Health Insurance and Breast-Conserving Surgery With Radiation Treatment

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ABSTRACT

Objectives

To examine the impact of health insurance type on treatment of early-stage breast cancer using breast-conserving surgery (BCS) with radiation therapy (RT) among women in Florida and identify factors that contribute to the variations in receiving the treatment in women with the same health insurance type.

Study Design and Methods

Breast cancer cases diagnosed during 1997 to 2002 were obtained from the Florida Cancer Data System. Women 40 years and older diagnosed with localized breast cancer were included. Demographic, insurance, and treatment information were extracted and linked with 2000 census data. χ^2 and multilevel logistic regression analyses were used.

Results

A total of 33,706 women were diagnosed with localized breast cancer in Florida during 1997 to 2002. The average age of the women was 66 years, 58.62% had BCS while 38.61% had mastectomy, and only 2.77% had no surgical treatment. Type of health insurance plays a significant role in receiving BCS with RT. Furthermore, we found significant variations in the use of BCS with RT among women who have the same type health insurance by marital status, age, tumor size, year of diagnosis, level of education, and poverty level.

Conclusions

Although clinical practice guidelines recommend BCS with RT to treat women with localized breast cancer, significant differences in receiving the recommended treatment is found between and within types of health insurance. Identifying cultural barriers and educating the public about available treatment options are the major policy implications of this study. These observed differences require further study.

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Breast cancer occurs in both genders; however, it is the second leading cause of cancer death in women, behind only lung cancer.[1] Florida ranks third in the United States for new breast cancer cases and for breast cancer deaths.[1] There are variations in the incidence and mortality in breast cancer by race and ethnicity, and certain racial and ethnic groups are more vulnerable to breast cancer than others.[2] For example, white women are more likely to be diagnosed with breast cancer, while black women are more likely to die from it.[3] Differences in survival rates have been attributed to a variety of causes: late-stage diagnosis, type of treatment, characteristics of the tumor, and type of health insurance.[3-7] Specifically, it has been reported that Medicaid-insured patients with breast cancer have the lowest 8-year survival rates.[8]

Since 1990, the death rates for breast cancer have been steadily declining due to earlier detection and improved treatment.[1] Receiving timely treatment for newly diagnosed breast cancer is an important predictor of patient survival for localized breast cancer.[9] Women treated for localized breast cancer are more likely to survive than women treated for late-stage cancer.[10] Surgery (breast-conserving surgery [BCS], partial mastectomy, or full mastectomy), chemotherapy, radiation therapy (RT), and hormone therapy are some of the treatment options available for patients with breast cancer. Breast conservation therapy with radiation and mastectomy are equally effective for early-stage breast cancer and have similar survival rates.[11-15] The National Institutes of Health Consensus Development Conference on Treatment of Early-Stage Breast Cancer[16] recommends BCS with RT as the appropriate therapy for stage 1 and stage 2 breast cancer. BCS with RT is preferable to total mastectomy because it preserves the breast without shortening survival. The advantages of improved self-image and emotional well-being may make BCS the preferred treatment choice for women with stage 1 or stage 2 breast cancer.[13]

Decisions related to treatment options for early-stage breast cancer can be influenced by several intertwined factors

that operate at various levels. Even though BCS/RT and mastectomy are equally recommended treatments, the mastectomy rate in the late 2000s has increased to a rate similar to that of the 1990s, after showing a substantial decline in the early/mid 2000s.[17] In fact, excessive use of mastectomy has been well documented.[18] The preference for mastectomy has been attributed particularly to misconceptions about BCS and physicians' use of inappropriate selection criteria.[19] Other studies have shown that choosing BCS is influenced by type of health insurance,[8] marital status,[20] and level of high school education attained.[21,22] A recent study has documented that while BCS has become an increasingly popular choice, the use of RT after BCS has been decreasing.[23]

Take-Away Points

Examined the impact of type of health insurance in receiving BCS with radiation and identified factors that contribute to such variations among women diagnosed with early-stage breast cancer who were covered with the same insurance.

- Type of health insurance was significantly associated with the likelihood of receiving BCS with radiation.
- Significant differences were found by race, marital status, age, and education among women who have the same health insurance.
- Identify barriers and develop interventions to educate certain demographics to bridge the gap in treatment disparities.

The literature on the effect of the type of health insurance a woman has on the use of RT after BCS presents an unclear picture. A study that used data from the Metropolitan Detroit Cancer Surveillance System (n = 5719) found that women insured with Medicaid were less likely to use BCS with RT than women who were not insured with Medicaid.[8] Another study that used data obtained from 4 hospitals in the metropolitan New York area (n = 731) documented that Medicaid-insured and uninsured women were also less likely to use RT after BCS relative to privately insured or Medicare-insured women.[24] Both studies used data collected between 1994 and 1997. Using data collected between 1997 and 2000 (n = 23,817) from the Florida Cancer Data System (FCDS), Voti and colleagues reported that while Medicare-insured women were more likely to use standard treatment (mastectomy or BCS with RT) for local breast cancer than privately insured women, the uninsured as well as Medicaid-insured were less likely to use standard treatment for local breast cancer than privately insured women.[20]

The aim of this study was to examine the impact of health insurance type on treatment of early-stage breast cancer using the recommended BCS with RT, and identify factors that contribute to women's decision to choose such treatment. An additional aim of the study was to investigate racial/ethnic differences in the use of recommended treatment.

This study has 3 specific objectives: (1) to examine the impact of health insurance type and other socioeconomic and demographic factors on the use of BCS in combination with RT among women diagnosed with local breast cancer in Florida between 1997 and 2002 using a multilevel approach; (2) to investigate racial/ethnic differences in the use of recommended treatment and identify additional factors that contribute to the differences among women who were covered with the same type of health insurance; and (3) to analyze the trends in the use of recommended RT after BCS using a statewide cancer registry system.

There has been an unmet need for research on the relationship between race/ethnicity and the availability of advanced and shifting treatment choices and the role of health insurance type in eliminating health disparities. This study attempts to fill the gap in our knowledge about the impact of type of health insurance and other social and demographic factors on the use of RT after BCS and identify common and unique factors that contribute to disparities in the use of recommended treatment for breast cancer. The ongoing debate about health insurance and access to healthcare, in particular with the 2010 enactment of the Affordable Care Act (ACA), makes this study not only important, but timely.

In this paper, we used the Health Seeking Behavior Model (HSBM), the first conceptual behavioral model developed mainly to deal with public health problems,[25] to examine factors associated with the likelihood of receiving BCS with radiation. The HSBM provides a useful theoretical framework and may help us better understand treatment choices women make after receiving a localized breast cancer diagnosis. It specifically models how patients use or do not use different kinds of health services. According to the model, factors related to use of healthcare services are characteristics of the patient (age, sex, marital status, ethnicity, education, and resources), service characteristics, and the characteristics as well as the patient's perception of the disorder. The HSBM has been used to investigate the choices people make about whether or not to use various health services.[26]

METHODS

Data Source

To examine the impact of health insurance coverage on receiving BCS with RT for localized breast cancer, we

obtained data for the years 1997 to 2002 from the FCDS. This registry began collecting data in 1981 on the incidence of cancer. Hospitals, ambulatory diagnostic and treatment centers, clinical laboratories, and physicians' offices are required by Florida law to electronically report most malignant cancers on a quarterly basis.

The database contains patient demographic information, characteristics of the tumor, insurance status and type, type of treatment received, as well as the provider's identification information. To examine the impact of poverty and education, we linked FCDS data with the 2000 United States Census at the census tract level.

Study Population

Women 40 years and older who were diagnosed with localized breast cancer during the time period of 1997 to 2002 were included in the study. Only new cases of breast cancer were included in the study. Patients presenting with recurring breast cancer were excluded. Census data for the year 2000 was used because this year represents the midpoint of the study period. Cases with missing or unknown values for the study variables were excluded from the analysis. The linkage between the FCDS and census data was completed using state, county, and census tract codes. The data extraction and linkage process is summarized and shown in **eAppendix A** (available at **www.ajmc.com**).

Study Variables

The outcome variable of interest was a dichotomous variable indicating the choice of treatment for localized breast cancer. Localized breast cancer is defined as cancer that originated in the breast and has not spread to the surrounding tissue or organs. The types of surgical treatment for localized breast cancer are BCS and mastectomy. BCS is defined as partial mastectomy with nipple resection, lumpectomy or excisional biopsy, reexcision of the biopsy site for gross or microscopic residual disease, and segmental mastectomy (including wedge resection, quadrantectomy, tylectomy). Mastectomy is defined as subcutaneous mastectomy, total (simple) mastectomy, modified radical mastectomy, radical mastectomy, and extended radical mastectomy. The FCDS also allows entries for no surgery, surgery, not otherwise specified, and unknown. Surgery, not otherwise specified, and unknown were not included in the analysis. The FCDS data include 9 categories of RT: no radiation; beam radiation; radioactive implant; radioisotopes; combinations of beam radiation with radioactive implants or radioisotopes (combination of 1 with 2 and/or 3); RT method or source not specified (NOS); patient or patient's guardian refused; RT recommended, unknown if administered; and unknown if RT administered. The following categories were not included in this study: RT recommended, unknown if administered and unknown if RT administered.

The treatment guidelines for localized breast cancer from the NCCN[12] recommends a lumpectomy followed by RT of varying intensities. FCDS includes both the date of surgery and the date radiation was administered, allowing the researcher to see if radiation treatment was administered after surgery.

The dependent variable is the use (code value 1) or nonuse (code value 0) of BCS with RT. The following individual-level explanatory variables were identified: patient's type of health insurance, age, race, marital status, tumor size, and year of diagnosis. Insurance status was defined by the primary method of payment at the time of diagnosis, and it has 5 categories. Marital status represented the marital status of the women at the time of diagnosis. Age represented age at diagnosis. The census tract-level variables were represented as percent with a high school education and percent who were below the poverty level. Education was defined as a percentage of adults 25 years and older who have a high school diploma (from census tract). The poverty level was defined as the percentage of population with income in 1999 below the poverty level. A list of the independent variables used, definitions, and how they were measured or coded are presented in **eAppendix B**.

Statistical Analysis

We applied a multilevel logistic regression analysis to examine how individual and census tract-level factors are associated with receiving recommended BCS with RT. We used a 2-level logistic regression to account for the clustering of women within census tracts with the assumption that they shared the same environment. The model we used can be summarized as follows:

Let y_{ij} represent a binary treatment option of the i^{th} woman diagnosed with localized breast cancer living in the j^{th} census tract. The probability that this woman will receive BCS with radiation, $p_{ij} = P(y_{if} = 1)$, is modeled using

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = x_{ij}^{T}\beta + u_j \qquad (1)$$

where x_{ij}^{T} is the vector of observed individual and census tract covariates, β is the vector of regression coefficients to be estimated and u_j is the census tract-level random effect. The random effect u_j represents unobserved census-tract factors that affect treatment choice and is shared by all

Table 1. Descriptive Statistics of Selected Characteristics of Women Diagnosed With Early-Stage Breast Cancer, Florida, 1997-2002 (n = 33,706)

Variable	Mean (SD)	Percentage	Variable	Percentage
Age (years)	66.16 (12.72)		**Year of diagnosis**	
40-49		12.79	1997	10.70
50-59		19.03	1998	16.15
60-69		23.75	1999	17.60
70 and above		44.43	2000	17.66
Marital status			2001	19.55
Married		57.65	2002	18.35
Separated		0.53	**Treatment options**	
Single		8.50	BCS	58.62
Divorced		9.17	Mastectomy	38.61
Widowed		24.15	No surgery	2.77
Race/ethnicity			Radiation after BCS	47.45
Non-Hispanic white		86.07	**Tumor size**	
Non-Hispanic black		5.59	<2 cm	64.96
Hispanic		7.73	≥2 cm	27.24
Other		0.61	Unknown	7.80
Insurance				
Private		31.54		
Medicaid		1.74		
Medicare		50.12		
Others		14.07		
Uninsured		2.54		

BCS indicates breast-conserving surgery.

women residing in census tract j. The distributional assumptions made about u_j were $u_j \sim N(0, \sigma_u^2)$. Odds ratios (ORs) and 95% CIs for each predictor variable considered were estimated overall and for each health insurance type. Log-likelihood ratio test was employed to assess goodness of fit of the estimated models. All the statistical analyses in this study were performed using STATA 11 and all statistical tests were 2-sided.

RESULTS

Descriptive Findings

The descriptive statistics of selected characteristics of women used in this study is presented in Table 1. The mean age at diagnosis was 66 years for the study period 1997 to 2002. Most women were 60 years and above (68.18%), married (57.65%), and non-Hispanic/white (86.07%). The distribution of women by health insurance type was 31.54% privately insured, 1.74% Medicaid, 50.12% Medicare, 14.07% other, and 2.54% uninsured. The primary payers for more than 81% of women in this study were either Medicare or private insurers. The majority of women (58.62%) received BCS. The remaining women had a mastectomy (38.61%) or received no surgery (2.77%). Of those who received BCS, only 47.45% received RT following BCS. Overall, 27.81% women received BCS with RT. In total, 65% of tumors were below 2 cm, 27.24% were 2 cm or larger, and 7.8% had an unknown size.

Table 2 provides the distribution of surgical treatment by type of insurance, race/ethnicity, marital status, age, tumor size, and year of diagnoses. The first 3 columns add up to 100%. The percentages presented in the last column were calculated among women who received BCS treatment. χ^2 analysis showed significant associations between each of the predictor variables listed in Table 2 and surgical treatment choice. Medicaid-insured and uninsured women were less likely to have surgical treatment than women with either private health insurance or Medicare or "other" types of government insurance (P <.01). The majority of women with private (61.67%), Medicare (57.22%), and other (60.24%) insurance received BCS. The percentage of women who received BCS among Medicaid-

Table 2. Percentage Distribution of the Study Population by Selected Characteristics and Surgical Treatment (n = 33,706)

Variables	Surgical Treatment			Radiation After BCS[a]
	No Surgery	BCS	Mastectomy	
Insurance				
Medicaid (n = 585)	5.64	47.18	47.18	41.30
Private (n = 10,631)	2.36	61.67	35.97	45.93
Medicare (n = 16,894)	2.44	57.22	40.34	47.87
Other (n = 4741)	3.52	60.24	36.24	51.05
Uninsured (n = 855)	8.19	47.13	44.68	40.94
Race/ethnicity				
Non-Hispanic white (n = 29,012)	2.60	59.47	37.94	47.83
Non-Hispanic black (n = 1883)	4.67	54.49	40.84	45.13
Hispanic (n = 2604)	3.22	53.19	43.59	43.83
Other (n = 207)	4.35	44.93	50.72	57.00
Marital Status				
Married (n = 19,430)	2.63	60.31	37.06	49.94
Separated (n = 178)	4.49	54.50	41.01	39.18
Single (n = 2865)	3.94	56.58	39.48	41.21
Divorced (n = 3092)	3.01	58.57	38.42	43.81
Widowed (n = 8141)	2.55	55.40	42.05	46.44
Age (years)				
40-49 (n = 4311)	3.50	58.11	38.39	43.23
50-59 (n = 6414)	3.10	61.59	35.31	48.94
60-69 (n = 8004)	2.49	60.11	37.40	51.44
70 and + (n = 14,977)	2.57	56.69	40.74	45.74
Tumor size				
<2 cm (n = 21,895)	1.96	66.00	32.04	50.79
≥2 cm (n = 9181)	2.84	44.86	52.29	39.82
Unknown (n = 2630)	9.24	45.17	45.59	33.33
Year of diagnosis				
1997 (n = 3606)	5.32	29.59	65.09	36.18
1998 (n = 5442)	3.14	55.27	41.58	55.25
1999 (n = 5931)	2.18	60.41	37.41	53.17
2000 (n = 5952)	2.17	62.11	35.72	49.15
2001 (n = 6589)	1.99	65.96	32.05	43.19
2002 (n = 6186)	2.94	65.57	31.49	42.60

BCS indicates breast-conserving surgery.
[a]This percentage was calculated of those who had BCS and the denominator was the number of women who underwent BCS in each category.

insured and uninsured women was less than 50% and almost identical (47.18% and 47.13%). Furthermore, there were significant variations by health insurance in the type of surgical treatment received. The percentages of women who received RT after BCS were similar for those insured by Medicaid and those uninsured (41.30% and 40.94%, respectively) and lower compared with women insured privately (45.93%), through Medicare (47.87%), and through other government programs (51.05%). It is important to note that the results presented in Table 2 show that in addition to substantial variations in women's surgical treatment within a specific type of health insurance, there were also considerable differences between types of health insurance coverage. More specifically, the bivariate analysis reveals that women who were either Medicaid beneficiaries or uninsured had a significant disadvantage in

receiving BCS as well as the recommended RT following BCS than women insured by the other 3 health insurance types.

Concerning racial/ethnic differences, non-Hispanic black women were more likely to have no surgery than non-Hispanic white women (P <.01). Similarly, separated, single, and divorced women were less likely to have surgery than married women (P <.01). Married women (49.94%) received RT after BCS at a higher rate than separated (39.18%), single (41.21%), divorced (43.81%), or widowed (46.44%) women. Older women (70+ years) were less likely to receive surgery than women in other age categories. Specifically, patients older than 70 years (45.74%) or 40 to 49 years (43.23%) were less likely to receive RT after BCS relative to women 50 to 69 years (48.94%) and 60 to 69 years (51.44%). Patients with a tumor smaller than 2 cm (50.79%) were more likely to get RT after BCS than women with a tumor 2 cm or larger (39.82%). The percentage of women with no surgery decreased from 5.32% in 1997 to 2.94% in 2002. Despite an upward trend in the use of BCS between 1997 and 2002 to treat early-stage breast cancer among women, the use of RT following BCS did not follow a similar trend.

Results From Multilevel Logistic Regression

Multilevel multivariate logistic regression was used to investigate the impact of health insurance and to identify factors related to receiving the recommended treatment for women diagnosed with early-stage cancer. Age-squared was included in the models to capture the nonlinearity of age in affecting use of BCS with radiation. The percentage of the study population with income below the poverty level and the percentage of those who were 25 years and older and had a high school diploma were skewed, thus natural logarithm transformations of these variables were used in the regression models. The regression analysis was restricted to non-Hispanic whites, non-Hispanic blacks, and Hispanics due to the small sample size for the other race categories. Women who were separated were also excluded from the analysis due to the small sample size.

Predictors of BCS With RT: Non-Stratified Analysis

Table 3 presents the likelihood of receiving BCS with radiation, using a 2-level logistic regression model. The results show that health insurance type had a significant impact on which patients received BCS with radiation even after controlling for sociodemographic factors. The odds of receiving RT after BCS decreased by 27% (OR = 0.73; 95% CI, 0.60-0.88) among women without health insurance relative to women with private health insurance. On the other hand, Medicare-insured women were more likely (OR = 1.10; 95% CI, 1.02-1.18) to receive the recommended treatment than women insured privately. Moreover, women insured by "other" insurance programs (other than Medicaid or Medicare, including Tricare, Military, Veterans Affairs, and Indian/Public Health Services) were more likely (OR = 1.10; 95% CI, 1.01-1.19) to receive the recommended treatment than women who were insured privately. However, women insured by Medicaid were not significantly different from women insured by private health insurance (OR = 0.80; 95% CI, 0.64, 1.01) in their likelihood of having the recommended treatment.

The impact of race/ethnicity was not significant in who received the recommended treatment. The effect of marital status was significant, however. Single, divorced, or widowed women were significantly less likely to receive BCS with RT compared with married women. Age also had a significant effect on receiving BCS with RT. As a woman gets older, she is more likely to receive the recommended treatment; however, the increase was not linear, as it began to decline starting at 70 years (Table 2) and by the estimated coefficient of age-squared. As expected, tumor size also had a significant impact on the odds of receiving RT after BCS. Patients with a tumor 2 cm or larger had significantly lower odds of having RT after BCS (OR = 0.45; 95% CI, 0.43-0.49). In addition, year of diagnosis was significantly associated with use of BCS with RT. Women diagnosed in 1997 were significantly less likely to receive the recommended treatment compared with women diagnosed in 2002.

Moving on the to the impacts of census tract variables, women who resided in census tracts with higher percentages of individuals with at least a high school education were found to be significantly associated with higher odds of receiving RT after BCS. This finding is consistent with those reported in the literature: that women with low education levels are at a disadvantage with respect to breast cancer treatment. The other census tract-level predictor variable considered in this analysis—percentage of people living below poverty—was not significant. The estimate of the random effects variation at the census tract-level was highly significant. This indicates the appropriateness of the multilevel modeling approach in our analysis instead of using the commonly used multivariate logistic regression, which does not take into account the correlation among women who resided in the same neighborhood, as they may be influenced by observed or unobserved common environmental factors.

Table 3. Multilevel Logistic Regression of Receiving BCS With Radiation Treatment, Florida, 1997-2002 (n = 33,668)

Variables	Odds Ratio	95% CI	
Insurance			
Private (ref)	1.00	—	—
Medicaid	0.80	0.64	1.01
Medicare	1.10[b]	1.02	1.18
Other	1.10[b]	1.01	1.19
Uninsured	0.73[a]	0.60	0.88
Race/ethnicity			
Non-Hispanic white (ref)	1.00	—	—
Non-Hispanic black	1.04	0.92	1.17
Hispanic	0.93	0.83	1.04
Marital status			
Married (ref)	1.00	—	—
Single	0.77[a]	0.70	0.85
Divorced	0.90[b]	0.82	0.98
Widowed	0.91[b]	0.85	0.97
Age at diagnosis			
Age	1.15[a]	1.13	1.18
Age^2	0.99[a]	0.98	1.00
Tumor size			
<2 cm (ref)	1.00	—	—
≥2 cm	0.45[a]	0.43	0.49
Unknown	0.38[a]	0.34	0.43
Year of diagnoses			
1997	0.35[a]	0.28	0.36
1998	1.16[a]	1.07	1.27
1999	1.24	1.14	1.35
2000	1.14[a]	1.05	1.24
2001	1.03	0.95	1.12
2002 (ref)	1.00	—	—
% Below poverty	1.04	0.97	1.13
% High school	2.69[a]	2.01	3.60
Random effects σ (sigma)	0.49[a]		
Standard error	(0.02)		

BCS indicates breast-conserving surgery.
[a]P <.01; [b]P <.05.

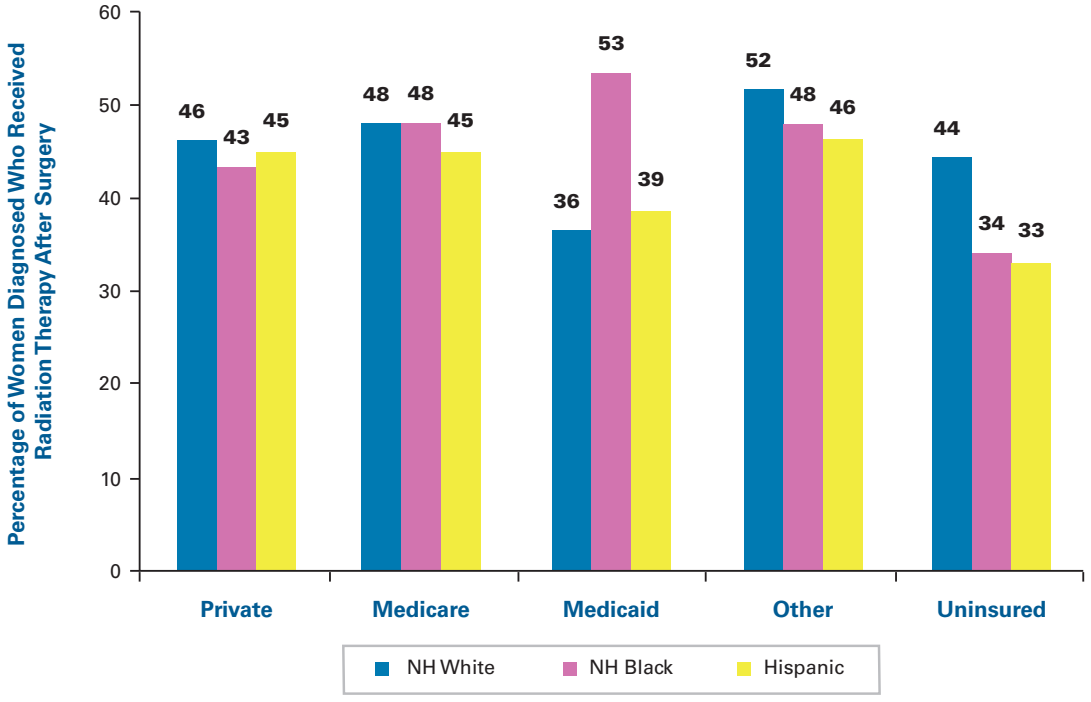
Predictors of BCS With RT Stratified by Health Insurance Type

Our findings show that receiving the recommended BCS followed by RT among women diagnosed with early-stage breast cancer varied substantially by type of health insurance. Of note is the fact that 1 of the objectives of this study was to investigate whether racial/ethnic disparities exist in the receipt of RT after BCS among patients insured by the same type of health insurance. To meet this objective, before we ran the multilevel regression models that included other predictors and controls, we explored the bivariate relationships between race/ethnicity and the receipt of RT after BCS by controlling for the type of health insurance. The **Figure** displays the percentage of women who received RT following BCS by race/ethnicity for each health insurance type. A χ^2 test was also conducted to measure associations between race/ethnicity and the receipt of RT after BCS for each health insurance type.

Race/ethnicity was unrelated to the receipt of RT following BCS among women who were insured privately, through Medicare, had "other" insurance, or were uninsured. However, among Medicaid-insured women, there was significant association (P <.05) between race/ethnicity and the receipt of RT after BCS. Among Medicaid-insured women, non-Hispanic white women (36%) and Hispanic women (39%) were less likely to receive RT following BCS compared with non-Hispanic black women (53%). It is also noteworthy to indicate that uninsured non-Hispanic white women fared better (44%) than Medicaid-insured non-Hispanic white women (36%) in receiving RT after BCS.

We were further interested in whether the significant racial/ethnic differences in using the recommended treatment among Medicaid-insured women observed in the Figure would hold true when the effects of other factors were controlled. Therefore, in an attempt to better understand what other factors may also contribute to such differences, and to identify barriers to the receipt of the recommended treatment, we analyzed the data stratified by health insurance type. To achieve this, 5 separate insurance-specific multilevel logistic regressions were fitted. The large sample size we used gave us the opportunity to detect associations by fitting regression

Figure. Percentage of Women Diagnosed With Early-Stage Breast Cancer Who Received Radiation Therapy After Breast-Conserving Surgery by Type of Health Insurance and Race/Ethnicity, Florida, 1997-2002



models stratified by health insurance type without being worried that the power of the test may diminish. The results are presented in Table 4.

Consistent with the results displayed in the Figure, after controlling for the effects of marital status, age, size of tumor, year of diagnosis, poverty and education, we found that in the group of women insured by Medicaid, non-Hispanic black women were more likely to have the recommended treatment than were non-Hispanic white women (OR = 2.08; 95% CI, 1.13-3.83). No significant difference was found by race/ethnicity in the likelihood of receiving the recommended treatment among women insured with the other 4 health insurance types. It is important to note that, although statistically non-significant, among the uninsured women, non-Hispanic black women (27%) and Hispanic women (25%) were less likely to receive RT after BCS relative to non-Hispanic white women. Single women were 19% (OR = 0.81; 95% CI, 0.69-0.94) and 24% (0.76; 95% CI, 0.64-0.90) less likely to receive BCS with RT than married women in the privately insured and Medicare populations, respectively. Age at diagnosis as well as age-squared were also significant predictors in the receipt of the recommended treatment, except in the uninsured group, suggesting that the nonlinear effect of age still holds in the insurance-specific models. As expected, tumor size and the likelihood of receiving BCS with RT were inversely related. Year of diagnosis was not significantly related to the use of the recommended treatment among Medicaid-insured women. But significant relationships between year of diagnosis and the use of recommended treatment were found among women in the remaining health insurance types showing that women who were diagnosed with early stage breast cancer in 1997 were significantly less likely to receive the recommended treatment than were women diagnosed in 2002.

Concerning the effects of census tract-level variables, contrary to our expectation, an increase in the poverty levels for the census tracts in which the women resided were positively associated with the likelihood of getting the recommended treatment in the Medicaid-insured women. The effect of education in receiving the recommended treatment was consistent and significant across all health insurance types, indicating that women who lived in neighborhoods that had higher percentages of educated population had an increased likelihood of receiving the recommended treatment. The census tract-level random intercept estimates were significant in the private, Medicare, and "other" health insurance type models. Again, this indicated the appropriateness of our modeling approach since failing to account for the corre-

Table 4. Multilevel Logistic Regression of Receiving BCS with Radiation Treatment by Health Insurance Type, Florida, 1997-2002

	Private (n = 10,619)		Medicaid (n = 585)		Medicare (n = 16,875)		Other (n = 4735)		Uninsured (n = 854)	
Variables	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Race/ethnicity										
Non-Hispanic white (ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
Non-Hispanic black	1.13	0.94-1.36	2.08[b]	1.13-3.83	0.99	0.81-1.21	0.94	0.68-1.30	0.73	0.39-1.38
Hispanic	0.89	0.75-1.05	1.04	0.59-1.86	1.06	0.88-1.27	1.01	0.75-1.38	0.75	0.44-1.28
Marital status										
Married (ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
Single	0.81[a]	0.69-0.94	0.53	0.28-1.03	0.76[a]	0.64-0.90	0.82	0.65-1.03	1.14	0.65-2.01
Divorced	0.91	0.79-1.44	1.32	0.73-2.40	0.82[b]	0.70-0.96	1.03	0.83-1.28	1.66	0.99-2.8
Widowed	1.00	0.86-1.17	0.82	0.40-1.70	0.88[a]	0.81-0.96	0.87	0.67-1.13	1.17	0.59-2.32
Age at diagnosis										
Age	1.14[a]	1.09-1.18	1.26[b]	1.05-1.51	1.43[a]	1.34-1.52	1.10[a]	1.03-1.17	1.04	0.85-1.27
Age^2	0.99[a]	0.98-1.00	0.99[b]	0.98-1.00	0.99[a]	0.98-1.00	0.99[a]	0.98-1.00	1.00	0.99-1.00
Tumor size										
<2 cm (ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
≥2 cm	0.46[a]	0.42-0.52	0.28[a]	0.17-0.47	0.45[a]	0.41-0.49	0.48[a]	0.41-0.51	0.36[a]	0.23-0.56
Unknown	0.40[a]	0.33-0.49	0.13[a]	0.04-0.45	0.40[a]	0.34-0.47	0.29[a]	0.21-0.41	0.24[a]	0.23-0.56
Year of diagnosis										
1997	0.50[a]	0.19-0.32	0.52	0.19-1.42	0.34[a]	0.29-0.41	0.31[a]	0.23-0.43	0.27[a]	0.06-0.66
1998	1.30[a]	1.13-1.51	1.22	0.54-2.75	1.09	0.96-1.24	1.08	0.86-1.35	1.59	0.82-3.08
1999	1.14	0.99-1.31	1.60	0.77-3.33	1.27[a]	1.13-1.44	1.22	0.98-1.53	2.30[b]	1.19-4.44
2000	1.05	0.91-1.20	0.94	0.45-1.98	1.20[a]	1.06-1.36	1.10	0.87-1.38	1.61	0.84-3.08
2001	0.92	0.80-1.06	1.37	0.66-2.84	1.11	0.99-1.25	0.94	0.75-1.19	1.08	0.84-2.14
2002(ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
% Below poverty	1.06	0.96-1.16	1.86[b]	1.13-3.06	1.05	0.96-1.15	0.95	0.83-1.10	1.31	0.86-2.00
% High school	2.12[a]	1.36-3.30	5.72[b]	1.06-0.74	3.47[a]	2.25-5.34	2.11[b]	1.06-4.2	6.57[b]	1.38-31.32
Random effects σ (sigma)	0.37[a]		0.45		0.60[a]		0.48[a]		0.75	
Standard error	(0.05)		(0.65)		(0.03)		(0.07)		(0.4)	

BCS indicates breast-conserving surgery; OR, odds ratio.
[a]P <.01; [b]P <.05

lation among women who resided in a given census tract may have led to biased estimates and consequently to misleading conclusions.

DISCUSSION

Since the early 1990s, BCS in combination with RT has become a standard—a recommended treatment for eligible women with early-stage breast cancer—and has replaced mastectomy as the leading treatment because it provides similar outcomes to mastectomy while preserving the breast.[27] This study examined the impact of health insurance and other factors on the receipt of the recommended treatment over a 6-year period in the state of Florida. A distinguishing feature of our study was the simultaneous consideration of patient characteristics and community factors as predictors in the use of the recommended treatment for early-stage breast cancer using a multilevel modeling approach and an investigation of racial/ethnic disparities stratified by health insurance type. Data obtained from the FCDS for the period of 1997 to 2002 were merged with the 2000 census data. Descriptive statistics, χ^2 analysis, and multilevel logistic regression were used for data analysis. Our investigation on the impact of health insurance type on the receipt of recommended treatment accounted for the effects of other fac-

tors including race/ethnicity, age, marital status, size of tumor, year of diagnosis, poverty, and education, as well as unobserved factors at the census tract level that may contribute to receiving the treatment.

Overall, the average use of BCS and mastectomy between 1997 and 2002 were 58.62% and 38.61%, respectively. On the use of RT following BCS, we found that only 47.45% of women with early-stage breast cancer reported RT. According to the American College of Radiology,[27] close to 80% of patients with early-stage breast cancer are suitable candidates for breast-conserving therapy. However, it is reported that in the United States, only between 38% and 65% of patients choose this treatment. In addition to indicating an underuse of the recommended therapy in our study population, the lower rate may also be an indicator of a problem of underreporting in RT. Yet, the reported low rate of RT use following BCS is consistent with 2 previous studies that used FCDS.[20,28] Using the FCDS, Voti and colleagues[21] documented that 48.5% of women received RT after BCS between 1997 and 2000. Another study[29] that used year 2001 data from the FCDS documented a rate of 43% for 2001, which is in agreement with the rate reported for 2001 in Table 2 (43.19%). A study by McGuire and colleagues[30] found that mastectomy and BCS combined with RT rates for patients treated for invasive and in situ breast cancer at the Moffitt Cancer Center between 1994 and 2007 were 63.7% and 36.3%, respectively, although the authors acknowledge their study population was a more homogenous population with respect to socioeconomic status. Although the data they used came from patients treated in 1 center instead of from a state-wide cancer registry system, it still highlights the possibility of a serious problem of underreporting of RT in the FCDS.

Health Insurance Type and BCS With RT

Our analysis confirmed significant differences among women diagnosed with early-stage breast cancer in the use of recommended treatment by health insurance type. Differences in treatment options by health insurance have been reported in past studies.[6,20,31,32] Furthermore, the finding that women insured by Medicare were 10% more likely (OR = 1.10; 95% CI, 1.02-1.18) to receive BCS with radiation than were women with private health insurance is in agreement with 2 previous studies.[20,32] Similarly, women insured by "other" programs were also more likely to receive BCS with RT than women with private health insurance. Similar to Voti and colleagues,[20] our findings did show a trend that women enrolled under Medicaid were 20% (OR = 0.80, 95% CI, 0.64-1.01) less likely to receive the recommended treatment compared with privately insured women, although our findings were not statistically significant. One plausible explanation for the differences in receiving the recommended treatment between private insurance, Medicare, and "other" insurance could be related to reimbursement plans and treatment modalities available during the specific time the patient was treated, or to the amount of out-of-pocket co-payment, as reported in other studies.[20] The variations in type of treatment may also partly depend on possible differences in recommendations of the physician-based reimbursement schedules and incentives of health insurance plans, patient characteristics, and factors like comorbidity.[33]

In contrast to previous studies,[6,19-21] we found no difference in the receipt of recommended treatment by race/ethnicity in the nonstratified analysis. This could be attributed in part to the type of covariates we included as a control, as well as the multilevel approach we used. The relationship between age and the likelihood of receiving the recommended treatment was significant and nonlinear. The odds of a woman to undergo BCS with RT increased with age and then decreased for older women (after age 70 years). This finding was also similar to other studies.[19,32,35] As noted by Silliman and colleagues[35] and the American College of Radiology,[28] for women older than 70 years, omission of RT after BCS is a preferable option especially if the patient has comorbid conditions. Year of diagnosis also played a role in the likelihood of receiving BCS with RT, which was supported by the literature.[34] In contrast to 1 previous study that found a decrease in the use of the recommended treatment over time,[23] this study found an increase in the use of the recommended treatment over time. Our findings also showed that being unmarried was a risk factor for not receiving the recommended treatment. This finding was also in agreement with earlier, similar studies[20,35] and may be attributed to married women having more information and access to social support and social networks that encourage recommended treatment.

Before the analysis was stratified by health insurance type, of the 2 census tract-level variables included in our model, poverty was not associated with the receipt of recommended treatment. But living in a neighborhood with a higher education level was positively associated with an increased likelihood of receiving the recommended treatment. The environment in which patients reside exerts an important influence on the receipt of recommended treatment since neighborhoods with more educated people are capable of creating a higher percentage of patients who are informed about their health. Moreover, patients who

reside in neighborhoods where there is higher proportion of educated people are also likely to be educated themselves and therefore have more knowledge and awareness about their health, including cancer diagnostics and treatment. Also, they may have better access to timely and accurate information from community organizations, health clubs, or online sources regarding the importance of cancer screening and the availability of certain treatment options. A positive association of education and the receipt of recommended treatment was also supported by past research.[21,22,34,36]

Stratified Analysis of BCS With RT

In further analysis, this study sought to find the factors that were associated with variations in the receipt of BCS with RT among women who have had the same type of health insurance by estimating insurance-specific multilevel models. There were common as well as unique insurance-specific predictors of the use of recommended treatment. Education and tumor size were the only common significant factors that predicted the receipt of recommended treatment across all 5 types of health insurance coverage. Tumor size of 2 cm or larger and unknown size were significantly associated with receipt of BCS with RT less often compared with tumor size of less than 2 cm in the whole (nonstratified) analysis as well as across all insurance types. This is consistent with previous studies.[27,29,35,37] Age was also an important predictor in all types of health insurance except the uninsured. Year of diagnosis was a significant predictor in all but Medicaid-insured women. Results show an increase in the use of the recommended treatment in 2002 compared with 1997 among women insured by private, Medicare, or "other" insurance plans or who were not insured, while a modest trend was observed in the use of the recommended treatment in the period of 1997 to 2002 among Medicaid recipients. Single women were 19% (OR = 0.81; 95% CI, 0.69-0.94) and 24% (OR = 0.76; 95% CI, 0.64-0.90) less likely to receive BCS with RT than married women in the privately insured and Medicare populations, respectively.

In the privately insured and Medicare-insured groups, compared with married women, being single was significantly associated with less utilization of BCS with RT; divorced women and widows did not significantly differ from married women across all health insurance types. Financial considerations[35] related to the amount of copay and reimbursement schedules among single women, and better access to social support and social networks[21] among married women, are likely to contribute to the differences between single and married women in using BCS with RT in the privately insured and Medicare groups.

The most provocative findings of this study were that race/ethnicity and poverty were unique significant factors among Medicaid-insured women. Among women insured by Medicaid, non-Hispanic black women were more likely to receive the recommended treatment compared with non-Hispanic white women. In addition, among the same group of women, an increase in poverty rate was associated with the use of the recommended treatment. Additional thorough analyses were done to be sure that this finding was not related to some issues about the data and to get some insights behind the unexpected findings concerning the effects of race/ethnicity and poverty among women insured by Medicaid. Among Medicaid-insured women, the average age of non-Hispanic white and non-Hispanic black women were similar. Examination of the time trends in the receipt of the recommended treatment using year of diagnosis by race/ethnicity in the period of 1997 to 2002 showed no change for 1 particular group. Interaction effects of race/ethnicity by age, poverty level, and education were not significant. Excluding either of the census tract variables poverty or education from the models did not change the ORs in any significant manner. Hence, among women insured by Medicaid, it does not appear that the finding that non-Hispanic black patients were more likely to use BCS with RT compared with non-Hispanic white women is an artifact of some model misspecification. Our result is also similar to a study by Koehlmoos[28] which reported that non-Hispanic black patients on Medicaid in Florida in 2001 had the highest rate of RT use. We are unsure why non-Hispanic black women and residents in neighborhoods with a high percentage of poor people were associated with an increased likelihood of receiving the recommended treatment. It is possible that interventions that targeted non-Hispanic black residents and poor neighborhoods or low socioeconomic classes regarding early breast cancer diagnosis and treatment during or before the study period may have created an informed community that is more likely to seek the recommended treatment. Government and non-governmental programs and interventions that aim to reduce racial/ethnic disparities in breast cancer mortality by targeting minorities and women from low socioeconomic status may have contributed toward closing or surpassing the racial/ethnic gap in cancer treatment among Medicaid-insured women by creating awareness and disseminating vital information about the importance of early cancer screening and treatment. For example, the National Breast and Cervical Cancer Early Detection Program that

was created in response to the Breast and Cervical Cancer Mortality Prevention Act of 1990 and administered by the CDC funds the Florida Breast and Cervical Cancer Early Detection Program (FBCCEDP).[38] Through funding from the CDC, the FBCCEDP is administered via the state Medicaid program and has provided breast cancer screening and diagnostic services since 1994. Since mid-2001, the program has been providing paid breast and cervical cancer treatment through Medicaid for eligible women.[38] As this funding is administered via state Medicaid programs, including Florida, this program is hopefully having a significant effect among minorities and low-income women in expanding early breast cancer screening and treatment services. It is also expected that the ACA will significantly expand the health insurance coverage of Americans regardless of pre-existing conditions and hence provide access to low-income women to get early screening and recommended treatments without delay.

Two separate studies[6,37] have analyzed Medicaid-insured data separately and both have documented the ORs of black versus white patients in the receipt of BCS with RT. Bradley, Given, and Roberts[7] reported that among women who were insured by Medicaid, black women were more likely to have BCS for cancer (OR = 1.63, 95% CI, 1.33-1.98) than white women. The comparison for BCS with RT was not significant (OR = 1.07, 95% CI, 0.82-1.37), although black women were 7% more likely to receive BCS with RT compared with white women. A study by Kimmick and colleagues[37] also reported a nonsignificant difference in the receipt of BCS with RT (OR = 0.75, 95% CI, 0.40-1.40) between black and white patients in the use of BCS with RT. Consequently, racial/ethnic differences in the receipt of recommended treatment requires further investigation because longer waiting time to receive an appropriate treatment, including delays in getting timely radiation, were documented to be more prevalent among minority women and women of low socioeconomic status.[39]

Patterns of BCS With RT

BCS in combination with RT is the recommended treatment for early-stage breast cancer. Still, there is a concern that use of mastectomy in the United States has been increasing in the past 10 years.[28,30] This is particularly alarming in an era where individualized medicine and patient-oriented decision making have been accepted as appropriate models of care. The increased trend in the use of mastectomy raises several questions, including whether accurate information has been communicated to patients. It is crucial to educate patients earlier about the pros and cons of each treatment option and to develop strategies that help to communicate available treatment choices to women and their families facing the stress of a new cancer diagnosis. BCS with RT rather than mastectomy is a form of individualized care that provides local control and survival equal to those seen after mastectomy, and an increasing body of evidence suggests that it is the biology of the cancer rather than the type of local therapy that determines risk of local recurrence, whether treated with mastectomy or BCS with RT.[17]

It is not easy to predict how recently passed laws, especially the ACA, and new advances in radiation technology developed to treat early-stage breast cancer will affect surgical treatment for affected women. With recent advances in radiation technology and novel treatment approaches including targeted and shorter treatments, one may expect that the patterns of early-stage breast cancer treatment will trend toward receiving the recommended treatment. Over the past 2 decades, evidence from several randomized trials have shown that women diagnosed with early-stage breast cancer who underwent BCS with RT had equivalent overall survival rates compared with women who underwent mastectomy with the advantage that breast tissue could safely be preserved.[27,30,40] Additional advantages of BCS with RT are the provision of short-term physical functioning and better quality of life while minimizing complications.[27] However, there has been a concern about the rate of local recurrence after receiving BCS with RT and concerns about the inconvenience and costs associated with daily treatments that are administered over a 3-to-6-week period. Recently, advances in modern radiation technologies such as breast imaging, and the addition of adjuvant RT as well as innovative approaches and treatment techniques to early-stage cancer treatments, have resulted in a substantial decrease in the rates of local recurrence after receiving the recommended treatment.[40] In addition, RT is well-tolerated and, when delivered using modern technologies, carries a low risk of serious morbidity.

The ACA, which enables all Americans to have access to healthcare at an affordable cost, is understood to change the patterns of healthcare in the United States enormously when fully implemented. The expansion of Medicaid to cover low-income individuals and families is estimated to cover 16 million new Medicaid enrollees,[33] which is very significant on its own in terms of breast cancer treatment among low-income women. Therefore, the implementation of this new law is more likely to favor more use of BCS in combination with RT, regardless of types of health insurance, by encouraging eligible or appropriate patients to receive the recommended treat-

ment without delay. The role of physician preference is equally important to that of patient preference in early-stage breast cancer treatment choices and outcomes; however, how US healthcare reform will affect surgeons is not clear. On the one hand, an increase in the number of patients with health insurance creates more insured customers for surgeons. On the other hand, as suggested by Adepoju and colleagues,[33] surgeons may not be incentivized properly for providing less-invasive procedures of equal efficacy. For example, for early-stage breast cancer treatment, surgeons are reimbursed 40% less for BCS with RT than they are for mastectomy,[33] which shows reimbursement is associated with the type of surgery that is performed.

Strengths and Limitations of the Study

The strengths of our study include the following: (1) we compared surgical breast cancer treatment that was received within and between health insurance types; (2) we used multilevel modeling to account for the fact that women living in a community share common factors and exposure to treatment facilities and health services; (3) we fitted insurance-specific regression models to identify predictors that are common or unique to each type of health insurance; (4) our data cover more years than previous studies[20,28] and the sample size is large enough to allow for insurance-specific analysis; and (5) in addition to age at diagnosis, we included age-squared to our models and were able to capture the nonlinear relationship between age and the likelihood of receiving the recommended treatment.

This study also has a number of limitations. First, information about radiation therapy can be underreported if treatment was delivered in a facility other than a reporting facility such as a free-standing center or a physician office. FCDS recognized this problem, and beginning in January 2003, it initiated the Florida Statewide Free-Standing Radiation Therapy Centers Cancer Case Identification Program to identify patients seen in free-standing ambulatory patient care centers using RT modalities in addition to the continued reporting of all cases of cancer diagnosed and/or treated as an inpatient or outpatient in any of the reporting facilities.

The program was designed to identify cases not seen in any hospital or other facility, such as a radiation center owned by a hospital, and provides a reporting mechanism for centers to report to FCDS. It is also possible that some of the patients seen in free-standing centers for an initial course of therapy may have been reported by a hospital or another reporting facility without mention of the RT. In addition, there is a possibility that some women may have obtained treatment in other states and their information is not reported in the FCDS. However, the problem of underreporting in the FCDS is likely to affect all cases randomly and there is no reason to believe that it affects a certain group with respect to health insurance in a systematic way. In addition, the FCDS is a nationally recognized cancer registry system that is regularly enhanced. It is unlikely that this limitation will seriously affect the findings and conclusions of the study.

Second, our analysis does not cover the period after 2002 because the data was not available to us. With the rapid advancement of medical technology and new innovations, it is reasonable to assume that patterns of early-stage breast cancer treatment may have changed since then. Third, some key variables were not available in the data. For example, census tract-level high school completion rate was used as a proxy for education. Data availability hampers the inclusion of other variables that are desirable, such as comorbidity that interferes with cancer treatment and distance to a radiation treatment center. More importantly, this study was unable to capture the influence of patient's breast size, patient's preference, physician-patient interactions, family support, patient fear of genetic or recurrence risk, and other psychological factors that contribute to treatment choice. Fourth, type of facility and quality of care where treatment was received were not included in this study due to lack of data availability.

Another limitation was that the categories of health insurance type used were general. For instance, our study did not distinguish between normal Medicare and fee-for-service Medicare.

Policy Implications

Despite these limitations, this study was able to document the influence of health insurance and other variables on decisions related to receiving BCS with RT using a large data set from a statewide population-based cancer registry system. More importantly, we found common and unique factors that influence women's decisions on receiving BCS with RT among women who had the same health insurance.

Our findings reveal that the choice of receiving BCS with RT varied not only between women with different health insurance types but also among women with the same health insurance. Overall, being unmarried (that is, single, divorced, or widowed) was a risk factor for not receiving the recommended treatment. This finding was also true among women insured either by Medicare or private insurance. Smaller tumor size and higher levels of education, measured by the percentage of the population

with at least a high school education at census tract level, were the only common predictors that were associated with receiving the recommended treatment in all of our models, regardless of type of health insurance.

Hence, some of the policy implications of the study include: (1) uninsured women were less likely to use the recommended treatment, so increasing access to healthcare for women would prove especially beneficial; (2) initiating and implementing policy programs that aim to improve the education level of the general population is warranted, as having a higher percentage of high school educated individuals at the census tract level has a strong positive effect on people's willingness to use healthcare, regardless of type of health insurance; (3) increase awareness to minimize fear and misperceptions about radiation recurrence among women and educate patients about the importance of being compliant with the whole radiation treatment schedule; (4) develop public health programs that reach out to unmarried women by disseminating timely and accurate information about the benefits of treatment options.

CONCLUSIONS

The findings of this study provide better understanding regarding the type of surgical treatments provided to women diagnosed with early-stage breast cancer from 1997 to 2002, and the impact of type of health insurance in the receipt of recommended treatment in Florida. We found that access to healthcare has a substantial impact in the likelihood of receiving the recommended treatment among women diagnosed with localized breast cancer. Specifically, there was significant variation in the use of RT after BCS by type of health insurance. In addition, marital status, age, tumor size, year of diagnosis, and education level were significant predictors. Race/ethnicity was not significantly related to the use of RT after BCS. However, non-Hispanic black women were significantly associated with higher likelihood of receiving RT after BCS among Medicaid-insured than were non-Hispanic white women. Poverty was also significantly associated with higher likelihood of receiving radiation after BCS only among Medicaid-insured women. BCS with radiation is the recommended treatment for women with localized breast cancer with its usage having increased over time. The results must be interpreted with caution with the limitations of the study in mind. Our study calls for more inquiry into why non-Hispanic black women insured by Medicaid are more likely to use BCS with RT than non-Hispanic white women, and why single women with private insurance are less likely to use BCS with RT than married women. These observed differences require further study.

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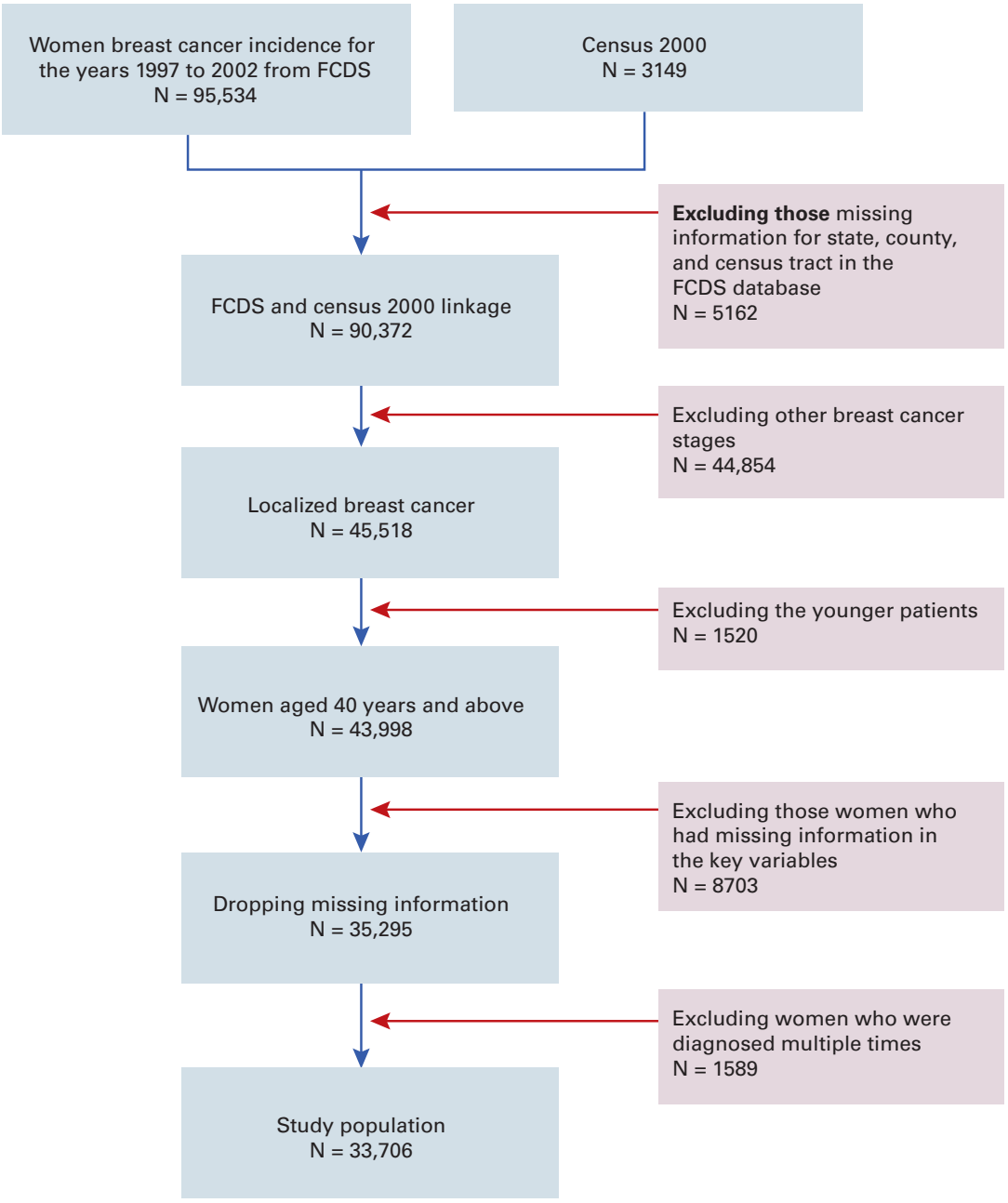
■ **eAppendix A.** Summary of Data Extraction



FCDS indicates Florida Cancer Data Systems

eAppendix B. Variable Definition and Measurement Used in the Analysis

Variable Name	Definition and Measurement
Dependent variable Type of treatment (Breast conserving surgery followed with radiation)	The combination of breast conserving surgery with radiation. If the woman received this combination of treatment it will be 1, otherwise it is 0.
Insurance	
Private insurance (reference group)	—
Medicaid	1 if the woman has Medicaid insurance, otherwise 0
Medicare	1 if the woman has Medicare insurance, otherwise 0
Other	1 If the woman has TRICARE, military, Veterans Affairs, or Indian/public health services, otherwise 0
No insurance	1 if the woman doesn't have insurance, otherwise 0
Race and Ethnicity	
White non-Hispanic (reference group)	—
Black non-Hispanic	1 if the woman is black and non-Hispanic, otherwise 0
Hispanic	1 if the woman is Hispanic, otherwise 0
Others	1 if the women is not white non-Hispanic, black non-Hispanic, or Hispanic, otherwise 0
Marital Status	
Married (reference group)	—
Single (never married)	1 if the woman was single otherwise 0
Divorced	1 if the woman was divorced otherwise 0
Widowed	1 if the woman was widowed otherwise 0
Age	
Age and age squared	Age is used as a continuous variable. Age-squared is added to capture a non-linear relationship between age and use of BCS.
Diagnosis year	The year the patient was diagnosed with breast cancer. The years are represented as 5 dummy variables with 1997 being the comparison year.
Tumor size	Size of tumor is grouped into the following categories: — <2 cm — ≥2 cm — Unknown

BCS indicates breast-conserving surgery.