Published in final edited form as:

Plast Reconstr Surg. 2019 June ; 143(6): 1560–1570. doi:10.1097/PRS.00000000000005611.

Decline in Racial Disparities in Postmastectomy Breast Reconstruction: A Surveillance, Epidemiology, and End Results Analysis from 1998 to 2014

Amanda R. Sergesketter, B.S., Samantha M. Thomas, M.S., Whitney O. Lane, M.D., Jonah P. Orr, B.S., Ronnie L. Shamas, M.D., Oluwadamilola M. Fayanju, M.D., Rachel A. Greenup, M.D., Scott T. Hollenbeck, M.D.

Division of Plastic, Maxillofacial, and Oral Surgery and the Department of Surgery, Duke University Medical Center; and the Department of Biostatistics and Bioinformatics, Duke Cancer Institute. Durham, N.C.

Abstract

Background: Despite increasing emphasis on reducing racial disparities in breast cancer care in the United States, it remains unknown whether access to breast reconstruction has improved over time. The authors characterized contemporary patterns of breast reconstruction by race and ethnicity.

Methods: The Surveillance, Epidemiology, and End Results database was used to identify women undergoing mastectomy for stage 0 to III breast cancer from 1998 to 2014. Multivariable logistic regression was used to estimate the association of demographic factors with likelihood of postmastectomy reconstruction. Multivariable logistic regression was used to predict reconstruction subtype. Patients undergoing reconstruction were grouped by diagnosis year to assess change in the population over time by race and ethnicity.

Results: Of 346,418 patients, 21.8 percent underwent immediate reconstruction. Non-Hispanic black race (OR, 0.71) and Hispanic ethnicity (OR, 0.63) were associated with a decreased likelihood of reconstruction (all $p < 0.001$). Race was predictive of reconstruction type, with non-Hispanic black (OR, 1.52) and Hispanic women (OR, 1.22) more likely to undergo autologous versus implant-based reconstruction ($p < 0.001$). Although rates of reconstruction increased over time across all races, non-Hispanic black and Hispanic patients had a higher adjusted per-year increase in rate of reconstruction compared with non-Hispanic white patients (interaction $p < 0.001$).

Conclusions: Rates of postmastectomy reconstruction have increased more quickly over time for minority women compared with white women, suggesting that racial disparities in breast reconstruction may be improving. However, race continues to be associated with differences in

scott.hollenbeck@duke.edu.

Presented at the American College of Surgeons Clinical Congress, in Boston, Massachusetts, October 21 through 25, 2018.

Disclosure: The authors have no conflicts of interest to report.

Supplemental digital content is available for this article. Direct URL citations appear in the text; simply type the URL address into any Web browser to access this content. Clickable links to the material are provided in the HTML text of this article on the *Journal's* website (www.PRSJournal.com).

types and rates of reconstruction. Further research is necessary to continue to improve access to breast reconstruction in the United States.

CLINICAL QUESTION/LEVEL OF EVIDENCE: Risk, III.

Postmastectomy breast reconstruction is associated with significant psychosocial and physical benefits for breast cancer patients and is an essential component of comprehensive breast cancer care.^{1,2} Rates of immediate reconstruction have risen considerably since passage of the Women's Health and Cancer Rights Act of 1998 that mandated insurance coverage of reconstruction for breast cancer patients³; however, over 75 percent of women still forgo reconstruction after mastectomy.⁴ Recent evidence suggests that disparities in reconstruction persist, with women of lower socioeconomic status and minority race/ethnicity significantly less likely to undergo reconstruction.^{5–14}

Many studies have described persisting disparities in breast reconstruction to understand how race, ethnicity, and socioeconomic status influence the receipt of breast reconstruction and determine which factors are potentially modifiable through population-based interventions. Continued efforts to understand these disparities are essential steps toward improving surgical decision-making and reducing barriers to care. However, despite increasing overall rates of reconstruction and the advent of educational initiatives to improve knowledge about and access to reconstruction among racial and ethnic minorities,^{15,16} whether access to reconstruction is improving remains relatively unknown.

In this study, we sought to determine contemporary patterns in rates and type of reconstruction by race and ethnicity, ultimately aiming to determine whether racial disparities in reconstruction have improved over time. We hypothesized that with shifting emphasis toward improving disparities in reconstruction, differences in rates of breast reconstruction among different races and ethnicities may have improved over the past decade.

PATIENTS AND METHODS

The National Cancer Institute's Surveillance, Epidemiology, and End Results database was used for this study. The Surveillance, Epidemiology, and End Results database is a population-based cancer registry that represents approximately 28 percent of the U.S. population, capturing patient demographics and tumor and treatment data points from representative geographic regions. This study was exempt from institutional review board approval because of use of deidentified patient data. We identified female patients aged 18 years or older, diagnosed with stage 0 to III breast cancer from 1973 to 2014 who underwent mastectomy. Women with metastatic (M1) disease or unknown relationship status were excluded. Because surgery of the primary site was available only for patients diagnosed in 1998 and after and because the Women's Health and Cancer Rights Act was passed in 1998, all patients diagnosed before 1998 were also excluded.

Patients were divided into two cohorts based on receipt of reconstruction (yes or no). Demographic variables included patient age at diagnosis (hereafter denoted as age), race/ethnicity, insurance status, marital status, year at diagnosis, geographic location, and social

support. Social support was defined as “yes” if a patient was married or recoded as unmarried/domestic partner at the time of diagnosis, and “no” if a patient was single, divorced, separated, or widowed at the time of diagnosis. Income was defined as the median household income of the patient’s county of residence as reported in the Census 2012 to 2016 American Community Survey, and is recorded in 2016 inflation-adjusted dollars. Tumor characteristics included estrogen receptor, progesterone receptor, and human epidermal growth factor receptor 2 status; grade; and tumor and node stages. Treatment characteristics included receipt of chemotherapy, radiation therapy, and type of primary surgery. Patient demographic, clinical, and treatment characteristics were summarized with number and percentages for categorical variables and median (interquartile range) for continuous variables, for all patients, reconstruction versus no reconstruction, and by year of diagnosis. Differences were tested using the chi-square test, *t* test, the Fisher’s exact test, or analysis of variance, as appropriate.

Rates of reconstruction were calculated as the number of patients who underwent reconstruction of the total number of patients who underwent mastectomy in a given year, specified by race. Multivariable logistic regression was used to identify factors associated with receipt of reconstruction after adjustment for known covariates. To assess change in rates of reconstruction over time by race, the year-by-race interaction term was added to subsequent adjusted logistic models.

Subgroup analyses were conducted using patients who underwent reconstruction and had available reconstruction type. A logistic model was used to identify factors associated with tissue versus implant reconstruction.

Only patients with complete data were included in each model, and sample sizes are included for each table/figure. No adjustments were made for multiple comparisons. A significance level of 0.05 was used for all statistical tests. All statistical analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, N.C.).

RESULTS

Starting with the initial Surveillance, Epidemiology, and End Results population of 1,287,238 patients diagnosed with breast cancer between 1973 and 2014, application of the defined inclusion and exclusion criteria resulted in the final study population of 346,418 women undergoing mastectomy for breast cancer (Fig. 1), 21.8 percent of whom (75,506) underwent reconstruction. Median follow-up was 87 months (95 percent CI, 86 to 87 months). (See Table, Supplemental Digital Content 1, which shows patient demographic characteristics by reconstruction status, <http://links.lww.com/PRS/D459>.) During the 17-year study period, the proportion of patients undergoing breast reconstruction increased significantly (11.4 percent in 1998 to 38.3 percent in 2014; $p < 0.001$). Women undergoing reconstruction were younger (median age, 51 years versus 63 years; $p < 0.001$) and more likely to be insured (67.7 percent versus 46.2 percent; $p < 0.001$). Rates of reconstruction varied by race/ethnicity, with a higher proportion of non-Hispanic white women undergoing reconstruction (23.3 percent) compared with non-Hispanic black (19.1 percent) and

Hispanic women (18.7 percent) ($p < 0.001$). (See Table, Supplemental Digital Content 2, which shows reconstruction and type by race, <http://links.lww.com/PRS/D460>.)

Oncologic and treatment characteristics are summarized in Table, Supplemental Digital Content 1, <http://links.lww.com/PRS/D459>. Women undergoing reconstruction were more likely to have T1 (57 percent versus 46 percent; $p < 0.001$) and N0 (62.4 percent versus 55.4 percent; $p < 0.001$) stage disease, with median tumor size being lower among those undergoing reconstruction (1.8 cm; interquartile range, 1 to 3 cm) compared with those who did not (2.1 cm; interquartile range, 1.3 to 3.5 cm; $p < 0.001$). A higher proportion of breast cancers in reconstructed women were grades 1 or 2 compared with those undergoing mastectomy without immediate reconstruction. Regarding treatment, women undergoing reconstruction were more likely to undergo a simple/complete mastectomy (55.8 percent versus 37.4 percent; $p < 0.001$), with contralateral prophylactic mastectomy significantly higher in the reconstruction cohort (39.1 percent versus 11.2 percent; $p < 0.001$). Although a higher proportion of the reconstruction group underwent chemotherapy (53.1 percent versus 44.4 percent; $p < 0.001$), women undergoing reconstruction were less likely to undergo radiation therapy (20 percent versus 22.3 percent; $p < 0.001$). Of women undergoing radiation therapy, the majority of both reconstruction patients and those who did not undergo reconstruction received it in the adjuvant setting (97.8 percent and 97.3 percent, respectively).

Factors Associated with Immediate Reconstruction

After multivariable adjustment, women undergoing reconstruction after mastectomy were significantly younger (OR, 0.94; 95 percent CI, 0.94 to 0.94; $p < 0.001$), insured (OR, 0.44; 95 percent CI, 0.40 to 0.49; $p < 0.001$), and more often white compared to non-Hispanic black race (OR, 0.71; 95 percent CI, 0.69 to 0.74; $p < 0.001$) or Hispanic ethnicity (OR, 0.63; 95 percent CI, 0.61 to 0.65). Lower stage disease was associated with reconstruction, with patients with T0/Tis stage disease more likely to undergo reconstruction compared with those with T1 stage disease (OR, 1.25; 95 percent CI, 1.01 to 1.55; $p = 0.04$), and higher tumor grades and nodal involvement were associated with a decreased likelihood of reconstruction after mastectomy (all $p < 0.001$). Women undergoing a contralateral prophylactic mastectomy were significantly more likely to undergo reconstruction (OR, 2.57; 95 percent CI, 2.51 to 2.62; $p < 0.001$) (Table 1). (See Figure, Supplemental Digital Content 3, which shows the receiver operating characteristic curve for the logistic regression model predicting receipt of reconstruction, <http://links.lww.com/PRS/D461>.) The area under the receiver operating characteristic curve was 0.81, indicating that this model predicts receipt of reconstruction with 81 percent accuracy.

Receipt of Reconstruction and Subtype by Race

Reconstruction rates and subtype by race are summarized in Supplemental Digital Content 2 (see Table, Supplemental Digital Content 2, <http://links.lww.com/PRS/D460>). Briefly, whereas 23.3 percent of white women underwent reconstruction during the study period, 19.1 percent of non-Hispanic black and 18.7 percent of Hispanic women underwent reconstruction ($p < 0.001$). Rates of tissue-based reconstruction were lower among white women compared to non-Hispanic black and Hispanic women (white, 32.2 percent; non-

Hispanic black, 40.3 percent; Hispanic, 33.1 percent), whereas rates of implant reconstruction were higher in white women (white, 34.7 percent; non-Hispanic black, 26.3 percent; Hispanic, 33.3 percent) ($p < 0.001$).

Rates of Reconstruction over Time by Race/Ethnicity

Rates of reconstruction increased significantly over time for all races/ethnicities from 1998 to 2014 (Fig. 2). On univariate analysis, there was an association between year of diagnosis and race with regard to reconstruction status (Table 2). After multivariable adjustment, the year-by-race interaction was significant, indicating that even after adjustment for known covariates including social support, age, insurance, patient region, grade, T stage, N stage, surgery type, and contralateral prophylactic surgery, change in rates of reconstruction over time differed by race (interaction $p < 0.001$). The magnitude of per-year increase in reconstruction rates was higher for non-Hispanic black patients (OR for each additional year, 1.08; 95 percent CI, 1.08 to 1.09), Hispanic patients (OR, 1.09; 95 percent CI, 1.08 to 1.09), and patients of other races/ethnicities (OR, 1.11; 95 percent CI, 1.10 to 1.12) compared with non-Hispanic white patients (OR, 1.07; 95 percent CI, 1.07 to 1.08), meaning that reconstruction rates of minority races increased more quickly compared with white patients (Table 3).

Factors Associated with Reconstruction Type

Non-Hispanic white women were more likely to undergo combined tissue and implant or implant-based reconstruction than tissue-based reconstruction (78 percent and 77.7 percent versus 74.2 percent); however, non-Hispanic black and Hispanic women were more likely to undergo tissue-based reconstruction than implant-based reconstruction (tissue versus implant, 10.8 percent versus 6.8 percent and 8.6 percent versus 7.9 percent, respectively; all $p < 0.001$). Whereas tissue-based reconstruction was favored in the East, implant-based was more common in the Northern Plains and Pacific Coast ($p < 0.001$). Patients undergoing contralateral prophylactic mastectomy were significantly more likely to undergo implant reconstruction ($p < 0.001$). Among patients with known income, median income was higher among patients undergoing implant-based reconstruction compared with those undergoing tissue or combined tissue and implant-based reconstruction ($p = 0.003$) (Table 4).

After multivariable adjustment, non-Hispanic black (OR, 1.52; 95 percent CI, 1.42 to 1.63; $p < 0.001$) and Hispanic (OR, 1.22; 95 percent CI, 1.14 to 1.31; $p < 0.001$) patients were significantly more likely to undergo tissue versus implant-based reconstruction compared with non-Hispanic white patients. Tissue over implant-based reconstruction was associated with receipt of care in the East (OR, 1.64; 95 percent CI, 1.58 to 1.72; $p < 0.001$) or Southwest (OR, 1.22; 95 percent CI, 1.12 to 1.33; $p < 0.001$). Women undergoing contralateral prophylactic mastectomy were significantly less likely to undergo tissue-based (OR, 0.77; 95 percent CI, 0.74 to 0.80; $p < 0.001$) compared to implant reconstruction. Year of diagnosis was associated with reconstructive subtype, with a more recent year of diagnosis associated with decreased likelihood of tissue-based reconstruction (OR, 0.95; 95 percent CI, 0.94 to 0.96; $p < 0.001$). Patient age was not associated with reconstruction subtype ($p = 0.64$) (Table 5).

DISCUSSION

To our knowledge, this study is the largest series to date to evaluate the contemporary patterns of postmastectomy breast reconstruction by race and ethnicity, highlighting the evolution of racial trends and variation in reconstruction subtype in the United States. Importantly, our findings suggest that the racial gap in receipt of breast reconstruction after mastectomy may be narrowing, with non-Hispanic black and Hispanic patients showing a higher adjusted per-year increase in rate of reconstruction compared to non-Hispanic white patients over a 17-year span. Despite this improvement, our data illustrate the need for continued efforts to improve racial and ethnic disparities in breast reconstruction. Finally, we describe contemporary trends in subtype by race and ethnicity with the hope of expanding the current understanding of how patient factors influence receipt of reconstruction.

Passage of the Women's Health and Cancer Rights Act mandated insurance coverage of reconstruction for breast cancer patients, eliminating a significant barrier to breast reconstruction for many women.³ Our data highlight this trend, as rates of immediate reconstruction rose significantly after passage of the Act in 1998, increasing to over 38 percent in 2014. However, as evidenced by the variation in reconstruction rates seen with insurance status and race observed in our study, disparities in receipt of reconstruction persist.

Our study found that black and Hispanic women were significantly less likely to undergo reconstruction even after adjusting for known covariates, a trend that has been shown in studies using institutional data^{10,17}; earlier analyses of the Surveillance, Epidemiology, and End Results database^{5,9,14,18}; and both the National Surgical Quality Improvement Program and Nationwide Inpatient Sample.^{6,19} Insurance status alone likely does not explain racial differences in reconstruction rates: although a higher proportion of minority patients have public insurance or lack insurance, limiting access to plastic surgeons and precluding some surgeons from offering reconstruction,²⁰ minorities remain significantly less likely to undergo reconstruction even after controlling for insurance type.^{8,13,19,21,22} Other socioeconomic barriers likely also contribute to this trend. For example, work-related socioeconomic concerns could limit access to reconstruction. Jagsi et al. found that women undergoing mastectomy with reconstruction were more likely to miss more than 1 month of work or stop work altogether compared to women receiving lumpectomy alone.²³ For women already at a socioeconomic disadvantage, this consideration could sway women from reconstruction. In fact, in a survey sent to breast cancer patients forgoing reconstruction in the Surveillance, Epidemiology, and End Results registries, Morrow et al. reported that Latinas more commonly cited concerns about time off work as their rationale for not pursuing reconstruction.⁵ Hospital and system-level considerations, such as geographic access to academic centers offering reconstruction, type of hospital, and density of plastic surgeons, have also been found to contribute to differences in reconstruction rates.^{22,24,25} Finally, provider-level considerations, including initial referral to a plastic surgeon and discussions about reconstruction from both surgical oncologists and plastic surgeons, have been found to vary by race, ethnicity, and insurance status,^{7,20,26} and could contribute to our reported lower rates of reconstruction among minorities and the uninsured.

Before attributing variation in reconstruction rates solely to system-level, provider-level, and socioeconomic disparities, differences in patient preference must also be disentangled from persisting barriers to care. Although some view reconstruction as the standard of care because of the substantial perceived psychosocial and physical benefits, many patients forgo reconstruction because of personal preference rather than lack of access. Latinas have been reported to elect to forgo reconstruction because of concern about reconstruction interfering with cancer detection,⁵ despite a lack of clinical evidence to support this belief. Other studies have reported that higher self-esteem and body image among black patients could lead to reduced reconstruction rates.^{27,28} Race and ethnicity have been associated with strong treatment preferences regarding primary surgical resection and endocrine therapy in breast cancer treatment.^{29,30} Accordingly, shared decision-making should be informed by an understanding on the part of providers as to how both misinformation on the part of some patients in addition to culturally prescribed and race-related patient preferences may influence both treatment and reconstructive decision-making. Such awareness will improve the quality of multidisciplinary counseling and dispel myths about treatment while encouraging respect for patient autonomy.

In addition to rates of reconstruction, race and ethnicity are associated with surgical decision-making with regard to reconstruction subtype. Interestingly, we found that although trends in implant versus tissue-based reconstruction did not vary by other social or demographic factors, race was a highly significant predictor of reconstruction type, with black and Hispanic patients more likely to undergo autologous over implant-based reconstruction. This partiality toward tissue-based reconstruction among African American women has been previously reported both at an institutional level¹⁰ and nationally using the National Surgical Quality Improvement Program database,³¹ although our study is the largest sample to date and the first to use a population-based registry to examine subtype trends. This trend has been attributed to the higher average body mass index among minority patients, who are more likely to have a body habitus that facilitates autologous tissue transfer. However, Offodile et al. reported that black race or Hispanic ethnicity predicted receipt of autologous reconstruction even after adjusting for body mass index among other covariates.³¹ Cultural aversion to implants could contribute to this preference; Rubin et al. found that black women more commonly reported a desire to avoid implants because of concerns about implant safety and a desire to avoid foreign materials.³² Finally, increased socioeconomic and work considerations among minorities could also explain subtype preferences, as minority patients may perceive staged implant-based reconstruction requiring multiple clinic visits for expansion and a second exchange procedure as more burdensome,³¹ despite the longer and more invasive nature of autologous tissue transfer. Understanding this variation in reconstruction modality by race and ethnicity should be considered in the context of counseling patients about their best options for reconstruction, such that surgeons can tailor these presurgical discussions to patients' medical and physical characteristics in addition to their culturally informed preferences.

Although variation in absolute rates of reconstruction between racial subgroups persist, throughout our 17-year period, reconstruction rates among black or Hispanic women increased more quickly compared with rates among white women, highlighting that disparities in breast reconstruction may be improving. This improvement may reflect the

success of educational initiatives to increase the distribution of information about reconstruction among minorities. For example, the Breast Education Act was implemented in 2015 by the American Society of Plastic Surgeons to better inform minority patients about their federally mandated right to reconstruction after mastectomy.¹⁵ Furthermore, New York passed a state law in 2010 mandating discussion of reconstruction and referral to facilities offering reconstruction before the initiation of breast cancer treatment.¹⁶ These initiatives, coupled with growing knowledge and acceptance of reconstruction among different minority subgroups and improved provider communication, may have contributed to the narrowing gap in reconstruction disparities we observed. Regardless, although further targeted educational interventions remain important to ensure adequate information and education for all patients, our study shows that disparities in breast reconstruction rates are moving in a positive direction.

Together, these demographic and cultural considerations must be taken into account by clinicians while counseling patients about reconstructive options. Many studies have suggested that provider-patient communication is one of the most influential components of reconstructive decision-making, independent of sociodemographic considerations.^{27,33} Given the importance women place on their providers' views in their decision-making process, it is important for clinicians to understand how race and culture may influence the reconstructive decision-making process to help patients make the best-informed decisions tailored to their individual needs.³⁴

This study's strengths lie in its large sample drawn from population-based registries representing the longest studied period to date. However, it also has limitations that merit consideration, including the retrospective nature of the cohort and the associated potential for coding errors. The lack of available information on delayed reconstruction in the Surveillance, Epidemiology, and End Results database is perhaps the most important limitation of our data, as this limits our conclusions about demographic determinants of type of reconstruction undergone. Although we observed a statistically significant difference in the change of reconstruction rates by race, the clinical significance of this finding may be confounded by other sociodemographic and policy factors. For example, the lack of data on body mass index, comorbidities, and type of hospital, which are known covariates for reconstruction and subtype, limits our described associations. However, this study represents the most recent analysis of trends in immediate breast reconstruction; although racial disparities in reconstruction have been reported, we include the evolution of racial trends in reconstruction over time and sociodemographic predictors of type of reconstruction chosen. Ultimately, we aim for our findings to emphasize that disparities in breast reconstruction after mastectomy may be improving, and also to highlight the social and cultural factors that continue to influence receipt of reconstruction. Future directions should include examining how the influence of race and ethnicity extends to other phases of reconstruction, including delayed reconstruction and later revisions.

CONCLUSIONS

Although persistent racial and ethnic disparities in breast reconstruction exist, receipt of reconstruction after mastectomy has improved over time. Additional research is needed to

further understand patient-, provider-, and system-level contributions to evolving reconstruction patterns.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGMENTS

Oluwadamilola M. Fayanju, M.D., is supported by the National Center for Advancing Translational Sciences of the National Institutes of Health under award number 5KL2TR001115 (principal investigator: Leigh E. Boulware, M.D., M.P.H.). Rachel A. Greenup, M.D., is supported by the National Institutes of Health Building Interdisciplinary Research Careers in Women's Health grant K12HD043446 (principal investigator: Nancy C. Andrews, M.D., Ph.D.). This work is also supported by the Duke Cancer Institute through National Institutes of Health grant P30CA014236 (principal investigator: Michael B. Kastan, M.D., Ph.D.). The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

REFERENCES

1. Zhong T, Hu J, Bagher S, et al. A comparison of psychological response, body image, sexuality, and quality of life between immediate and delayed autologous tissue breast reconstruction: A prospective long-term outcome study. *Plast Reconstr Surg* 2016;138:772–780. [PubMed: 27673514]
2. Eltahir Y, Werners LL, Dreise MM, et al. Quality-of-life outcomes between mastectomy alone and breast reconstruction: Comparison of patient-reported BREAST-Q and other health-related quality-of-life measures. *Plast Reconstr Surg* 2013;132:201e–209e.
3. Xie Y, Tang Y, Wehby GL. Federal health coverage mandates and health care utilization: The case of the Women's Health and Cancer Rights Act and use of breast reconstruction surgery. *J Womens Health (Larchmt.)* 2015;24:655–662. [PubMed: 26131570]
4. Reddy KG, Strassle PD, McGuire KP. Role of age, tumor grade, and radiation therapy on immediate postmastectomy breast reconstruction. *Clin Breast Cancer* 2018;18:313–319. [PubMed: 29305307]
5. Morrow M, Li Y, Alderman AK, et al. Access to breast reconstruction after mastectomy and patient perspectives on reconstruction decision making. *JAMA Surg* 2014;149: 1015–1021. [PubMed: 25141939]
6. Kamali P, Zettervall SL, Wu W, et al. Differences in the reporting of racial and socioeconomic disparities among three large national databases for breast reconstruction. *Plast Reconstr Surg* 2017;139:795–807. [PubMed: 28350648]
7. Greenberg CC, Schneider EC, Lipsitz SR, et al. Do variations in provider discussions explain socioeconomic disparities in postmastectomy breast reconstruction? *J Am Coll Surg* 2008;206:605–615. [PubMed: 18387464]
8. Butler PD, Familusi O, Serletti JM, Fox JP. Influence of race, insurance status, and geographic access to plastic surgeons on immediate breast reconstruction rates. *Am J Surg* 2018;215:987–994. [PubMed: 29103529]
9. Joslyn SA. Patterns of care for immediate and early delayed breast reconstruction following mastectomy. *Plast Reconstr Surg* 2005;115:1289–1296. [PubMed: 15809588]
10. Sharma K, Grant D, Parikh R, Myckatyn T. Race and breast cancer reconstruction: Is there a health care disparity? *Plast Reconstr Surg* 2016;138:354–361. [PubMed: 27465159]
11. Alderman AK, Hawley ST, Janz NK, et al. Racial and ethnic disparities in the use of postmastectomy breast reconstruction: Results from a population-based study. *J Clin Oncol* 2009;27:5325–5330. [PubMed: 19805680]
12. Panieri E, Lazarus D, Dent DM, Hudson DA, Murray E, Werner ID. A study of the patient factors affecting reconstruction after mastectomy for breast carcinoma. *Am Surg* 2003;69:95–97. [PubMed: 12641345]

13. Yang RL, Newman AS, Lin IC, et al. Trends in immediate breast reconstruction across insurance groups after enactment of breast cancer legislation. *Cancer* 2013;119:2462–2468. [PubMed: 23585144]
14. Lang JE, Summers DE, Cui H, et al. Trends in post-mastectomy reconstruction: A SEER database analysis. *J Surg Oncol* 2013;108:163–168. [PubMed: 23861196]
15. Breast Cancer Patient Education Act of 2015, HR 2540, 114 Congress, 1st Session (2015).
16. New York State Senate. S A10094B, 2009–2010 Legislative Session (2010).
17. Rodby KA, Danielson KK, Shay E, Robinson E, Benjamin M, Antony AK. Trends in breast reconstruction by ethnicity: An institutional review centered on the treatment of an urban population. *Am Surg* 2016;82:497–504. [PubMed: 27305880]
18. Alderman AK, McMahon L Jr, Wilkins EG. The national utilization of immediate and early delayed breast reconstruction and the effect of sociodemographic factors. *Plast Reconstr Surg* 2003;111:695–703; discussion 704–705. [PubMed: 12560690]
19. Shippee TP, Kozhimannil KB, Rowan K, Virnig BA. Health insurance coverage and racial disparities in breast reconstruction after mastectomy. *Womens Health Issues* 2014;24: e261–e269. [PubMed: 24794541]
20. Odom EB, Schmidt AC, Myckatyn TM, DW II Buck. A cross-sectional study of variations in reimbursement for breast reconstruction: Is a healthcare disparity on the horizon? *Ann Plast Surg* 2018;80:282–286. [PubMed: 28984659]
21. Schumacher JR, Taylor LJ, Tucholka JL, et al. Socioeconomic factors associated with post-mastectomy immediate reconstruction in a contemporary cohort of breast cancer survivors. *Ann Surg Oncol* 2017;24:3017–3023. [PubMed: 28766209]
22. Hershman DL, Richards CA, Kalinsky K, et al. Influence of health insurance, hospital factors and physician volume on receipt of immediate post-mastectomy reconstruction in women with invasive and non-invasive breast cancer. *Breast Cancer Res Treat* 2012;136:535–545. [PubMed: 23053659]
23. Jagsi R, Abrahamse PH, Lee KL, et al. Treatment decisions and employment of breast cancer patients: Results of a population-based survey. *Cancer* 2017;123:4791–4799. [PubMed: 28990155]
24. Vora H, Chung A, Lewis A, et al. Reconstruction among patients undergoing mastectomy: The effect of surgical deserts. *J Surg Res* 2018;223:237–242. [PubMed: 29433880]
25. Ballard TNS, Zhong L, Momoh AO, Chung KC, Waljee JF. Improved rates of immediate breast reconstruction at safety net hospitals. *Plast Reconstr Surg* 2017;140:1–10. [PubMed: 28654581]
26. Alderman AK, Hawley ST, Waljee J, Mujahid M, Morrow M, Katz SJ. Understanding the impact of breast reconstruction on the surgical decision-making process for breast cancer. *Cancer* 2008;112:489–494. [PubMed: 18157830]
27. Tseng JF, Kronowitz SJ, Sun CC, et al. The effect of ethnicity on immediate reconstruction rates after mastectomy for breast cancer. *Cancer* 2004;101:1514–1523. [PubMed: 15378473]
28. Nelson JA, Nelson P, Tchou J, Serletti JM, Wu LC. The ethnic divide in breast reconstruction: A review of the current literature and directions for future research. *Cancer Treat Rev* 2012;38:362–367. [PubMed: 22321197]
29. Hurtado-de-Mendoza A, Jensen RE, Jennings Y, Sheppard VB. Understanding breast cancer survivors' beliefs and concerns about adjuvant hormonal therapy: Promoting adherence. *J Cancer Educ* 2018;33:436–439. [PubMed: 28205022]
30. Bickell NA, Weidmann J, Fei K, Lin JJ, Leventhal H. Underuse of breast cancer adjuvant treatment: Patient knowledge, beliefs, and medical mistrust. *J Clin Oncol* 2009;27:5160–5167. [PubMed: 19770368]
31. AC II Offodile, Tsai TC, Wenger JB, Guo L. Racial disparities in the type of postmastectomy reconstruction chosen. *J Surg Res* 2015;195:368–376. [PubMed: 25676466]
32. Rubin LR, Chavez J, Alderman A, Pusic AL. 'Use what God has given me': Difference and disparity in breast reconstruction. *Psychol Health* 2013;28:1099–1120. [PubMed: 23557084]
33. Ananian P, Houvenaeghel G, Protière C, et al. Determinants of patients' choice of reconstruction with mastectomy for primary breast cancer. *Ann Surg Oncol* 2004;11:762–771. [PubMed: 15249342]

34. Hasak JM, Myckatyn TM, Grabinski VF, Philpott SE, Parikh RP, Politi MC. Stakeholders' perspectives on postmastectomy breast reconstruction: Recognizing ways to improve shared decision making. *Plast Reconstr Surg Glob Open* 2017;5: e1569. [PubMed: 29263969]

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Fig. 1. Consolidated Standards of Reporting Trials diagram for patient selection. *SEER*, Surveillance, Epidemiology, and End Results; *NOS*, not otherwise specified.

Fig. 2.
Rates of reconstruction over time by race/ethnicity, 1998 to 2014.

Table 1.
Factors Associated with Immediate Reconstruction after Mastectomy ($n = 318,172$)*

	OR (95% CI)	p	Overall p
Age	0.94 (0.94–0.94)	<0.001	<0.001
Race/ethnicity			<0.001
Non-Hispanic white	Reference		
Non-Hispanic black	0.71 (0.69–0.74)	<0.001	
Hispanic	0.63 (0.61–0.65)	<0.001	
Other	0.56 (0.54–0.58)	<0.001	
Year of diagnosis	1.08 (1.07–1.08)	<0.001	<0.001
Insurance status			<0.001
Insured	Reference		
Uninsured	0.44 (0.40–0.49)	<0.001	
Unknown; diagnosed before 2007	0.93 (0.89–0.96)	<0.001	
Patient region			<0.001
Pacific Coast/Alaska	Reference		
East	1.54 (1.51–1.58)	<0.001	
Northern Plains	1.70 (1.64–1.76)	<0.001	
Southwest	1.34 (1.28–1.40)	<0.001	
Social support			<0.001
No	Reference		
Yes	1.31 (1.28–1.34)	<0.001	
Grade			<0.001
1	Reference		
2	0.94 (0.92–0.97)	<0.001	
3	0.77 (0.75–0.79)	<0.001	
T stage			<0.001
T1	Reference		
T0/Tis	1.25 (1.01–1.55)	0.04	
T2	0.78 (0.76–0.80)	<0.001	
T3	0.67 (0.65–0.70)	<0.001	

	OR (95% CI)	<i>p</i>	Overall <i>p</i>
T4	0.36 (0.34–0.39)	<0.001	<0.001
TX	0.72 (0.67–0.78)	<0.001	
N stage			
N0	Reference		<0.001
N1	0.91 (0.89–0.94)	<0.001	
N2	0.75 (0.72–0.78)	<0.001	
N3	0.66 (0.62–0.70)	<0.001	
NX	0.80 (0.70–0.91)	<0.001	
Surgery type			<0.001
Simple/complete or subcutaneous mastectomy	Reference		
Modified radical mastectomy	0.56 (0.55–0.57)	<0.001	
Contralateral prophylactic	2.57 (2.51–2.62)	<0.001	

* Subcutaneous mastectomy was grouped with simple/complete because of limited sample size of patients who underwent subcutaneous mastectomy. Alaska was grouped with Pacific Coast because of limited sample size of patients from Alaska, and estrogen receptor/progesterone receptor–borderline patients were grouped with estrogen receptor/progesterone receptor–negative patients because of limited sample sizes of estrogen receptor/progesterone receptor–borderline patients.

Table 2.Rate of Reconstruction over Time by Race/Ethnicity, 1998 to 2014^{*}

	Year of Diagnosis																	<i>p</i>
	1998	1999	2000	2001	2002	2003	2005	2004	2006	2007	2008	2009	2010	2011	2012	2013	2014	
All patients	11.4	12.6	12.8	13.1	13.4	14.0	14.9	15.9	17.2	19.8	21.9	25.1	27.1	29.3	32.6	35.7	38.3	<0.001
Race/ethnicity																		
Non-Hispanic white	12.5	13.5	13.7	13.9	14.2	15.7	16.5	17.6	19.3	21.6	24.2	27.8	29.2	31.7	35.0	38.7	40.6	<0.001
Non-Hispanic black	9.6	12.7	10.2	10.4	12.1	10.8	12.0	15.1	13.9	16.8	16.7	19.9	23.8	25.5	28.8	29.7	36.5	<0.001
Hispanic	9.4	11.0	11.7	12.4	11.1	9.5	10.8	10.0	10.8	14.5	16.1	18.5	22.1	24.7	27.6	31.7	34.2	<0.001
Other	6.2	6.5	7.7	8.6	9.0	6.9	8.8	9.7	11.4	14.1	16.8	17.1	20.9	22.1	25.4	27.5	31.1	<0.001

^{*} Data presented as percentages.

Table 3.Adjusted Odds Ratios for Year of Diagnosis by Race ($n = 318,172$)

	Adjusted OR for Each Additional Year (95% CI) *	Interaction p
Race		<0.001
Non-Hispanic white	1.07 (1.07–1.08)	
Non-Hispanic black	1.08 (1.08–1.09)	
Hispanic	1.09 (1.08–1.09)	
Other	1.11 (1.10–1.12)	

* Odds ratios also adjusted for social support, age, insurance, patient region, grade, T stage, N stage, surgery type, and contralateral prophylactic surgery.

Table 4.

Patient Characteristics by Reconstruction Type *

	All Patients (%)	Reconstruction Type			p
		Tissue plus Implant (%)	Implant (%)	Tissue-Based (%)	
No.	59,166	8772	25,572	24,822	
Age, yr					
Median	51	51	51	51	
IQR	44–59	44–59	44–59	44–58	<0.001
Race/ethnicity					<0.001
Non-Hispanic white	45,135 (76.3)	6839 (78)	19,875 (77.7)	18,421 (74.2)	
Non-Hispanic black	5129 (8.7)	712 (8.1)	1746 (6.8)	2671 (10.8)	
Hispanic	4963 (8.4)	691 (7.9)	2142 (8.4)	2130 (8.6)	
Other	3759 (6.4)	505 (5.8)	1737 (6.8)	1517 (6.1)	
Insurance status					<0.001
Insured	40,165 (67.9)	6046 (68.9)	18,795 (73.5)	15,324 (61.7)	
Uninsured	413 (0.7)	54 (0.6)	182 (0.7)	177 (0.7)	
Unknown; diagnosed before 2007	18,169 (30.)	2613 (29.8)	6391 (25)	9165 (36.9)	
Income (in tens) [†]					
Median	5797	5795	5885	5795	
IQR	5159–7048	5154–7198	5190–7196	5107–7048	0.003
Patient region					<0.001
Alaska	24 (0)	1 (0)	11 (0)	12 (0)	
East	26,438 (44.7)	3863 (44)	9984 (39)	12,591 (50.7)	
Northern Plains	7148 (12.1)	1351 (15.4)	3267 (12.8)	2530 (10.2)	
Pacific Coast	23,041 (38.9)	3331 (38)	11,157 (43.6)	8553 (34.5)	
Southwest	2515 (4.3)	226 (2.6)	1153 (4.5)	1136 (4.6)	
Laterality					0.71
Bilateral	4 (0)	0 (0)	2 (0)	2 (0)	
Unilateral	59,155 (100)	8770 (100)	25,568 (100)	24,817 (100)	
Grade					<0.001
1	10,478 (17.7)	1585 (18.1)	4799 (18.8)	4094 (16.5)	

	Reconstruction Type				p
	All Patients (%)	Tissue plus Implant (%)	Implant (%)	Tissue-Based (%)	
2	24,367 (41.2)	3610 (41.2)	10,708 (41.9)	10,049 (40.5)	
3	20,815 (35.2)	3090 (35.2)	8620 (33.7)	9105 (36.7)	
Unknown	3506 (5.9)	487 (5.6)	1445 (5.7)	1574 (6.3)	
Tumor size, cm					
Median	1.8	1.8	1.8	1.8	
IQR	1–3	1–3	1–2.8	1–3	<0.001
T stage					<0.001
T0/Tis	256 (0.4)	42 (0.5)	124 (0.5)	90 (0.4)	
T1	33,770 (57.1)	5009 (57.1)	14,883 (58.2)	13,878 (55.9)	
T2	18,553 (31.4)	2699 (30.8)	7986 (31.2)	7868 (31.7)	
T3	4329 (7.3)	679 (7.7)	1792 (7)	1858 (7.5)	
T4	1040 (1.8)	147 (1.7)	339 (1.3)	554 (2.2)	
TX	1174 (2)	188 (2.1)	433 (1.7)	553 (2.2)	
N stage					<0.001
N0	36,782 (62.2)	5532 (63.1)	16,141 (63.1)	15,109 (60.9)	
N1	17,102 (28.9)	2526 (28.8)	7171 (28)	7405 (29.8)	
N2	3351 (5.7)	440 (5)	1435 (5.6)	1476 (5.9)	
N3	1538 (2.6)	222 (2.5)	691 (2.7)	625 (2.5)	
NX	349 (0.6)	44 (0.5)	119 (0.5)	186 (0.7)	
Treatment with chemotherapy	31,529 (53.3)	4552 (51.9)	13,709 (53.6)	13,268 (53.5)	0.02
Treatment with radiation therapy	11,718 (19.8)	1720 (19.6)	5160 (20.2)	4838 (19.5)	0.15
Timing of radiation therapy [‡]					0.07
Neoadjuvant radiation therapy only	122 (1)	14 (0.8)	47 (0.9)	61 (1.3)	
Neoadjuvant and adjuvant radiation therapy	70 (0.6)	18 (1)	26 (0.5)	26 (0.5)	
Adjuvant radiation therapy only	11,471 (97.9)	1681 (97.7)	5065 (98.2)	4725 (97.7)	
Other (intraoperative/unknown)	55 (0.5)	7 (0.4)	22 (0.4)	26 (0.5)	
Surgery type					<0.001
Simple/complete mastectomy	34,789 (58.8)	5166 (58.9)	15,804 (61.8)	13,819 (55.7)	
Modified radical mastectomy	23,895 (40.4)	3470 (39.6)	9657 (37.8)	10,768 (43.4)	
Radical mastectomy	482 (0.8)	136 (1.6)	111 (0.4)	235 (0.9)	

	Reconstruction Type				p
	All Patients (%)	Tissue plus Implant (%)	Implant (%)	Tissue-Based (%)	
Contralateral prophylactic	24,024 (40.6)	3354 (38.2)	11,664 (45.6)	9006 (36.3)	<0.001

IQR, interquartile range.

* Patients with known reconstruction type only. Percentages may not add up to 100 because of rounding or missing values.

[†] Available for 19,136 patients only.

[‡] Of number of patients who were treated with radiation therapy.

Table 5.
Logistic Model Predicting Tissue-Based versus Implant Reconstruction ($n = 46,870$)

	OR (95% CI)	<i>p</i>	Overall <i>p</i>
Age	1 (0.999–1.002)	0.64	0.64
Race/ethnicity			<0.001
Non-Hispanic white	Reference		
Non-Hispanic black	1.517 (1.416–1.625)	<0.001	
Hispanic	1.224 (1.143–1.31)	<0.001	
Other	1.129 (1.045–1.221)	0.002	
Year of diagnosis	0.949 (0.941–0.957)	<0.001	<0.001
Insurance status			0.04
Insured	Reference		
Uninsured	1.082 (0.868–1.349)	0.48	
Unknown; diagnosed before 2007	1.102 (1.02–1.19)	0.01	
Patient region			<0.001
Pacific Coast/Alaska	Reference		
East	1.643 (1.575–1.715)	<0.001	
Northern Plains	0.959 (0.899–1.023)	0.20	
Southwest	1.223 (1.115–1.342)	<0.001	
Social support			0.14
No	Reference		
Yes	1.032 (0.99–1.075)	0.14	
Grade			0.001
1	Reference		
2	1.033 (0.981–1.087)	0.22	
3	1.097 (1.039–1.159)	<0.001	
T stage			<0.001
T1	Reference		
T0/Tis	0.699 (0.467–1.048)	0.08	
T2	1.037 (0.993–1.083)	0.10	
T3	1.137 (1.053–1.228)	0.001	

	OR (95% CI)	p	Overall p
T4	1.553 (1.335–1.807)	<0.001	0.35
TX	1.163 (0.992–1.364)	0.06	
N stage			
N0	Reference		
N1	0.976 (0.933–1.021)	0.29	
N2	1.011 (0.929–1.101)	0.80	
N3	0.911 (0.806–1.029)	0.13	<0.001
NX	0.976 (0.933–1.021)	0.29	
Surgery type			
Simple/complete mastectomy	Reference		
Modified radical mastectomy	1.035 (0.991–1.081)	0.12	<0.001
Radical mastectomy	1.814 (1.424–2.31)	<0.001	
Contralateral prophylactic	0.771 (0.741–0.802)	<0.001	