender-affirming surgery,[45] and secondary cleft lip procedures.[46] Application of these analyses to reduction mammaplasty would likely provide additional information on the effects of health disparities in the various stages of patient care.

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DISCLOSURE

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this article.

REFERENCES

1. Plastic Surgery Statistics Report. American Society of Plastic Surgeons. 2020.
2. Amaral MH, Dao H, Shin JH. Racial and socioeconomic disparities in reduction mammoplasty: an analysis of Nationwide Inpatient Sample database. *Ann Plast Surg.* 2011;66:476–478.
3. Rogliani M, Gentile P, Labardi L, et al. Improvement of physical and psychological symptoms after breast reduction. *J Plast Reconstr Aesthet Surg.* 2009;62:1647–1649.
4. Mello AA, Domingos NAM, Miyazaki MC. Improvement in quality of life and self-esteem after breast reduction surgery. *Aesthetic Plast Surg.* 2010;34:59–64.
5. Saariniemi KMM, Keranen UH, Salminen-Peltola PK, et al. Reduction mammaplasty is effective treatment according to two quality of life instruments—A prospective randomized controlled trial. *J Plast Reconstr Aesthet Surg.* 2008;61:1472–1478.
6. Morrison KA, Frey JD, Karp N, et al. Revisiting reduction mammaplasty: Complications of oncoplastic and symptomatic macromastia reductions. *Plast Reconstr Surg.* 2023;151:267–276.
7. Liu D, Wu M, Xu X, et al. Risk factors and complications in reduction mammaplasty: a systematic review and meta-analysis. *Aesthetic Plast Surg.* 2023;47:2330–2344.
8. Waltho D, Gallo L, Gallo M, et al. Outcomes and outcome measures in breast reduction mammaplasty: a systematic review. *Aesthet Surg J.* 2020;40:383–391.
9. Morris MP, Christopher AN, Patel V, et al. Assessing disparities in reduction mammaplasty: there is room for improvement. *Aesthet Surg J.* 2021;41:NP796–NP803.
10. Haug V, Kadakia N, Wang AT, et al. Racial disparities in short-term outcomes after breast reduction surgery—A National Surgical Quality Improvement Project analysis with 23,268 patients using propensity score matching. *J Plast Reconstr Aesthet Surg.* 2022;75:1849–1857.
11. Soleimani T, Evans TA, Sood R, et al. Pediatric reduction mammaplasty: a retrospective analysis of the Kids Inpatient Database (KID). *Surgery.* 2015;158:793–801.
12. National Inpatient Sample. Healthcare Cost and Utilization Project (HCUP). 2016, 2017, 2018. Rockville, MD: agency for healthcare research and quality.
13. Elixhauser A, Steiner C, Harris DR, et al. Comorbidity measures for use with administrative data. *Med Care.* 1998;36:8–27.
14. Moore BJ, White S, Washington R, et al. Identifying increased risk of readmission and in-hospital mortality using hospital administrative data: the AHRQ Elixhauser Comorbidity Index. *Med Care.* 2017;55:698–705.
15. Schafer RE, Blazel MM, Nowacki AS, et al. Risk of complications in combined plastic surgery procedures using the Tracking Operations and Outcomes for Plastic Surgeons database. *Aesthet Surg J.* 2023;43:1384–1392.
16. Shammas RL, Ren Y, Thomas SM, et al. The association of overall annual hospital volume and perioperative outcomes following free flap breast reconstruction. *Plast Reconstr Surg.* 2021;147:196e–206e.
17. Billig JI, Lu Y, Momoh AO, et al. A nationwide analysis of cost variation for autologous free flap breast reconstruction. *JAMA Surg.* 2017;152:1039–1047.
18. Python [Computer Software]. Version 3.9. Python Software Foundation; 2020. Available at http://python.org.
19. Jud SM, Brendle-Behnisch A, Hack CC, et al. Macromastia: an economic burden? A disease cost analysis based on real-world data in Germany. *Arch Gynecol Obstet.* 2021;303:521–531.
20. Khubchandani JA, Shen C, Ayturk D, et al. Disparities in access to emergency general surgery care in the United States. *Surgery.* 2018;163:243–250.
21. Hisam B, Zogg CK, Chaudhary MA, et al. From understanding to action: interventions for surgical disparities. *J Surg Res.* 2016;200:560–578.
22. Baxter NB, Howard JC, Chung KC. A systematic review of health disparities research in plastic surgery. *Plast Reconstr Surg.* 2021;147:529–537.
23. Webster TK, Baltodano PA, Lu X, et al. Nationally validated scoring system to predict unplanned reoperation and readmission after breast reduction. *Aesthetic Plast Surg.* 2022;46:2140–2151.
24. Liu H, Akhavan A, Ibelli T, et al. Using the modified frailty index to predict complications in breast reduction: a National Surgical Quality Improvement Program study of 14,160 cases. Aesthet Surg J*i* 2022;42:890–899.
25. Simpson AM, Donato DP, Kwok AC, et al. Predictors of complications following breast reduction surgery: a national surgical quality improvement program study of 16,812 cases. J Plast Reconstr Aesthet Surg. 2019;72:43–51.
26. Lewin R, Göransson M, Elander A, et al. Risk factors for complications after breast reduction surgery. *J Plast Surg Hand Surg.* 2014;48:10–14.
27. Ogunleye AA, Leroux O, Morrison N, et al. Complications after reduction mammaplasty: a comparison of Wise pattern/inferior pedicle and vertical scar/superomedial pedicle. *Ann Plast Surg.* 2017;79:13–16.
28. Martin MS, Kebede S, Saad OA, et al. Impact of socioeconomic status on breast reconstruction outcomes. *Ann Plast Surg.* 2022;88(5 Suppl 5):S481–S484.
29. Wu RT, Peck CJ, Shultz BN, et al. Racial disparities in cleft palate repair. *Plast Reconstr Surg.* 2019;143:1738–1745.
30. Massey GG, Firriolo JM, Nuzzi LC, et al. Risk factors associated with severe macromastia among adolescents and young women. *Plast Reconstr Surg.* 2022;150:1212–1218.
31. Chesley CF, Chowdhury M, Small DS, et al. Racial disparities in length of stay among severely ill patients presenting with sepsis and acute respiratory failure. *JAMA Netw Open.* 2023;6:e239739.
32. Milto AJ, El Bitar Y, Scaife SL, et al. Differences in hospital length of stay and total hospital charge by income level in patients hospitalized for hip fractures. *Osteoporos Int.* 2022;33:1067–1078.
33. El Bitar YF, Illingworth KD, Scaife SL, et al. Hospital length of stay following primary total knee arthroplasty: Data from the National Inpatient Sample database. *J Arthroplasty.* 2015;30:1710–1715.
34. Hall BM, Odum SM, Fehring TK, et al. Differences in hospital billing for total joint arthroplasty based on hospital profit status. *J Arthroplasty.* 2016;31:37–40.
35. Thomas HM, Jarman MP, Mortensen S, et al. The role of geographic disparities in outcomes after orthopaedic trauma surgery. *Injury.* 2023;54:453–460.
36. Al Jammal OM, Shahrestani S, Delavar A, et al. Demographic predictors of treatments and surgical complications of lumbar degenerative diseases: an analysis of over 250,000 patients from the National Inpatient Sample. *Medicine (Baltim).* 2022;101:e29065.
37. Weidman AA, Kim E, Valentine L, et al. Outcomes of patients in rural communities undergoing autologous breast reconstruction: a comparison of cost and patient demographics with implications for rural health policy. *Microsurgery.* 2024;44:e31052.
38. Kardashian A, Serper M, Terrault N, et al. Health disparities in chronic liver disease. *Hepatology.* 2023;77:1382–1403.

39. Ross-Driscoll K, Kramer M, Lynch R, et al. Variation in racial disparities in liver transplant outcomes across transplant centers in the United States. *Liver Transpl*. 2021;27:558–567.
40. Spaniol JR, Buchanan PJ, Greco RJ. Secondary reduction mammaplasty: Does initial pedicle design matter? *J Plast Surg Hand Surg*. 2019;53:105–110.
41. Hudson DA, Skoll PJ. Repeat reduction mammaplasty. *Plast Reconstr Surg*. 1999;104:401–408.
42. Losee JE, Caldwell EH, Serletti JM. Secondary reduction mammaplasty: is using a different pedicle safe? *Plast Reconstr Surg*. 2000;106:1004–1008; discussion 1009.
43. Zhao Y, Paschalidis IC, Hu J. The impact of payer status on hospital admissions: Evidence from an academic medical center. *BMC Health Serv Res*. 2021;21:930.
44. Retrouvey H, Solaja O, Gagliardi AR, et al. Barriers of access to breast reconstruction: a systematic review. *Plast Reconstr Surg*. 2019;143:465e–476e.
45. Tabaac AR, Jolly D, Boskey ER, et al. Barriers to gender-affirming surgery consultations in a sample of transmasculine patients in Boston, Mass. *Plast Reconstr Surg Glob Open*. 2020;8:e3008.
46. Phillip S, Hauc SC, Sasson DC, et al. Sociodemographic disparities in access to cleft rhinoplasty. *J Craniofac Surg*. 2023;34:92–95.