SPECIAL TOPIC

Effect of Regional Hospital Market Competition on Use Patterns of Free Flap Breast Reconstruction

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Background: Market competition is believed to promote patient access and health care delivery. The authors examined the relationship between market competition and use of surgical services for cancer, using free flap immediate breast reconstruction as a model scenario.

Methods: This retrospective cross-sectional analysis of the 2008 to 2011 Nationwide Inpatient Sample identified female patients undergoing immediate breast reconstruction. The Herfindahl-Hirschman Index was used to describe hospital markets as competitive or consolidated. The relationship between market competition and free flap immediate breast reconstruction use was explored using a hierarchical model before and after race stratification.

Results: Seven thousand three hundred seventy-two (10.7 percent) of 68,966 patients underwent free flap immediate breast reconstruction. A consolidated market was associated with 35 percent lower odds of free flap immediate breast reconstruction (95 percent CI, 0.43 to 0.97). Undergoing an operation in a later year [OR, 1.40; 95 percent CI (per year), 1.21 to 1.63], nonwhite race (OR, 1.33; 95 percent CI, 1.10 to 1.60), private insurance (OR, 2.09; 95 percent CI, 1.59 to 2.76), and teaching hospital status (OR, 2.67; 95 percent CI, 1.73 to 4.13) were associated with higher rates of free flap reconstruction. Market consolidation was associated with 48 percent lower odds of undergoing free flap immediate breast reconstruction in nonwhite patients only (95 percent CI, 0.29 to 0.92).

Conclusions: A hospital's willingness to provide surgical services may be subject to market pressures. Market competition is associated with increased odds of free flap immediate breast reconstruction and higher use by racial minorities. (*Plast. Reconstr. Surg.* 142: 1438, 2018.)

In recent years, hospital systems in the United States have become increasingly consolidated.[1] At present, nearly 50 percent of U.S. hospital market organization can be characterized as consolidated or less competitive,[2] and 561 hospital mergers have transpired since 2010.[1] Protecting marketplace competition, through the use of antitrust regulation, is a primary goal of executive agencies such as the Federal Trade Commission.[3] Among policy experts and health economists, there is a tacit consensus that a competitive marketplace translates into improved patient choice and access.[1] However, few studies have scrutinized the impact of market competition on the use of health care services, in particular for cancer.[4–6]

Free flap immediate breast reconstruction techniques have grown in popularity in recent years.[7,8] These procedures are for women who are not ideal candidates for implant-based reconstruction (i.e., large breast volume, adjuvant

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radiotherapy) or who simply desire autologous tissue for breast reconstruction, typically the lower abdomen soft tissue and skin.[9] Of particular interest is that this health care service bears unique characteristics that render it susceptible to market-level forces. First, it is not universally available (as in the case of a tissue expander) because it is technically complicated, resource-intensive, and requires fellowship training for plastic surgeons to become proficient. In other words, patients need to shop around to find a provider (i.e., microvascular-trained reconstructive surgeon) and an institution that perform free flap immediate breast reconstruction. Second, it is never performed emergently and is usually prearranged weeks in advance, to facilitate the appropriate workup and operative planning (i.e., preoperative computed tomographic angiography imaging for vessel identification and booking an operating room for an entire day). Third, patients pursuing free flap breast reconstruction, relative to other forms of breast reconstruction (i.e., implants and pedicled flaps), are well-informed decision-makers and significantly more likely to be self-referred.[10] Lastly, the decision about whether to pursue free flap breast reconstruction of a postmastectomy defect is optional and preference sensitive. These characteristics make free flap immediate breast reconstruction *relatively* analogous to a market good, and place it in sharp relief from most other surgical procedures. For example, an active smoker in need of a colectomy will not be dissuaded from the procedure or told to refrain from smoking for at least 4 weeks before surgery, whereas such recommendations are routine for breast free flap patients.

Beyond the fact that there is a dearth of studies looking at the effects of hospital market competition, the available data systematically assume that its effects across a population group (i.e., age, gender, and race) are uniform.[4–6] As a result, much of the findings are reported at the aggregate level and not according to subgroups. This is critical because there is sufficient evidence to show that racial disparities already exist in the use of free flap immediate breast reconstruction. Population-based and single-institution studies have shown that minority patients are significantly less likely to be recipients of immediate breast reconstruction overall[11–14] and more likely to undergo a free flap immediate breast reconstruction.[11,15]

The aim of the present study is twofold. First, we examine how market competition influences the use of preference-sensitive procedures such as free flap immediate breast reconstruction. Second, we study whether market competition is a determinant of racial/ethnic disparities in free flap immediate breast reconstruction by looking at use trends, between consolidated and competitive markets, by race. This information will help inform the current debate about the degree of market competition, and in turn regulation, that is necessary to ensure adequate health care delivery.

PATIENTS AND METHODS

Study Population

Adult (aged 18 years or older) female patients who underwent mastectomy and immediate breast reconstruction were identified in the Nationwide Inpatient Sample for the years 2008 to 2011 using the respective *International Classification of Disease, Ninth Revision*, codes.[16] The inclusion of specific coding to identify microvascular breast reconstruction was widely used only beginning in the 2008 Nationwide Inpatient Sample, rendering prior years unsuitable for our analysis. The Nationwide Inpatient Sample, which is maintained by the Agency for Healthcare Research and Quality, is part of the Healthcare Cost and Utilization Project.[17] Thus, it is publicly available, deidentified, and compliant with the Health Insurance Portability and Accountability Act of 1996. The Nationwide Inpatient Sample is a stratified random sample of hospitals represented in all state inpatient databases and represents approximately 20 percent of all hospital discharges in the United States.[17] The study was approved by the Johns Hopkins University Institutional Review Board.

Patients undergoing immediate breast reconstruction were stratified into those undergoing free flap (free flap immediate breast reconstruction) and non–free flap reconstruction. Consistent with prior descriptions of trends in breast reconstruction, patients undergoing delayed free flap reconstruction (i.e., not performed at the same time as the mastectomy) accounted for a small proportion of cases and were excluded from analysis.[7] We observed that over 95 percent of operations were performed in urban hospitals in markets of 200 hospitals or fewer. Rural hospital markets accounted for less than 4 percent of free flap immediate breast reconstruction cases. In addition, rural markets can be thought of as "natural monopolies" in light of the very low density of

hospitals and providers in these areas (i.e., critical access hospitals). To simplify our analysis, we consequently limited our study sample to only urban hospitals.

Patient comorbidity during the inpatient hospital stay was assessed using the Charlson Comorbidity Index, calculated using a predefined algorithm.[18] Additional patient-level risk factors including age, race, income level, primary insurance payer, obesity (*International Classification of Disease, Ninth Revision*, code 278.0x), diabetes (*International Classification of Disease, Ninth Revision*, code 250.xx), or a history of smoking (*International Classification of Disease, Ninth Revision*, code 305.1) were abstracted from the Nationwide Inpatient Sample data set. Hospital characteristics including urban versus rural, U.S. region, teaching status, bedsize category, not-for-profit status, and membership in a multihospital system were determined using the American Hospital Association Linkage Files provided by the Healthcare Cost and Utilization Project. Overall and free flap annual hospital volume was categorized at the third tercile to identify "high-volume" centers.

Hospital markets were specified using a variable-radius definition. The variable radius is the area around a hospital from which 75 percent of discharge zip codes are drawn.[5,6] Within each of these markets, the degree of hospital-level competition was determined with the Herfindahl-Hirschman Index. The Herfindahl-Hirschman Index is calculated by summing the squares of the fraction of discharges from each hospital in the market. The Herfindahl-Hirschman Index is a validated and widely applied metric of market competition, which indicates the degree to which any one "entity" (i.e., "hospital") possesses a disproportionate share of consumers (i.e., patients).[19] A smaller Herfindahl-Hirschman Index means a market has more hospitals with a share of the patient population (i.e., that market is more competitive). In turn, a higher Herfindahl-Hirschman Index means a market has fewer hospitals with a share of the patient population (i.e., the market is consolidated). Prior studies have used the Herfindahl-Hirschman Index to examine the influence of hospital market competition on the provision of surgical procedures (e.g., renal transplantation,[4] robotic hysterectomy,[5] and abdominal aneurysm repair).[6]

For our analysis, the Herfindahl-Hirschman Index was evaluated as a categorical variable, dichotomized at 0.25, with a Herfindahl-Hirschman Index greater than 0.25 considered to be a consolidated market.[20] Our selected cutoff point for the Herfindahl-Hirschman Index is consistent with existing federal labor standards/guidelines, as outlined by the Department of Justice and the Federal Trade Commission, for determining the competitiveness of a marketplace.[20] The inverse of the Herfindahl-Hirschman Index is referred to as the "effective number of firms" and describes the number of new market participants with equal market share that would be needed to create a balanced and competitive market. It was used in place of the Herfindahl-Hirschman Index because it facilitates the examination of market concentration as a continuous variable.[21]

Statistical Analysis

Continuous variables were examined as means and standard deviations or medians with interquartile range and evaluated using the *t* test or nonparametric Kruskal-Wallis test. Categorical variables were compared using Pearson chi-square or Fisher's exact test, as appropriate. Frequency estimates across categories were obtained using sampling weights published by the Nationwide Inpatient Sample. Pearson correlation coefficients were calculated between total immediate breast reconstruction caseload and hospital Herfindahl-Hirschman Index (log-transformed) after hospitals were stratified by the total fraction of cases that were free flap cases.

The odds of undergoing free flap immediate breast reconstruction versus other forms of breast reconstruction after mastectomy were modeled using a multivariable hierarchical logistic regression model, with patients clustered within hospitals (random intercept: hospital identification number). To account for trends in overall use of free flap immediate breast reconstruction, the year of operation was included as a covariate. We also adjusted for total immediate breast reconstruction volume per hospital per year. Subanalyses were conducted in which patients were stratified by race (white/nonwhite), to assess whether the association between receipt of free flap and market concentration varied across racial/ethnic groups. Nonwhite race consisted of black, Hispanic, Asian, and Native American patients. In all hierarchical models, the continuous variables were centered at the mean to preserve model interpretability. Design weights were rescaled to accommodate the hierarchical nature of the model and applied at the patient and hospital levels, as previously described for pooling data across multiple years of the Nationwide Inpatient Sample.[22] Model parameters were exponentiated

to obtain odds ratios. All analyses were conducted using Stata 14.0 MP (StataCorp LP, College Station, Texas), and a two-tailed value of $p < 0.05$ was used to determine statistical significance.

RESULTS

Patient and Hospital Characteristics

A weighted total of 68,966 immediate breast reconstruction patients were identified over the study period. Of these patients, 70.2 percent ($n = 48{,}408$) received their care in competitive markets where a significantly increased use of free flap immediate breast reconstruction occurred (12.8 percent versus 5.7 percent). We noted that 10.7 percent ($n = 7372$) of all immediate breast reconstruction patients underwent free flap immediate breast reconstruction. The median patient age was 51 years (interquartile range, 45 to 59 years), and 79.4 percent of patients underwent immediate breast reconstruction because of cancer. We observed that patients in competitive markets were less likely to have a diagnosis of obesity or active tobacco use and more likely to be a racial minority. Over three-quarters of immediate breast reconstruction patients [$n = 53{,}347$ (77.4 percent)] had private insurance as the primary payer.

In competitive markets, a greater proportion of patients had their reconstruction performed in a teaching hospital. Hospitals in competitive markets were typically high-volume institutions for immediate breast reconstruction and geographically positioned along the U.S. Northeast corridor and West Coast (Table 1). Among hospitals that did not perform a significant volume of free flap immediate breast reconstruction (<10 percent of total immediate breast reconstruction volume), increasing market competition was still associated with higher annual immediate breast reconstruction volume (correlation coefficient, −0.29).

Factors Associated with Receipt of Free Flap

A consolidated hospital market was associated with lower odds of receipt of free flap immediate breast reconstruction (reference: competitive hospital market, OR, 0.65; 95 percent CI, 0.43 to 0.97; $p = 0.037$). A separate multivariable analysis that examined hospital market competition as the effective number of firms in the market (the inverse of the Herfindahl-Hirschman Index) found that, for every additional five hospitals in a hospital's market, the odds of receipt of free flap immediate breast reconstruction increased significantly (OR, 1.23; 95 percent CI, 1.07 to 1.41; $p = 0.004$) (Table 2).

After adjustment for hospital-level market competition on multivariable analysis, undergoing an operation in a later year of the study period was associated with increased odds of undergoing free flap immediate breast reconstruction. Similarly, nonwhite race, obesity, private insurance, hospitals in the largest bedsize category, and teaching hospitals were all associated with increased free flap immediate breast reconstruction. In contrast, a hospital's participation in a multihospital system was associated with a lower odds of undergoing free flap immediate breast reconstruction.

Association between Receipt of Free Flap Reconstruction and Race and Hospital Market Concentration

Patients were then stratified by race, and the association between hospital market competition and free flap reconstruction was examined in hierarchical logistic regression models. Hospital market consolidation was associated with decreased odds of free flap immediate breast reconstruction in nonwhite patients (reference: competitive market, OR, 0.52; 95 percent CI, 0.29 to 0.92; $p = 0.024$). This relationship between hospital market competition and receipt of free flap immediate breast reconstruction was not reproduced in white patients [reference: competitive market; OR (consolidated market), 0.73; 95 percent CI, 0.46 to 1.15; $p = 0.17$). In addition, among white patients, a hospital's participation in a multihospital system was associated with lower odds of receipt of free flap immediate breast reconstruction (OR, 0.56; 95 percent CI, 0.35 to 0.90; $p = 0.016$) (Table 3).

In both white and nonwhite patients, an operation in a later year was associated with increased odds of undergoing free flap immediate breast reconstruction. Similarly, undergoing an operation at a teaching hospital, or at a hospital in the largest bed size category, was allied with increased odds of free flap immediate breast reconstruction. Private and Medicaid insurance were also noted to be associated with over double the odds of undergoing free flap immediate breast reconstruction for white patients only.

DISCUSSION

The results herein indicate that a competitive marketplace is independently associated with the following tangible gains: (1) 35 percent increased odds of free flap immediate breast reconstruction overall; and (2) greater use of free flap immediate breast reconstruction for racial minorities and Medicaid beneficiaries. For every additional

Table 1. Demographic and Clinical Characteristics of Patients in the 2008 to 2011 Nationwide Inpatient Sample Undergoing Breast Reconstruction after Mastectomy, Stratified by Hospital Market Competition

	Competitive (HHI ≤ 0.25) (%)	Consolidated (HHI > 0.25) (%)	Total (%)	*p*
No.	48,408	20,559	68,966	
Operation				<0.001
Non–free flap	42,209 (87.2)	19,385 (94.3)	61,595 (89.3)	
Free flap	6198 (12.8)	1174 (5.7)	7372 (10.7)	
Charlson Comorbidity Index				0.13
≤1	9818 (20.3)	3856 (18.8)	13,674 (19.8)	
2	24,867 (51.4)	11,052 (53.8)	35,919 (52.1)	
≥3	13,723 (28.3)	5651 (27.5)	19,373 (28.1)	
Obesity diagnosis				0.11
Nonobese	45,469 (93.9)	19,093 (92.9)	64,562 (93.6)	
Obese	2939 (6.1)	1466 (7.1)	4404 (6.4)	
Diabetes diagnosis				0.016
Absent	45,500 (94.0)	19,070 (92.8)	64,570 (93.6)	
Present	2908 (6.0)	1489 (7.2)	4396 (6.4)	
Smoking status				0.011
Nonsmoker	41,756 (86.3)	17,136 (83.4)	58,892 (85.4)	
Smoker	6652 (13.7)	3422 (16.6)	10,074 (14.6)	
Indication				0.28
Cancer	38,292 (79.1)	16,496 (80.2)	54,788 (79.4)	
DCIS/LCIS	10,116 (20.9)	4062 (19.8)	14,178 (20.6)	
Race				<0.001
White	35,684 (73.7)	17,265 (84.0)	52,949 (76.8)	
Nonwhite minority	12,724 (26.3)	3293 (16.0)	16,017 (23.2)	
Insurance status				<0.001
Medicare	5757 (11.9)	3332 (16.2)	9089 (13.2)	
Medicaid	3122 (6.4)	1100 (5.4)	4222 (6.1)	
Private	37,881 (78.3)	15,466 (75.2)	53,347 (77.4)	
Other	1648 (3.4)	661 (3.2)	2309 (3.3)	
Hospital region				0.030
Northeast	7370 (15.2)	2729 (13.3)	10,099 (14.6)	
Midwest	6014 (12.4)	4657 (22.7)	10,671 (15.5)	
South	19,837 (41.0)	9093 (44.2)	28,930 (41.9)	
West	15,186 (31.4)	4081 (19.9)	19,267 (27.9)	
Teaching status				<0.001
Nonteaching	14,917 (30.8)	12,446 (60.5)	27,364 (39.7)	
Teaching	33,490 (69.2)	8112 (39.5)	41,602 (60.3)	
Hospital bedsize				0.09
Small	5215 (10.8)	2840 (13.8)	8055 (11.7)	
Medium	9064 (18.7)	5525 (26.9)	14,589 (21.2)	
Large	34,129 (70.5)	12,194 (59.3)	46,323 (67.2)	
Hospital ownership/control				0.76
Public or private not-for-profit	43,031 (88.9)	18,486 (89.9)	61,517 (89.2)	
Private for-profit	5377 (11.1)	2073 (10.1)	7450 (10.8)	
Hospital procedural volume				<0.001
Low-volume	4853 (10.0)	7805 (38.0)	12,658 (18.4)	
High-volume	43,555 (90.0)	12,754 (62.0)	56,308 (81.6)	
Hospital is part of a multihospital system				0.19
No	12,644 (26.1)	6828 (33.2)	19,473 (28.2)	
Yes	35,763 (73.9)	13,730 (66.8)	49,494 (71.8)	
Age, yr				
Median	51	52	51	
IQR	45–59	45–61	45–59	

HHI, Herfindahl-Hirschman Index; DCIS, ductal carcinoma in situ; LCIS, lobular carcinoma in situ; IQR, interquartile range.

five hospitals that were introduced into a hospital market, the odds of free flap immediate breast reconstruction receipt increased by 23 percent. In other words, market competition was associated with greater distribution of a surgical service among a population.

There are a few reasons why increased market competition translates into enhanced use of free flap immediate breast reconstruction, especially among racial minorities. First (and most clearly), competition may be driven by the entry into the market of a new provider (i.e., hospital) that offers a profitable service line to a broad payer mix and patient population to generate revenue.[4] In the present study, obese patients, Medicaid beneficiaries, and racial minorities were more likely to be

Table 2. Results of Univariable Analyses and Hierarchical Logistic Regression Models of Receipt of Free Flap Reconstruction*

	Univariable Analysis		Multivariable Analyses: Hospital Market Competition as Categorical Variable		Multivariable Analyses: Hospital Market Competition as "Effective Number of Firms"	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Age, yr	0.99 (0.99–1.00)	0.010	1.01 (1.00–1.01)	0.12	1.01 (1.00–1.01)	0.12
Year	1.30 (0.98–1.71)	0.07	1.40 (1.21–1.63)	<0.001	1.40 (1.21–1.63)	<0.001
Charlson Comorbidity Index						
≤1	Reference		Reference		Reference	
2	0.77 (0.66–0.90)	0.001	1.00 (0.46–2.16)	1.00	1.00 (0.46–2.16)	1.00
≥3	0.53 (0.44–0.65)	<0.001	0.73 (0.33–1.60)	0.43	0.73 (0.33–1.61)	0.43
Nonobese	Reference		Reference		Reference	
Obese	1.26 (0.88–1.81)	0.20	1.63 (1.27–2.10)	<0.001	1.64 (1.27–2.11)	<0.001
No diabetes	Reference		Reference		Reference	
Diabetes	0.97 (0.77–1.24)	0.83	1.15 (0.85–1.56)	0.37	1.15 (0.85–1.56)	0.37
Smoking history absent	Reference		Reference		Reference	
Positive smoking history	0.81 (0.62–1.07)	0.13	1.10 (0.92–1.31)	0.28	1.10 (0.92–1.31)	0.28
Insurance status						
Medicare	Reference		Reference		Reference	
Medicaid	1.59 (1.14–2.21)	0.007	1.68 (1.08–2.62)	0.022	1.69 (1.08–2.63)	0.021
Private	1.92 (1.53–2.40)	<0.001	2.09 (1.59–2.76)	<0.001	2.09 (1.59–2.76)	<0.001
Other	1.56 (1.01–2.42)	0.045	1.28 (0.79–2.08)	0.31	1.29 (0.79–2.09)	0.31
Race						
White	Reference		Reference		Reference	
Nonwhite minority	1.71 (1.37–2.14)	<0.001	1.33 (1.10–1.60)	0.003	1.33 (1.10–1.61)	0.004
Indication						
Cancer	Reference		Reference		Reference	
DCIS/LCIS	1.45 (1.27–1.66)	<0.001	1.26 (0.60–2.67)	0.54	1.26 (0.60–2.67)	0.54
Hospital region						
Northeast	Reference		Reference		Reference	
Midwest	1.62 (0.90–2.94)	0.11	1.17 (0.65–2.10)	0.59	1.13 (0.63–2.04)	0.68
South	2.09 (1.01–4.31)	0.046	1.25 (0.76–2.05)	0.39	1.30 (0.79–2.13)	0.31
West	1.07 (0.61–1.90)	0.81	1.06 (0.61–1.86)	0.83	1.10 (0.63–1.91)	0.74
Hospital teaching status						
Nonteaching	Reference		Reference		Reference	
Teaching	3.00 (1.89–4.77)	<0.001	2.67 (1.73–4.13)	<0.001	2.57 (1.66–3.98)	<0.001
Hospital bedsize						
Small	Reference		Reference		Reference	
Medium	1.31 (0.71–2.42)	0.39	1.31 (0.72–2.39)	0.38	1.36 (0.74–2.48)	0.32
Large	2.64 (1.44–4.84)	0.002	2.01 (1.19–3.39)	0.009	2.00 (1.19–3.38)	0.009
Hospital ownership/control						
Public or private not-for-profit	Reference		Reference		Reference	
Private for-profit	3.64 (1.23–10.83)	0.020	1.41 (0.76–2.64)	0.28	1.41 (0.76–2.63)	0.28
Hospital procedural volume						
Low-volume	Reference		Reference		Reference	
High-volume	1.95 (1.26–3.01)	0.003	1.02 (0.69–1.52)	0.91	1.02 (0.68–1.53)	0.93
Hospital market competition						
HHI ≤ 0.25	Reference		Reference		—	—
HHI > 0.25	0.41 (0.26–0.65)	<0.001	0.65 (0.43–0.97)	0.037	—	—
Effective no. of hospitals (every 5)	1.15 (1.00–1.33)	0.05	—	—	1.23 (1.07–1.41)	0.004
Part of multihospital system						
No	Reference		Reference		Reference	
Yes	1.20 (0.71–2.01)	0.49	0.67 (0.46–0.97)	0.032	0.68 (0.47–0.98)	0.040

DCIS, ductal carcinoma in situ; LCIS, lobular carcinoma in situ; HHI, Herfindahl-Hirschman Index.
*Hospital market competition has been modeled both as a categorical variable (HHI ≤0.25 or >0.25) and as the effective number of firms (1/HHI).

free flap recipients in competitive markets relative to consolidated markets. Marketplace competition therefore produces strong economic incentives, a powerful lever for behavioral change,[23] which in turn drives hospitals to offer free flap reconstruction to as many patients as possible. This raises the possibility that provider-induced demand might partially underpin the finding of increased free flap immediate breast reconstruction in competitive markets, especially among minority patients.[24]

After stratification by race, increased market competition translated into increased free flap immediate breast reconstruction use by only racial minority patients. This is an important finding

Table 3. Results of Hierarchical Logistic Regression Models of Receipt of Free Flap Reconstruction, Stratified by Race

	White		Nonwhite Minority	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Age, yr	1.01 (1.01–1.02)	0.001	0.99 (0.98–1.01)	0.21
Year	1.34 (1.13–1.59)	0.001	1.56 (1.28–1.88)	<0.001
Charlson Comorbidity Index				
≤1	Reference		Reference	
2	1.24 (0.53–2.88)	0.62	0.68 (0.17–2.78)	0.59
≥3	0.90 (0.38–2.15)	0.82	0.51 (0.13–2.09)	0.35
Nonobese	Reference		Reference	
Obese	1.45 (1.08–1.96)	0.015	2.13 (1.41–3.23)	<0.001
No diabetes	Reference		Reference	
Diabetes	0.87 (0.58–1.31)	0.50	1.71 (1.04–2.80)	0.033
Smoking history absent	Reference		Reference	
Positive smoking history	1.10 (0.89–1.35)	0.39	1.10 (0.73–1.64)	0.66
Insurance status				
Medicare	Reference		Reference	
Medicaid	2.17 (1.26–3.72)	0.005	0.94 (0.46–1.89)	0.85
Private	2.59 (1.89–3.57)	<0.001	1.46 (0.85–2.49)	0.17
Other	1.22 (0.72–2.06)	0.47	1.15 (0.48–2.73)	0.76
Indication				
Cancer	Reference		Reference	
DCIS/LCIS	1.56 (0.68–3.56)	0.29	0.96 (0.24–3.84)	0.95
Hospital region				
Northeast	Reference		Reference	
Midwest	1.15 (0.60–2.21)	0.68	2.62 (1.08–6.36)	0.033
South	1.25 (0.71–2.22)	0.44	1.37 (0.69–2.72)	0.37
West	1.19 (0.62–2.27)	0.60	0.80 (0.37–1.74)	0.57
Hospital teaching status				
Nonteaching	Reference		Reference	
Teaching	3.17 (1.91–5.25)	<0.001	2.07 (1.18–3.65)	0.012
Hospital bedsize				
Small	Reference		Reference	
Medium	1.12 (0.56–2.26)	0.75	2.03 (0.84–4.92)	0.12
Large	1.87 (1.03–3.41)	0.041	2.79 (1.24–6.29)	0.014
Hospital ownership/control				
Public or private not-for-profit	Reference		Reference	
Private for-profit	1.60 (0.75–3.40)	0.23	1.46 (0.66–3.22)	0.35
Hospital procedural volume				
Low-volume	Reference		Reference	
High-volume	1.06 (0.67–1.69)	0.79	1.04 (0.61–1.78)	0.88
Part of a multihospital system				
No	Reference		Reference	
Yes	0.56 (0.35–0.90)	0.016	0.92 (0.53–1.61)	0.77
Hospital market competition				
HHI ≤ 0.25	Reference		Reference	
HHI > 0.25	0.73 (0.46–1.15)	0.17	0.52 (0.29–0.92)	0.024

DCIS, ductal carcinoma in situ; LCIS, lobular carcinoma in situ; HHI, Herfindahl-Hirschman Index.

because racial minority patients are already significantly more likely to undergo free flap immediate breast reconstruction.[11,15] A 2015 population-based study found higher odds of free flap immediate breast reconstruction receipt among Hispanics (OR, 1.66) and blacks (OR, 2.13) compared to whites. Therefore, market competition has an unintended consequence of widening or increasing preexisting racial differences in the use of free flap immediate breast reconstruction.[11,15] Future antitrust initiatives (designed to promote competition) in health care markets should be mindful of this downstream effect.

Why these differences exist in the first place is tough to discern given the fact that breast reconstruction is a preference-sensitive condition. However, there is compelling evidence that free flap immediate breast reconstruction techniques (and autologous breast reconstruction, more generally) are more consistent with the norms related to femininity and appearance among racial minorities.[25] Our results are also consistent with published work that identified market competition as associated with increased use of surgical services that are sensitive to patient and provider preferences. These include an increased uptake

of endovascular (versus open) aneurysm repair[6] and robotic procedures.[5]

We noted that hospitals in competitive markets, typically large and with an academic affiliation, had (1) a predilection for free flap immediate breast reconstruction and (2) a greater overall clinical volume of immediate breast reconstruction (Table 1). These phenomena may be attributable to attribution of a significant amount of institutional resources to a particular profitable service line (i.e., free flap breast reconstruction).[6] Competition spurs an increased investment in innovative products and care processes as a means of maximizing market share and profits (i.e., a medical arms race).[2] Technologic advances such as light spectroscopy for flap monitoring and process innovations such as a uniform postoperative care pathway for free flaps are able to generate efficiency gains, which in turn allow for care provision to more patients. Although plastic surgeons working in these academic institutions are likely to be salaried, the use of productivity-based contractual agreements and insurance "carve-outs" can generate sufficient incentives for employed surgeons to perform free flap immediate breast reconstruction. Future study in this area is warranted.

Our finding that participation in a multihospital system is associated with lower odds of free flap immediate breast reconstruction, among white patients, suggests that the ongoing wave of hospital mergers into larger networks is not accompanied by a decentralization of specialized care (i.e., improved patient access and use), at least as it pertains to free flap immediate breast reconstruction. It is possible that increased multihospital system representation in a regional market serves to reduce the number of independent hospital owners, which in turn weakens the competitive landscape. Although provider efficiencies from economies of scale and improved care coordination have been ascribed to hospital mergers, its impact on patient access has yet to be systematically examined. Further research inquiry in this arena is needed and beyond the scope of the present study.

This study is subject to limitations that warrant acknowledgment. First, the use of an administrative data set limits our ability to demonstrate causality. Second, several patient and hospital-level factors associated with free flap use are not captured in the data set (e.g., cancer stage, availability of a staff plastic surgeon able to perform free flaps, and number of payers in a market). Specifically, our data do not span a period that is sufficient to assess whether changes in market structure led to changes in hospital organization, which in turn altered the availability of providers within academic institution or incentivized the creation of niche practices within nonacademic institutions that could furnish free flap immediate breast reconstruction. The use of the Herfindahl-Hirschman Index as a proxy for competition, although validated and widely accepted, may not fully capture the peculiarities of hospital markets, as it does not fully account for hospital networks or strategic partnerships.[6] Finally, our study did not examine the role of third-party payers, whose variable willingness to reimburse physicians for a more specialized procedure might influence the use of free flap breast reconstruction.

Our study has considerable implications for health policy. Prospective health care policies that promote market competition will improve the accessibility of immediate microvascular reconstruction to breast cancer patients overall and vulnerable segments of this population in particular (racial minorities and economically disadvantaged). This will serve these patients well because immediate breast reconstruction has been convincingly shown to provide aesthetic and psychosocial benefits, such as improved physical functioning, quality of life, sexuality, and self-esteem.[26–30]

CONCLUSIONS

A more competitive health care market is significantly associated with an increased overall use of free flap immediate breast reconstruction. Racial minorities, relative to white patients, were the primary beneficiaries of this increased capacity. Therefore, increasing market competition widens preexisting disparities in the use of free flap immediate breast reconstruction. A deeper understanding of how hospital contextual factors influence care delivery will be of value to policy makers, health systems, front-line providers, and patients ("consumers"). Our aforementioned results expand the evidence base in this direction.

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