Are there differences in outcomes by race among women with metastatic triple-negative breast cancer?

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Abstract

Purpose Black women have higher breast cancer mortality rates than other groups, with Triple-negative breast cancer (TNBC) being more common among AAs with a worse prognosis. Our study seeks to explore differences among Non-Hispanic Black (NHB) vs. White (NHW) women, with Stage IV TNBC, focusing on survival and treatment patterns.

Methods SEER database was queried for TNBC patients diagnosed with metastatic disease from 2012 to 2016. Neighborhood socioeconomic status (nSES) was defined using the Yost index based on income, education, housing, and employment. Univariate and multivariate analyses were performed to evaluate receipt of surgery, radiation, and chemotherapy. Overall survival was evaluated using Kaplan–Meier curve and Cox proportional hazards model analysis.

Results 25,761 TNBC cases were identified with 1420 being metastatic (5.5%). Bone was the most common site for metastasis, with patients’ age being 63.7 years for NHW vs. 59.5 years for NHB. NHB women had the highest percentage of low nSES (62.3% vs 29.3%; p value = 0.001). On univariate analysis, fewer NHBs received radiation compared to NHWs (27.1 vs. 32.6%; p value = 0.040). On multivariate analysis, all women were less likely to undergo treatment if unmarried (p value < 0.01). NHB women had lower median survival compared to NHW women (13 vs. 15 months; p value < 0.01). Receipt of surgery and chemotherapy reduced the risk of mortality (p value <0.01).

Conclusion NHB women had lower median survival with metastatic TNBC. Race was associated with different treatment utilization. With a mortality differential between NHW and NHB women with metastatic TNBC, more investigation is needed to inform strategies to reduce this disparity.

Keywords Non-Hispanic Black · Non-Hispanic White · TNBC · Metastatic · Survival · Treatment

Introduction

Breast cancer

Breast, lung, and colorectal cancers are the three most frequent cancers among women, accounting for over half of all new cancer diagnoses by 2020 [1, 2]. For female breast malignancies, two unique distribution patterns of age at diagnosis are seen: incidence in White patients reach their peak at age 60, while non-White patients peak at their 40s [3]. Furthermore, Black women are more commonly diagnosed under the age of 45, compared to White women [3]. Black women with breast cancer also have a higher mortality rate and present with high-risk characteristics such as aggressive histopathology, greater tumor size at appearance, more nodal involvement, and negative estrogen receptor status [4].
Triple-negative breast cancer

Varied subtypes of breast cancer, based on biomarker status, have different tumor biology, prognoses, and therapeutic responses [5]. Triple-negative breast tumors lack the estrogen (ER), Progesterone (PR), and HER-2 receptors and this subgroup’s characteristics are similar to those of the basal-like breast cancer subgroup [6]. TNBC is more common in Black women than in White women, diagnosed at twice the rate [7–10]. This breast cancer phenotype currently lacks targeted treatment options and is linked to a shorter overall survival time [11]. Several histological series of malignancies in this category have documented poor clinical outcomes, and two studies have found a trend toward a worse outcome for individuals with tumors in this subgroup compared to those with HER2-positive tumors [6]. When compared to patients with other breast cancer subtypes, triple-negative breast cancer patients have a higher rate of local relapse and an earlier age of onset [6–11].

Racial disparities

Disparities in health care are defined as “racial or ethnic inequalities in the quality of health care that are not due to access-related variables or clinical needs, preferences, or appropriateness of intervention,” according to the IOM report [12]. Breast cancer death rates among minority Black women are much higher than those of White women and other ethnic groups in the USA [13]. Previous research has indicated that insufficient treatment, including adjuvant chemotherapy, is linked to a lower survival rate. Furthermore, in regard to systemic therapy, a higher percentage of Black women received less treatment than expected compared to White women [14]. Race/ethnicity and sociodemographic characteristics also are associated with a woman’s adherence to clinical breast examination, breast self-examination, or screening mammography guidelines, as well as the chance of seeking proper care if a breast mass is detected [15]. Consequently, non-White patients have a higher percentage of advanced breast cancers at the time of diagnosis than non-Hispanic White patients, including Stage IV or metastatic disease [3].

Metastatic breast cancer

Approximately 10% of new cases identified each year are metastatic at the time of presentation, with another 30% of individuals with early-stage cancer experiencing a recurrence [4]. African Americans have a shorter overall survival (OS) and breast cancer-specific survival (BCSS) at all stages, with the exception of Stage I HR+/HER2- illness, where survival is equal between African American and White patients [5]. Multivariate analysis revealed that African American patients with Stage IV HR-/HER2+ breast cancer had a significantly lower OS and BCSS [5]. However, in the TNBC group, this same study showed that despite African Americans having a greater incidence, their survival rates are comparable to White women [5].

These data do not explore granular details in differences in outcomes of the subgroup with TNBC. In particular, differences in outcomes by racial groups outside of survival, such as treatments received still remain unclear in metastatic TNBC. Our study seeks to explore differences among women (non-Hispanic Black vs. non-Hispanic White) with Stage IV TNBC with a focus on survival and treatment patterns. We hypothesize a lower overall survival for NHB woman with differences in receipt of trimodal treatment (surgery, radiation, and chemotherapy) compared to NHW woman.

Methods

Data collection

The Surveillance, Epidemiology, and End Results (SEER) Program is a collection of population-based central cancer registries capturing facts from 21 geographic areas representing 36.7% of the USA population [16]. With permission from the SEER Program, a specialized SEER dataset which included additional information about area-based (census tract level) measures reflecting socioeconomic status and urban/rural residence was used for these analyses [17]. Institutional review board approval was not necessary and ethical consent was not required because SEER data are deidentified and publicly available, albeit with permission for use of the dataset used in these analyses.

Participant/Cohort selection

Using a case listing session in SEER*Stat [18], the SEER Program dataset was queried for patients with TNBC over a 5-year period (2012–2016). For analysis we selected women diagnosed with metastatic or Stage IV disease at presentation and compare Non-Hispanic Black patients with Non-Hispanic White patients. Hispanic women were excluded to focus better on Black and White ethnic differences.

Study variables/outcome measures

Race/ethnicity was a key factor for this study. A SEER variable was used which divided race and ethnicity into five categories: Non-Hispanic White (NHW), Non-Hispanic Black (NHB), non-Hispanic Asian or Pacific Islander
predictor variables. Between the breast cancer survival time of patients and the hazards model was created to investigate the association between the racial groups. A multivariate Cox proportional test was used to compare breast cancer-specific mortality reported along with the Wald Chi-Square tests. A log-rank chemotherapy, and radiation therapy. Odds ratios were rates to predict factors responsible for the receipt of surgery, logistic regression was performed using appropriate covariates for chemotherapy and radiation therapies described in the Discussion; these include in inability to distinguish 'no' receipt of chemotherapy or radiation from 'unknown.' The outcome of major interest was overall survival (OS) which was calculated from follow-up durations as observed in time (month) and follow-up status as defined at last contact (alive, deceased due to cancer, deceased due to other cause).

Statistical analysis

The study cohort was divided into two racial groups: White and Black. Socio-demographic, clinical, pathologic, treatment, and outcome variables were tabulated as frequencies for the categorical variables and reported as mean ± standard deviation (SD) for continuous variables. Pearson’s Chi-Square tests and Analysis of Variance (ANOVA), were used, as appropriate for intergroup bivariate analysis. Multivariate logistic regression was performed using appropriate covariates to predict factors responsible for the receipt of surgery, chemotherapy, and radiation therapy. Odds ratios were reported along with the Wald Chi-Square tests. A log-rank test was used to compare breast cancer-specific mortality between the racial groups. A multivariate Cox proportional hazards model was created to investigate the association between the breast cancer survival time of patients and the predictor variables.

A p value of < 0.05 was considered statistically significant. Analyses were performed using Stata, Version 16.0 (Stata Corporation, College Station, TX). This study was deemed IRB-exempt.

Results

Study population characteristics

Table 1 presents the sociodemographic and clinical characteristics of the participants grouped by race. Of the 1420 women who presented with metastatic Triple-Negative Breast Cancer (TNBC), 995 (70.1%) were NHW and 425 (29.9%) were NHB. The mean age at diagnosis for both groups was 62.5 years, with the average age at diagnosis for NHW women being significantly (p < 0.001) higher compared to NHB women (63.7 vs. 59.5 years; p value < 0.001). Most women were insured, however, NHB women were less likely to be insured compared to NHW women (64.9% vs 82.0%; p value < 0.001). While 42.0% of the participants were married/partnered, NHB women were more likely to be single compared to NHW women (36.0% vs 14.5%; p < 0.001). Significantly more NHB women were in the low Neighborhood Socioeconomic Status (nSES) group compared to NHW women (62.3% vs 29.3%; p < 0.001) and were less likely to have lived in a rural area compared to NHW women (4.5% vs 12.3%; p < 0.001). The most common metastasis site was bone only among 24.2% of the participants. There was no statistically significant difference between the two racial groups in terms of average survival months post diagnosis and cause-specific mortality.

Treatment utilization

Shown in Table 2 are the different treatment modalities (surgery, chemotherapy, and radiation) received by the two racial groups. Of the total patient population, 33.0% received surgery. A total of 144 (34.3%) of NHB women and 321 (32.5%) of NHW women were surgery recipients. About 70.2% of the study population underwent chemotherapy with 70.6% NHW women and 71.0% NHB women receiving this type of treatment. However, there was no statistically significant difference between the two groups in terms of surgery and chemotherapy receipt. A total of 439 (30.9%) participants used radiation as a treatment option with fewer NHB women receiving this modality compared to NHW women (27.1% vs. 32.6%; p value = 0.04).

On multivariate logistic regression analysis, those who were insured compared to uninsured women (OR 2.39, 95% CI 1.07–5.30; p value = 0.033), and resided in neighborhoods with low nSES compared to high nSES (OR 1.56, 95% CI 1.11–2.18; p value = 0.009) faced higher odds of surgery receipt, whereas being single compared to being married (OR 0.60; 95% CI...
0.42–0.85; \( p \) value = 0.005) reduced the odds of undergoing surgery (Table 3). The factors associated with higher odds of receipt of chemotherapy included patients who were insured in general (OR 2.25, 95% CI 1.14–4.41; \( p \) value = 0.019) or had Medicaid (OR 2.44, 95% CI 1.19–5.02; \( p \) value = 0.015), all compared to being uninsured. Increasing age (OR 0.95, 95% CI 0.93–0.96; \( p \) value < 0.001), and marital status being separated or divorced (OR 0.61, 95% CI 0.42–0.88, REF: Married; \( p \) value = 0.009), single or unmarried (OR 0.59, 95% CI 0.40–0.87; \( p \) value = 0.007), or widowed (OR 0.49, 95% CI 0.34–0.72; \( p \) value < 0.001) all compared to being married, however, reduced the odds of chemotherapy receipt (Table 4). For receipt of radiation, the odds decreased with increasing age (OR 0.98, 95% CI 0.97–0.99; \( p \) value = 0.003) and being single compared to being married (OR 0.70, 95% CI 0.49–0.99; \( p \) value = 0.048) (Table 5). Race was not statistically significantly associated with either of the three types of treatment receipt.

### Table 1: Socio-demographic and clinical characteristics of patients with TNBC and metastasis stratified by race/ethnicity

| Variables                      | Total sample | NH White N=995 (0.7) | NH Black N=425 (0.3) | \( p \) value |
|-------------------------------|-------------|----------------------|----------------------|--------------|
| Age at diagnosis              | 62.47±(14.07) | 63.74±(13.94) | 59.50±(13.94) | <0.001*** |
| Insurance                     |             |                      |                      | <0.001*** |
| Uninsured                     | 51 (3.6)    | 24 (2.4)             | 27 (6.4)             |             |
| Medicaid                      | 263 (18.5)  | 145 (14.6)           | 118 (27.8)           |             |
| Insured                       | 1092 (76.9) | 816 (82.0)           | 276 (64.9)           |             |
| Unknown                       | 14 (1.0)    | 10 (1.0)             | 4 (0.9)              |             |
| Marital status                |             |                      |                      | <0.001*** |
| Married                       | 597 (42.0)  | 493 (49.5)           | 104 (24.5)           |             |
| Separated                     | 227 (16.0)  | 145 (14.6)           | 82 (19.3)            |             |
| Single                        | 297 (20.9)  | 144 (14.5)           | 153 (36.0)           |             |
| Widowed                       | 230 (16.2)  | 168 (16.9)           | 62 (14.6)            |             |
| Unknown                       | 69 (4.9)    | 45 (4.5)             | 24 (5.6)             |             |
| Census tract residence        |             |                      |                      | <0.001*** |
| Rural                         | 136 (9.9)   | 117 (12.3)           | 19 (4.5)             |             |
| Urban                         | 1235 (90.1) | 835 (87.7)           | 400 (95.5)           |             |
| nSES group                    |             |                      |                      | <0.001*** |
| Low                           | 529 (39.4)  | 274 (29.3)           | 255 (62.3)           |             |
| Middle                        | 457 (34.0)  | 342 (36.6)           | 115 (28.1)           |             |
| High                          | 358 (26.6)  | 319 (34.1)           | 39 (9.5)             |             |
| Metastasis                    |             |                      |                      | 0.240       |
| Bone only                     | 343 (24.2)  | 250 (25.1)           | 93 (21.9)            |             |
| Liver only                    | 130 (9.2)   | 95 (9.5)             | 35 (8.2)             |             |
| Lung only                     | 282 (19.9)  | 191 (19.2)           | 91 (21.4)            |             |
| Brain only                    | 44 (3.1)    | 26 (2.6)             | 18 (4.2)             |             |
| Distant lymph nodes only      | 44 (3.1)    | 27 (2.7)             | 17 (4.0)             |             |
| ≥ 2 metastasis               | 577 (40.6)  | 406 (40.8)           | 171 (40.2)           |             |
| Survival months               | 10.37±(10.82) | 10.57±(10.59) | 9.91±(11.32) | 0.290       |
| SEER cause-specific death classification |             |                      |                      | 0.120       |
| Alive or dead of other cause  | 382 (26.9)  | 260 (26.1)           | 122 (28.7)           |             |
| Dead (attributable to this cancer dx) | 773 (54.4)  | 547 (55.0)           | 226 (53.2)           |             |
| Dead (missing/unknown cause of death) | 2 (0.1)     | 0 (0.0)              | 2 (0.5)              |             |
| N/A not first tumor           | 263 (18.5)  | 188 (18.9)           | 75 (17.6)            |             |

Univariate analysis of study cohort based on socioeconomic and clinical factors, stratified by race. Results are listed as n (%) with n = sample size unless otherwise specified.

*NHW* Non-Hispanic Whites, *NHB* Non-Hispanic Blacks

***Statistical significance at 1% level, ** statistical significance at 5% level, and * statistical significance at 10% level
Survival

Median survival for NHW women was 15 months compared to 13 months for NHB women (Table 7). Kaplan–Meier curve (Fig. 1) and log rank test (Table 6) comparing survival by race showed no statistically significant difference in survival between the two racial groups. A Cox proportional hazards model analysis in Table 8 showed that woman who received surgery (HR 0.49, 95% CI 0.41–0.59; \( p \) value = 0.001) and chemotherapy (HR 0.49, 95% CI 0.40–0.59; \( p \) value = 0.001) compared to receiving neither were more likely to survive in reference to those who did not receive the treatment option.

Discussion

The goal of this study was to evaluate the racial differences in outcomes among women with de novo metastatic TNBC. We find no statistically significant racial differences in overall survival but differences in treatment utilization. More NHB women underwent surgery, and less likely to receive radiation or have unknown radiation receipt status than NHW women.

**Table 2** Treatment received stratified by race/ethnicity

| Variables | Total sample | NH White | NH Black | \( p \) value |
|-----------|-------------|----------|----------|--------------|
| Surgery   | 1420        | 995 (0.7) | 425 (0.3) | 0.500        |
| No        | 944 (67.0)  | 668 (67.5) | 276 (65.7) |               |
| Yes       | 465 (33.0)  | 321 (32.5) | 144 (34.3) |               |
| Surgery with axilla | 0.160 |            |          |               |
| No        | 272 (59.8)  | 194 (62.0) | 78 (54.9)  |               |
| Yes       | 183 (40.2)  | 119 (38.0) | 64 (45.1)  |               |
| Chemotherapy | 0.840 |          |          |               |
| None/unknown | 423 (29.8) | 298 (29.9) | 125 (29.4) |               |
| Yes       | 997 (70.2)  | 697 (70.1) | 300 (70.6) |               |
| Radiation | 0.040**     |           |          |               |
| None/unknown | 981 (69.1) | 671 (67.4) | 310 (72.9) |               |
| Yes       | 439 (30.9)  | 324 (32.6) | 115 (27.1) |               |

Univariate analysis of study cohort based on treatment types, stratified by race. Results are listed as \( n \) (%) with \( n = \) sample size unless otherwise specified

NHW Non-Hispanic Whites, NHB Non-Hispanic Blacks

***Statistical significance at 1% level, **statistical significance at 5% level, and *statistical significance at 10% level

**Table 3** Multivariable Logistic regression to predict the factors associated with receipt of surgery

| Variables | Odds Ratio | 95% Confidence Interval | \( p \) value |
|-----------|------------|-------------------------|--------------|
| Age at diagnosis | 0.99 | (0.98–1.00) | 0.077        |
| Race      |            |                         |              |
| NH White  | REF        |                         |              |
| NH Black  | 1.04       | (0.78–1.39)             | 0.788        |
| Insurance |            |                         |              |
| Uninsured | REF        |                         |              |
| Medicaid  | 1.93       | (0.84–4.41)             | 0.119        |
| Insured   | 2.39       | (1.07–5.30)             | 0.033**      |
| Marital status |        |                         |              |
| Married   | REF        |                         |              |
| Separated | 0.76       | (0.54–1.08)             | 0.133        |
| Single    | 0.60       | (0.42–0.85)             | 0.005***     |
| Widowed   | 1.08       | (0.75–1.55)             | 0.679        |
| Residence Census Tract |     |                         |              |
| Rural     | REF        |                         |              |
| Urban     | 0.99       | (0.66–1.49)             | 0.974        |
| nSES group |          |                         |              |
| Low       | 1.56       | (1.11–2.18)             | 0.009***     |
| Middle    | 0.99       | (0.72–1.36)             | 0.935        |
| High      | REF        |                         |              |

Multivariate analysis of factors associated with surgery receival. Results are listed as odds ratios

NHW Non-Hispanic Whites, NHB Non-Hispanic Blacks

***Statistical significance at 1% level, **statistical significance at 5% level, and *statistical significance at 10% level

Sociodemographic differences

Previous studies showed that NHB women were diagnosed with breast cancer at younger ages [5]. This study similarly showed that NHB women were diagnosed at younger mean age (NHB average age 58 vs. 61 in NHW). A higher proportion of NHB women were unmarried and resided in urban census tracts with more than half from low nSES census tracts. More NHB woman were uninsured compared to NBW woman with majority of the Black woman being insured either via Medicare or private insurance. While health insurance is the most commonly mentioned and significant obstacle to seeking care [19–21], a number of other issues, such as cancer-related out-of-pocket financial problems [22], required time away from work [23], and transportation issues [24, 25] may potentially have a disproportionate impact on African American women with cancer [26]. These socioeconomic characteristics are reflected in the Yost index (nSES) which we show NHB women comprising the overwhelming majority of those in the lowest tertile. Our findings are consistent with previous reports [19–25].
Management patterns in metastatic TNBC

In terms of treatment by race, more NHB women on univariate analysis received surgery (not statistically significant), fewer received or had an unknown status for radiation \((p \text{ value} < 0.05)\) while there are no differences seen with chemotherapy. We also did not find a statistically significant difference in receipt of surgery, chemotherapy, or radiation based on race with multivariate analysis. There are established data on treatment differences in NHB women compared to NHW in non-metastatic TNBC but there is a dearth of data in the metastatic group. Generally, for stage IV breast cancer, systemic therapies consisting of chemo, hormonal, targeted, and immune therapies are recommended. Local–regional therapy with surgery or radiation lacks consensus and is reserved for palliation of symptoms [26]. NHB women with earlier stages of breast cancer have a treatment preference for breast conservation, a higher rate of chemotherapy and radiation refusal [27–29].

One divergent finding is in our sample, women with low nSES were more likely to receive surgery. Therefore, surgery receipt especially if it occurs antecedent to chemotherapy would be considered low value care. Previous studies have shown that low value treatment options like surgery in the metastatic setting is disproportionately performed in women of low socioeconomic classes and medical facilities with a large concentration of Black patients [30]. Patients who are poor are sometimes given care that is neither medically necessary nor useful. The

Table 4 Multivariable Logistic regression to predict the factors associated with receipt of chemotherapy

| Variables          | Odds Ratio | 95% Confidence Interval | \( p \text{ value} \) |
|--------------------|------------|-------------------------|-----------------------|
| Age at diagnosis   | 0.95       | (0.93–0.96)             | <0.001***             |
| Race               |            |                         |                       |
| NH White REF       |            |                         |                       |
| NH Black           | 0.99       | (0.72–1.36)             | 0.952                 |
| Insurance          |            |                         |                       |
| Uninsured REF      |            |                         |                       |
| Medicaid Insured   | 2.44       | (1.19–5.02)             | 0.015**               |
|                   | 2.25       | (1.14–4.41)             | 0.019**               |
| Marital status     |            |                         |                       |
| Married REF        |            |                         |                       |
| Separated          | 0.61       | (0.42–0.88)             | 0.009***              |
| Single             | 0.59       | (0.40–0.87)             | 0.007***              |
| Widowed            | 0.49       | (0.34–0.72)             | <0.001***             |
| Residence Census Tract |        |                         |                       |
| Rural REF          |            |                         |                       |
| Urban              | 0.96       | (0.61–1.52)             | 0.868                 |
| nSES group         |            |                         |                       |
| Low                | 0.88       | (0.61–1.27)             | 0.496                 |
| Middle             | 0.99       | (0.70–1.41)             | 0.981                 |
| High               |            |                         |                       |

Multivariate analysis of factors associated with chemotherapy receipt. Results are listed as odds ratios

\textit{NHW} Non-Hispanic Whites, \textit{NHB} Non-Hispanic Blacks

***Statistical significance at 1% level, **statistical significance at 5% level, and *statistical significance at 10% level

Table 5 Multivariable Logistic regression to predict the factors associated with receipt of radiation

| Variables          | Odds Ratio | 95% Confidence Interval | \( p \text{ value} \) |
|--------------------|------------|-------------------------|-----------------------|
| Age at diagnosis   | 0.98       | (0.97–0.99)             | 0.003***              |
| Race               |            |                         |                       |
| NH White REF       |            |                         |                       |
| NH Black           | 0.76       | (0.56–1.02)             | 0.067                 |
| Insurance          |            |                         |                       |
| Uninsured REF      |            |                         |                       |
| Medicaid Insured   | 1.12       | (0.55–2.29)             | 0.747                 |
|                   | 1.02       | (0.51–2.02)             | 0.957                 |
| Marital status     |            |                         |                       |
| Married REF        |            |                         |                       |
| Separated          | 1.20       | (0.85–1.68)             | 0.294                 |
| Single             | 0.70       | (0.49–0.99)             | 0.048**               |
| Widowed            | 0.91       | (0.62–1.33)             | 0.622                 |
| Residence Census Tract |        |                         |                       |
| Rural REF          |            |                         |                       |
| Urban              | 1.24       | (0.81–1.91)             | 0.315                 |
| nSES group         |            |                         |                       |
| Low                | 1.01       | (0.72–1.42)             | 0.928                 |
| Middle             | 1.03       | (0.75–1.41)             | 0.858                 |
| High               |            |                         |                       |

Multivariate analysis of factors associated with radiation receipt. Results are listed as odds ratios

\textit{NHW} Non-Hispanic Whites, \textit{NHB} Non-Hispanic Blacks

***Statistical significance at 1% level, **statistical significance at 5% level, and *statistical significance at 10% level

Table 6 Log rank test comparing survival among \textit{NHW} vs. \textit{NHB} women

| Variable      | Events observed | Expected events | \( p \text{ value} \) |
|---------------|-----------------|-----------------|----------------------|
| Race          |                 |                 | 0.5898               |
| NH White      | 491             | 497.22          |                      |
| NH Black      | 202             | 195.78          |                      |

Log rank test compares survival among the two racial groups

\textit{NHW} Non-Hispanic Whites, \textit{NHB} Non-Hispanic Blacks

***Statistical significance at 1% level, **statistical significance at 5% level, and *statistical significance at 10% level
lack of health literacy to comprehend and make educated decisions about their health may be the cause [31]. We show crude rates of higher surgery in NHB and on logistic regression the effect of nSES on surgery suggests potential non-guideline concordant care.

In all treatment types (surgery, chemotherapy, and radiation), both NHW and NHB woman without a married partner were less likely to definitively undergo treatment. Previous studies agree with these results and showed that breast cancer survival is impacted by marital status [32–35] suggesting lack of support from spouse and family, finances (insurance) and concerns about potential physical deformities with treatment. Furthermore, having a strong social network is linked to a higher chance of survival in several studies [36–42]. Having family, friends, and spouses for support encourages patients to seek medical attention, complete their treatments, and seek support from breast cancer survivors [43–45].

Racial differences in survival

There is a median survival of 13 months vs. 15 months in NHB compared to NHW women but we did not detect a statistically significant difference in overall survival. In a previous study from Arciero et al., after correcting for age, tumor grade, surgery, and radiation treatments, NHB patients exhibited lower overall survival and BCSS (breast cancer-specific survival time) in both the univariate and multivariate analyses [5]. Another study explained that non-biological causes and factors unrelated to the stage at which the patient presents, such as residual treatment/healthcare inequalities

Table 7 Median survival in months

| Variable   | Number of subjects | Median (SD) | 95% Confidence Interval |
|------------|--------------------|-------------|-------------------------|
| Race       |                    |             |                         |
| NH White   | 914                | 15 (0.68)   | (14–17)                 |
| NH Black   | 384                | 13 (0.81)   | (11–15)                 |
| Total      | 1298               | 14 (0.58)   | (13–15)                 |

Median survival is provided in months for the study cohort

SD Standard Deviation, NHW Non-Hispanic Whites, NHB Non-Hispanic Blacks

Fig. 1 Kaplan–Meier curve comparing survival by race. The Kaplan–Meier curve shows breast cancer-specific survival by racial status: Non-Hispanic White (shown by black solid line) and Non-Hispanic Black women (shown by black dotted line). The vertical axis shows the probability of survival, and the horizontal axis shows the survival time in months. NHW Non-Hispanic Whites, NHB Non-Hispanic Blacks

Table 8 Multivariable Cox PH model to predict the disease-specific survival in NHB and NHW women

| Variables                      | Hazards Ratio | 95% Confidence Interval | p value |
|--------------------------------|---------------|-------------------------|--------|
| Race                           |               |                         |        |
| NH White REF                    |               |                         |        |
| NH Black                        | 1.06          | (0.86–1.29)             | 0.580  |
| Age at diagnosis                | 1.00          | (0.99–1.01)             | 0.522  |
| Insurance                       |               |                         |        |
| Uninsured REF                   |               |                         |        |
| Medicaid                        | 0.98          | (0.59–1.60)             | 0.925  |
| Insured                         | 0.75          | (0.46–1.22)             | 0.243  |
| Marital status                  |               |                         |        |
| Married REF                     |               |                         |        |
| Separated                       | 1.15          | (0.91–1.45)             | 0.225  |
| Single                          | 0.97          | (0.77–1.22)             | 0.817  |
| Widowed                         | 1.06          | (0.82–1.37)             | 0.647  |
| Residence census tract          |               |                         |        |
| Rural REF                       |               |                         |        |
| Urban                           | 1.17          | (0.89–1.55)             | 0.263  |
| nSES group                      |               |                         |        |
| Low                             | 1.11          | (0.88–1.41)             | 0.363  |
| Middle                          | 1.12          | (0.91–1.39)             | 0.282  |
| High                            | REF           |                         |        |
| Surgery                         |               |                         |        |
| No                              | REF           |                         |        |
| Yes                             | 0.49          | (0.41–0.59)             | 0.001***|
| Chemotherapy                    |               |                         |        |
| None/unknown REF                |               |                         |        |
| Yes                             | 0.49          | (0.40–0.59)             | 0.001***|
| Radiation                       |               |                         |        |
| None/unknown REF                |               |                         |        |
| Yes                             | 1.11          | (0.93–1.31)             | 0.244  |

Cox Proportional Hazards model analysis of factors associated with disease-specific mortality. Results are listed as hazards ratios

NHW Non-Hispanic Whites, NHB Non-Hispanic Blacks

***Statistical significance at 1% level, **statistical significance at 5% level, and *statistical significance at 10% level
due to socioeconomic and health-care system issues, could possibly account for a large amount of the mortality difference [46]. Other studies that investigated stage IV breast cancer patients identified between 1998 and 2003, found that survival for NHW women improved dramatically, whereas survival for NHB women did not [4]. The survival gap has continued to increase as a result of this tendency [47].

Predictors of disease-specific survival in our study population show receipt of surgery and chemotherapy to be significant. Surgery in the setting of metastatic breast cancer is controversial. Typically, it is reserved for patients showing significant disease stability [26, 48]. It is possible that those who received chemotherapy would also undergo surgery, with both treatments prolonging survival.

Limitations

Given the retrospective nature of this study, it has several limitations. SEER data represent individual variables such as race, while census data were used for nSES and rural/urban residence. nSES and rural/urban residence were assessed at one point in time and do not reflect potential (especially recent) changes in residence; further, it is possible that nSES does not accurately ascertain individual SES. In the models for receipt of radiation and chemotherapy, we cannot determine and exclude patients for whom treatment was not recommended to assess differences among NHB and NHW women. For chemotherapy and radiation therapy receipt, the SEER database does not distinguish between “no treatment received” and “unknown if treatment received” so those variables were combined into “no/unknown.” Further, there may be biases due to differences in whether or not treatments were received based on unmeasured factors including patient and provider preferences, patient refusal, distance traveled, hospital characteristics, and comorbidities. The data from providers detailing their recommendations would provide more meaningful assessment of racial differences in treatment. Ideally, we would know whether treatment was offered and refused, or not recommended based on patient factors such as comorbidities. Last, the categories for distant disease were not consistent in variables used by the SEER Program across the study time period so metastatic categories as clinically described may be heterogeneous.

Conclusion

With the lethality associated with metastatic TNBC, more investigation is needed to explore differences in survival among racial and ethnic groups and inform strategies to reduce disparity. A larger, prospective study of metastatic patients would allow analysis of mortality differences and treatment patterns.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by BAO, JLF, and YL. The first draft of the manuscript was written by AR, BAO, and EDP and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The dataset (referenced below) used during the current study is available through access granted from the SEER Program. The dataset is not available from the authors. In order to access this specialized database, you must already have access to the latest SEER Research Plus data with a valid institutional account and instructions on access can be found at: Census Tract-level SES and Rurality Database - SEER*Stat (cancer.gov), Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER 18 Regs (Excl AK) Custom Data (with additional treatment fields), Nov 2018 Sub (2000–2016) < Vintage 2016 Pops by Tract 2000/2010 Mixed Geographies >_Linked To Census Tract Attributes - Time Dependent (2000–2016) - SEER 18 (excl AK) Census 2000/2010 Geographies with Index Field Quantiles, National Cancer Institute, DCCPS, Surveillance Research Program, released January 2020, based on the November 2018 submission.

Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

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