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PRS GLOBAL OPEN

ORIGINAL ARTICLE
Breast

Current Trends in Breast Reconstruction following Bilateral Prophylactic Mastectomy

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Background: Individuals with genetic susceptibility to breast cancer may pursue bilateral prophylactic mastectomy (BPM) and subsequent breast reconstruction. This study aimed to characterize immediate reconstructive trends following BPM.
Methods: The ACS-NSQIP database (2010 -2019) was used to examine differences in demographics and operative outcomes based on breast reconstruction technique following BPM and factors predicting reconstruction type.
Results: Of 1945 patients (mean age, 43.8 ± 11.3 years), implant-based reconstruction (IBR) was most frequently (71.8%) performed following BPM. Patients who underwent IBR (n = 1396) were younger (42.6 years, $P < 0.001$), more likely to be White ($P < 0.05$), and more likely to have a BMI less than 25 ($P < 0.001$). Patients who underwent autologous reconstruction (AR) (n = 186, 45.8 years) were more likely to be Black or African American and have a BMI of 25–30. Patients who underwent mastectomy only (MO) without immediate reconstruction (n = 363) were older (47.6 years), more likely to be Asian, and more likely to have a BMI greater than 35. The MO cohort had the highest frequency of diabetes or smoking history. AR was associated with longer operations, longer lengths of stay, and increased complications. Increasing age and BMI were predictive of AR or MO compared to IBR. Smoking was predictive of MO.
Conclusion: This is the first large-scale study of genetically susceptible patients who underwent BPM demonstrating a significant relationship between patient demographics, operative outcomes, and immediate reconstruction technique. These results provide valuable insight for surgeons and patients during the shared decision-making process. *(Plast Reconstr Surg Glob Open 2022;10:e4277; doi: 10.1097/GOX.0000000000004277; Published online 18 April 2022.)*

INTRODUCTION

Breast cancer continues to be one of the most common malignancies in women, with upward of 280,000 cases of either invasive or in situ disease diagnosed each year in the United States.[1] Mutations in BRCA1 and 2 and TP53 genes, among many others, place patients at an overall increased lifetime risk of developing breast cancer that is often more aggressive and poorly differentiated, and carries a worse prognosis than breast cancer in non-mutation carriers.[2–7] Those with a genetic susceptibility to breast cancer without a cancer diagnosis face a difficult decision: whether to follow high-risk screening guidelines or undergo bilateral prophylactic mastectomy (BPM).[8]

The benefits of breast reconstruction have been well described and have demonstrated their durable nature for years following reconstruction. Overall satisfaction and quality of life tend to be higher among patients diagnosed with breast cancer who undergo postmastectomy reconstruction versus those who do not.[9–12] Furthermore, evidence suggests an oncological protective benefit of BPM of up to 95% in women with a strong family history of breast cancer or proven genetic susceptibility.[13–15] Several options exist for breast reconstruction following mastectomy based on timing and technique, including immediate, delayed-immediate, or delayed reconstruction using implant-based (IBR) or flap-based [autologous (AR)] reconstruction techniques. Immediate breast reconstruction may be implant-based or flap-based and is performed at the time

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Received for publication November 30, 2021; accepted February 28, 2022.

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS-NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

DOI: 10.1097/GOX.0000000000004277

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

of mastectomy. Delayed reconstruction is often chosen if postmastectomy radiation is required. The best reconstruction type is dependent on the clinical presentation, the patient's medical and surgical history, and patient preference. Although trends in postmastectomy reconstruction after contralateral prophylactic mastectomy (CPM) are well described in the literature, there is a paucity of data describing breast reconstruction trends after BPM in women with a genetic susceptibility to breast cancer, and the data that exist are limited and heterogeneous.[16–22]

Therefore, this study aims to first characterize breast reconstruction trends after BPM in genetically susceptible patients. Second, this study aims to define patient demographics, operative characteristics, and postoperative outcomes associated with the type of reconstruction and identify any factors predictive of adverse events. Ultimately, we aim to provide clinically relevant evidence for reconstructive surgeons to optimize the shared decision-making process with their patients.

Takeaways

Question: What type of immediate breast reconstruction do women who undergo BPM choose, and how do their outcomes differ?

Findings: A retrospective study identified 1945 women using the ACS-NSQIP database from 2010 to 2019 who underwent BPM. The majority of women (71%) underwent IBR. There were differences in reconstruction choice based on age, race, BMI, and comorbidities (diabetes and smoking history).

Meaning: A majority of women choose to undergo breast reconstruction following BPM, most commonly with IBR, with differences in choice based on demographic and medical factors.

METHODS

Patient Selection and Outcome Variables

This retrospective study was deemed exempt by the institutional review board at the University of California, Los Angeles (UCLA) as a nonhuman subject study. Patients in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database from 2010 to 2019 were accessed. ACS-NSQIP is a nationally validated program currently comprising over 700 hospitals that collects de-identified data on patients and their surgical outcomes to improve the quality of surgical care.

All patients with a postoperative diagnosis of genetic susceptibility to neoplasm [International Classification of Diseases (ICD)-9 code V84.0 or ICD-10 code Z15.0] were first identified. Current Procedural Terminology (CPT) codes were used to identify and divide patients into two groups: those who underwent mastectomy only (MO) and those who underwent mastectomy with immediate reconstruction (Table 1). The latter cohort was then divided into two groups based on the type of reconstruction: IBR and AR. IBR included both tissue expander placement and direct-to-implant.

Demographic information including age and race were obtained. Height and weight were used to calculate body mass index (BMI). Smoking status and a diagnosis of diabetes mellitus were also included. Operative time, hospital length of stay (LOS), return to operating room events secondary to the index operation, and postoperative complications [superficial incisional surgical site infection (SSI), deep incisional SSI, and organ space SSI; wound dehiscence; deep vein thrombosis; bleeding requiring transfusion postoperatively in the first 72 hours; and sepsis] were obtained. Complications with less than 1% occurrence overall were excluded from individual final analysis. Patients who underwent partial mastectomy (CPT codes 19301, 19302), those with breast cancer diagnoses, males, and subjects missing demographic information were excluded. In addition, those who underwent mixed reconstruction (implant-based and autologous, eg, free flap with implant or latissimus dorsi pedicle flap with implant) were excluded due to low sample size (Fig. 1).

Statistical Analysis

Descriptive statistics, one-way ANOVA with Tukey post-hoc test, and chi-square analyses were used to examine patient demographic variables and detect differences in demographics and complications between reconstruction methods. Multinomial logistic regression was used to determine factors that may influence reconstruction choice. The threshold of significance was a P value less than 0.05. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp, Armonk, N.Y.).

RESULTS

A total of 1945 patients from 2010 to 2019 were included in our study (Table 2; Fig. 1). There were 1396 (71.8%) patients who underwent IBR, 186 (9.6%) who underwent AR, and 363 (18.7%) in the MO group. Annually, the number of BPM cases logged in the ACS-NSQIP database increased, as did the proportion of BPM cases to total ACS-NSQIP cases logged, with IBR predominating over AR or MO (Fig. 2). The ratio of BPM cases to total cases per year also increased three-fold.

Demographics and Patient Characteristics

Patients were on average 43.8±11.3 years old with an average BMI of 27.8±6.8. The majority of patients were White (82.2%) and non-Hispanic (84.6%). There were 77 patients with diabetes (4.0%) and 159 patients who smoked (8.2%). Baseline patient characteristics are summarized in Table 2. Age was significantly different between the three groups ($P < 0.001$). Compared to AR and MO, patients in the IBR group were younger (mean age 42.6 years) with the highest frequency observed between ages 30–39 (Fig. 3), more likely to be White ($P < 0.05$), and more likely to have a BMI less than 25 ($P < 0.001$). Compared to other groups, AR peaked between the ages of 40 and 49 (mean age 45.8 years) and was more likely to be Black or African American with a higher BMI between 25 and 35. The MO group was older

Table 1. CPT Codes Used to Identify Patients Who Underwent Mastectomy and Those Who Underwent Implant-based and Autologous Reconstruction

Mastectomy Codes	
19303	Mastectomy simple complete
19304	Mastectomy subcutaneous
19305	Mastectomy, radical, including pectoral muscles, axillary lymph nodes
19306	Mastectomy, radical, including pectoral muscles, axillary and internal mammary lymph nodes (urban type operation)
19307	Mastectomy, modified radical, including axillary lymph nodes, with or without pectoralis minor muscle, but excluding pectoralis major muscle
Reconstruction Codes	
19340	Immediate insertion of breast prosthesis following mastopexy, mastectomy, or in reconstruction
19357	Breast reconstruction, immediate or delayed, with tissue expander, including subsequent expansion
19361	Breast reconstruction with latissimus dorsi flap, without prosthetic implant
19364	Breast reconstruction with free flap
19367	Breast reconstruction with TRAM, single pedicle, including closure of donor site
19368	Breast reconstruction with TRAM, single pedicle, including closure of donor site; with microvascular anastomosis (supercharging)
19369	Breast reconstruction with TRAM, double pedicle, including closure of donor site

TRAM, transverse rectus abdominis myocutaneous flap.

than the IBR group with the highest frequency observed at ages 50–64 (mean age 47.6 years), was more likely to be Asian, and was more likely to have the highest BMI greater than 35. In terms of comorbidities, the MO group had higher rates of diabetes (6.9% versus 3.1% IBR versus 4.8% AR, $P < 0.01$) and smoking (11.0% versus 8.0% IBR versus 3.8% AR, $P < 0.05$) than both reconstruction groups.

Operative Characteristics and Outcomes

Intraoperative characteristics and postoperative outcomes across MO and both reconstruction cohorts are listed in Table 3. The mean operative time was significantly shorter ($P < 0.001$) in the MO group compared to both reconstruction groups, and IBR had a significantly shorter operative time than AR. Mean LOS for all cohorts was 1.56 days. AR was associated with the longest LOS (mean 4.10 days, $P < 0.001$) compared to IBR and MO groups. The AR group also had a higher number of return to operating room events (14.5%, $P < 0.001$) and readmission within 30 days (9.4%, $P < 0.01$). The overall rate of early complications within 30 days of surgery was significantly higher in the AR group (24.7%, $P < 0.001$). More specifically, AR was associated with higher rates of superficial incisional SSI (4.3%, $P < 0.05$), wound dehiscence (3.3%, $P < 0.05$), and need for transfusion in the first 72 hours after the operation (16.7%, $P < 0.001$).

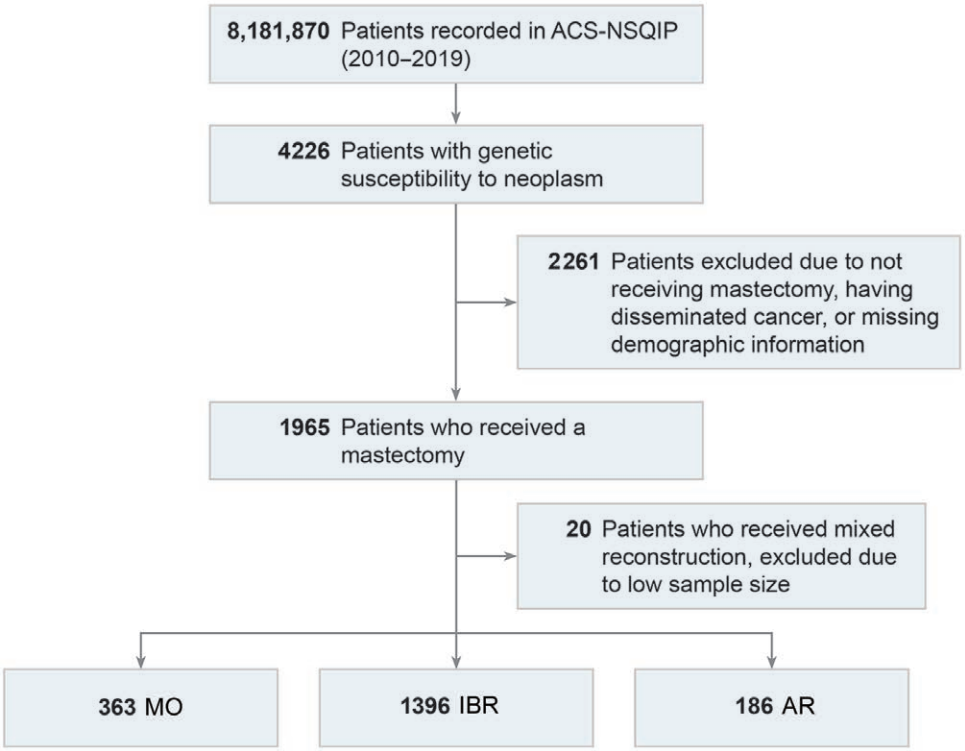

Fig. 1. CONSORT diagram of inclusion and exclusion criteria.

Table 2. Patient Demographics

	Total	MO (%)	Implant (%)	Autologous (%)	*P*
N	1945	363	1396	186	
Age, y					<0.001
<30	187	31 (8.5)	151 (10.8)	5 (2.7)	
30–39	590	77 (21.2)	469 (33.6)	44 (23.7)	
40–49	570	95 (26.2)	396 (28.4)	79 (42.5)	
50–64	515	124 (34.2)	340 (24.4)	51 (27.4)	
65+	83	36 (9.9)	40 (2.9)	7 (3.8)	
Race					<0.05
American Indian or Alaska native	5	1 (0.3)	4 (0.3)	0 (0)	
Asian	28	9 (2.5)	16 (1.2)	3 (1.6)	
Black or African American	92	24 (6.6)	53 (3.8)	15 (8.1)	
Native Hawaiian or Pacific Islander	5	1 (0.3)	4 (0.3)	0 (0)	
Unknown	217	30 (8.3)	157 (11.3)	30 (16.1)	
White	1598	298 (82.1)	1162 (83.2)	138 (74.2)	
Smoker					<0.05
Yes	159	40 (11.0)	111 (8.0)	7 (3.8)	
No	1786	323 (89.0)	1284 (92.0)	179 (96.2)	
Diabetes					<0.01
Yes	77	25 (6.9)	43 (3.1)	9 (4.8)	
No	1868	338 (93.1)	1353 (96.9)	177 (95.2)	
BMI categorized					<0.001
<25	811	118 (32.5)	650 (46.6)	43 (23.1)	
25–30	530	87 (24.0)	387 (27.7)	56 (30.1)	
30–35	318	73 (20.1)	193 (13.8)	52 (28.0)	
35–40	171	45 (12.4)	104 (7.5)	22 (11.8)	
40+	115	40 (11.0)	62 (4.4)	13 (7.0)	

Column percentages are listed in reference to reconstruction type.

Factors Predicting Reconstruction Type

Multinomial logistic regression identified factors predictive of reconstruction choice (Table 4). Increasing age was predictive of MO compared to IBR and AR, and predictive of AR compared to IBR. Increasing BMI was predictive of AR and MO compared to IBR. Smoking was predictive of MO compared to IBR or AR, as well as IBR compared to AR. Diabetes mellitus was not predictive of reconstruction type.

DISCUSSION

With the introduction of genetic screening in 1996, identification of women with genetic susceptibilities to breast cancer has increased dramatically.[23] For patients, discovering they harbor a genetic mutation associated with cancer can result in substantial physical and mental burdens. Using the 2010–2019 ACS-NSQIP datasets, we found that rates of BPM among women with a genetic susceptibility to breast cancer increased three-fold from 2010 to 2019. Using this data, we sought to establish the first large-scale study examining reconstruction trends following BPM in genetically susceptible patients and the relationship between patient demographics and operative outcomes with reconstruction technique. Our findings suggest that women with a genetic susceptibility to breast cancer were overall more likely to undergo reconstruction after BPM than not, and more likely to undergo IBR than other reconstructive techniques. Women younger than 40 years of age, White, and with a BMI less than 25 were the most likely to undergo IBR. Women between 40 and 49 years of age, Black, and with a BMI of 25–30 were more likely to undergo AR. Women older than 50 years of age,

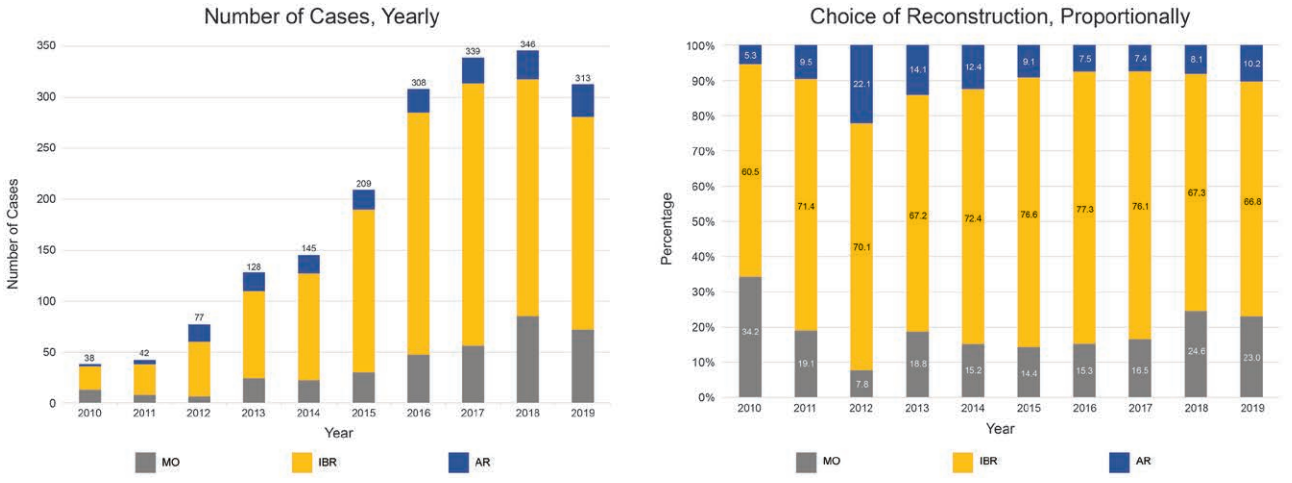

Fig. 2. Yearly trends in reconstruction following BPM. A, Number of BPM cases logged in the ACS-NSQIP database by year. B, Proportion of implant-based, autologous, or MO cases per year.

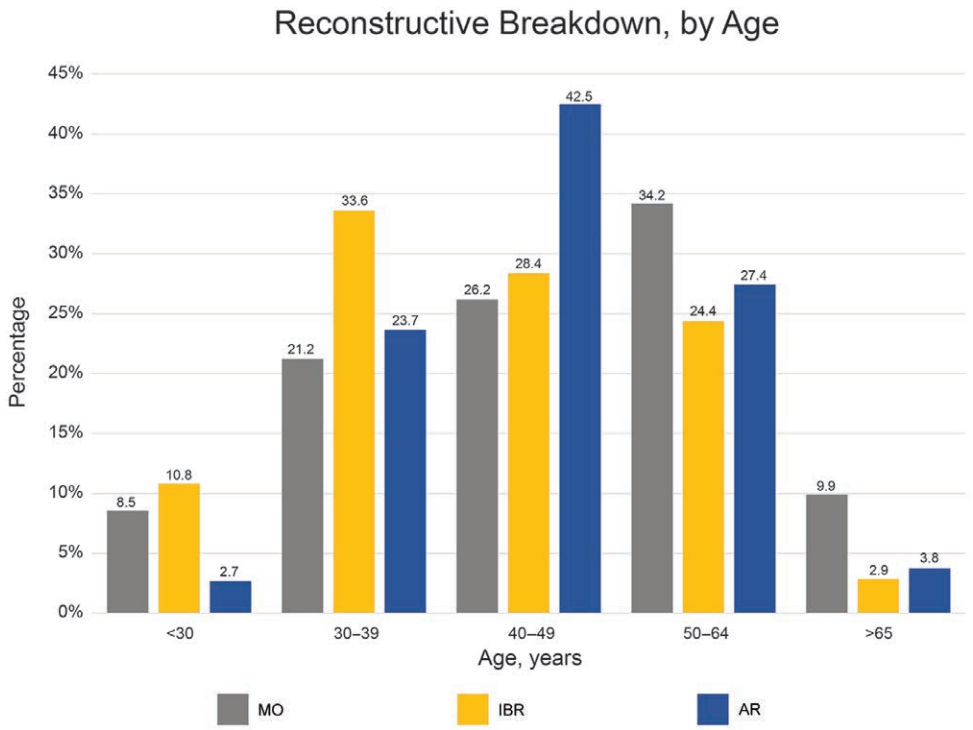

Fig. 3. Percentage of patients who underwent MO, implant-based reconstruction, or autologous reconstruction based on age.

Asian, who had a BMI greater than 35, and had comorbid diabetes or smoking history were more likely to undergo MO. Performance comorbidities, including increasing age, BMI, and smoking status, were all predictive of MO. The results of this study provide valuable insight for surgeons and patients to facilitate shared decision-making around the reconstruction approach individualized for each woman.

In the context of culturally appropriate medicine, it is essential to consider how ethnocultural and socioeconomic factors interplay in each patient's decision-making. Receipt of breast reconstruction following CPM has been shown to vary significantly by patient race and ethnicity, with minority women being significantly less likely than White women to receive breast reconstruction ($P < 0.001$).[24–26] One systematic review found that African American patients were less likely to receive postmastectomy breast reconstruction than White patients [odds ratio (OR) 0.36–0.71][27]; another study reported that Asian patients were one-fifth as likely to undergo reconstruction

Table 3. Operative Characteristics and Outcomes for Breast Reconstruction

	MO (%)	Implant (%)	Autologous (%)	*P*
Operation time (mean, min)	201.52	226.86	561.56	<0.001
Total hospital LOS (mean, d)	1.37	1.27	4.10	<0.001
Return to operating room related to initial procedure				<0.001
Yes	15 (4.1)	100 (7.2)	27 (14.5)	
No	348 (95.9)	1296 (92.8)	159 (85.5)	
Readmission within 30 d (2012–2019)				<0.01
Yes	19 (5.4)	56 (4.2)	17 (9.4)	
No	330 (94.6)	1279 (95.8)	164 (90.6)	
Complications within 30 d				<0.001
Yes	20 (5.5)	71 (5.1)	46 (24.7)	
No	343 (94.5)	1325 (94.9)	140 (75.3)	
Superficial incisional skin and soft-tissue infection (SSI)				<0.05
Yes	8 (2.2)	20 (1.4)	8 (4.3)	
No	355 (97.8)	1376 (98.6)	178 (95.7)	
Organ/space SSI				NS
Yes	3 (0.8)	20 (1.4)	3 (1.6)	
No	360 (99.2)	1376 (98.6)	183 (98.4)	
Wound dehiscence				<0.05
Yes	1 (0.3)	18 (1.3)	6 (3.3)	
No	337 (99.7)	1373 (98.7)	176 (96.7)	
Need for transfusion within 72 h				<0.001
Yes	6 (1.7)	8 (0.6)	31 (16.7)	
No	357 (98.3)	1388 (99.4)	155 (83.3)	

Table 4. Multinomial Logistic Regression-based Analysis of Perioperative Factors Associated with Type of Immediate Reconstruction following Bilateral Prophylactic Mastectomy, Listed as OR (95% Confidence Interval)

	MO Reference		Implant Reconstruction Reference
	Implant Reconstruction	Autologous Reconstruction	Autologous Reconstruction
Age, y	0.964 (0.954–0.974)	0.984 (0.969–1.000)	1.021 (1.007–1.035)
BMI	0.945 (0.929–0.961)	1.002 (0.980–1.026)	1.061 (1.039–1.084)
Smoking			
Yes	0.660 (0.445–0.980)	0.299 (0.131–0.683)	0.453 (0.206–0.993)
No	Reference	Reference	Reference

Diabetes mellitus was excluded as an independent variable in the final analysis to reduce confounding factors.

compared with White patients (OR 0.17).[28] The reasons why minority women are less likely to receive breast reconstruction following mastectomy are multivariable, and may include factors such as lack of knowledge, financial concerns, limited access to a plastic surgeon, and cultural perceptions and values. Although beyond the scope of the current study, our findings complement the literature, demonstrating that Asian and African American women were less likely to undergo IBR following BPM. In the context of race and ethnicity, it is crucial to understand how ethnocultural and socioeconomic factors interplay in each patient's decision-making.

Advanced age is an additional factor associated with a lower likelihood of receiving reconstruction. As one ages, the factors influencing decision-making around surgery evolve, as was apparent in our study. Reconstruction type significantly differed between age groups ($P < 0.001$), and age was a strong predictive factor of reconstruction choice following BPM. Expanded implant use among younger women may be attributed to improved aesthetic outcomes with newer devices, enhanced documented safety of implant devices, and decreased operative and postoperative recovery times. For older patients, the surgeon must weigh the risks of longer operative times, prolonged anesthesia, and increased morbidity when considering reconstructive options.[29] Moreover, Odom et al.[30] reported significantly lower reimbursement associated with AR compared to IBR across insurance types, especially Medicare, which may further dissuade surgeons from performing AR in older populations. Understanding the relationship between age and reconstruction trends is critical when counseling these patients and must be factored into the collaborative decision-making process.

Preoperative performance status, including comorbidities such as obesity or diabetes and social history, can influence the decision to undergo reconstruction and the reconstruction subtype. Obesity has been widely reported as an independent risk factor for complications after postmastectomy breast reconstruction. There is evidence to show that obesity increases the risk of complications after IBR and AR. Compared with normal-weight patients, overweight and obese patients have a significantly higher rate of overall flap complications, total flap loss, flap seroma, mastectomy flap necrosis, and overall donor-site complications.[31] In light of these increased risks, surgeons may be more likely to decline AR for obese patients. Our findings complement the former study, with obese patients more likely to forgo reconstruction after BPM. Another well-described risk factor for postoperative complications is diabetes. Hart et al.[32] found a significantly higher incidence of delayed wound healing after IBR among patients with diabetes compared to those without. However, interestingly, this difference is not observed after AR.[32,33] Although future studies are needed to clarify this difference, the current study found that patients with diabetes undergo no immediate reconstruction (MO) most frequently ($P < 0.01$). Finally, smoking, which has been associated with an increased risk for flap necrosis in IBR and donor-site complications in AR and, in some instances, has been considered a relative contraindication for reconstruction, played a significant role in reconstructive trends.[34] Patients who smoked most frequently did not undergo immediate reconstruction following BPM ($P < 0.05$).

Although reconstruction following mastectomy has been proven to improve a patient's quality of life significantly, it is not without risk. In the current study, AR was consistently associated with longer operating times, longer hospital lengths of stay, higher early complication rates than IBR, and higher 30-day readmission rates. Despite evidence of decreased donor-site morbidity and superior long-term satisfaction associated with autologous techniques, AR is technically more challenging, requiring microvascular training that places great demand on the patient, surgeon, and hospital.[35,36]

Although our study provides novel insight into this unique patient population, several limitations, including the retrospective study design, the limitations of the NSQIP database, and possible coding discrepancies exist. First, due to the de-identification of the data and surgical outcomes limited within 30 days of the index operation, it is impossible to identify patients who underwent BPM and delayed reconstruction. Thus, it is impossible to conclude any associations with MO or long-term complications definitively. As well, the NSQIP database does not capture long-term complications of IBR, including capsular contracture and implant rupture. The NSQIP database does not capture S codes (S2068, S2067) used by many microsurgeons for perforator flaps. Although this does result in some degree of selection bias, this study aims to define IBR trends on a broader level. Future studies may investigate AR trends in further detail using a specialty-specific database. Furthermore, although our results identified ethnic and racial differences in breast reconstruction trends, the small representation of ethnic and racial minorities in the NSQIP database limits the generalizability of our findings. First, as reflected in the US census, ethnicity is limited to two options, "Hispanic or Latino" and "Not Hispanic or Latino," which is carried over into many electronic

medical records and consequently the NSQIP database. Concurrently, the dataset has intrinsic selection bias as participating hospitals are generally larger, academic medical centers with predominately non-Hispanic White patient populations.[37] Moreover, as the database does not capture geographic and institutional specific factors, further studies comparing institutional reconstruction trends and outcomes can elaborate on the specific reconstruction subtypes associated with different ethno-racial and socioeconomic variables. Finally, the database does not provide insight into the type of genetic mutation identified and if a concomitant family history of breast malignancy was present. Future studies delineating the type of mutation and a positive family history may provide insight into additional factors influencing a patient's decision to undergo BPM and reconstruction type. However, the point of this study is to utilize the strengths of the NSQIP database, highlighting trends following BPM for the first time in this population. Ultimately, we aim to apply our findings derived from an extensive, national database to serve as a reference and to support reconstructive surgeons in their approach to reconstruction.

CONCLUSIONS

Our analysis of the ACS-NSQIP database highlights the differences in immediate reconstructive trends following BPM in genetically susceptible patients. These women are unique in that their reconstructive options are not limited by malignancy but rather patient-specific and healthcare-associated factors. Although IBR was most frequently performed on younger, White patients with a lower BMI, AR was more commonly performed in older, African American patients with higher BMIs. Those who deferred reconstruction (MO) were the oldest, with the highest BMIs and were most commonly Asian. With the ascent of prophylactic medicine and patient-centered healthcare, the familiarity of these findings will support the reconstructive surgeon and their patient during shared decision-making utilizing clinically relevant data.

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