Differences in Breast Cancer Presentation at Time of Diagnosis for Black and White Women in High Resource Settings

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Abstract

This paper provides a narrative review of the existing literature on differences in demographic and biological features of breast cancer at time of diagnosis between Black and White women in Canada, the United Kingdom and the United States. Electronic database searches for published peer-reviewed articles on this topic were conducted, and 78 articles were included in the final narrative review. Differences between Black and White women were compared for eight categories including age, tumour stage, size, grade, lymph node involvement, and hormone status. Black women were significantly more likely to present with less favourable tumour features at the time of diagnosis than White women. Significant differences were reported in age at diagnosis, tumour stage, size, grade and hormone status, particularly triple negative breast cancer. Limitations on the generalizability of the review findings are discussed, as well as the implications of these findings on future research, especially within the Canadian context.

Keywords Breast cancer · Race · Triple negative breast cancer · Canada · United States · United Kingdom

Introduction

Breast cancer continues to be a significant cause of morbidity and mortality for Canadian women. Breast cancer was responsible for a quarter of new cancer diagnoses in women and 13% of all cancer-related deaths in women in 2017 [1]. The influence of various social and demographic factors on the morbidity and mortality associated with breast cancer has been well established in the literature [2]. Race is one such factor, which in some contexts is used as a variable in analysis and reporting.

Race is a social construct rather than a biological determinant of health. However, the product of the construct of race—racism, experienced at an institutional and interpersonal level—has a profound and measurable impact on racialized individuals in all sectors of society including the health care system. In this review the term race is used as a proxy for racism and to denote two groups of women, those identified as Black and those defined as White, whilst recognizing the diversity of experiences within these categories. The influence of race and arguably racism on the experience of breast cancer amongst women in the United Kingdom (UK) and the United States (US) is particularly striking and well-established in the literature. Less is known about how breast cancer outcomes differ between racialized women in Canada, given the current lack of race-based data collected in the Canadian health care system. Significant differences in breast cancer incidence, diagnosis and prognosis have been demonstrated between ethnic and racial groups in the US and the UK [2]. Despite a greater incidence of breast cancer amongst White women [3], prognosis for Black women with breast cancer has been noted to be poorer in numerous studies [4–6]. Black women had a lower rate of overall 5-year survival in some studies [7], as well as lower rates of distant relapse-free survival [8]. Disease recurrence was also noted to be greater amongst Black women in the US diagnosed with earlier-stage breast cancers [9]. However, similar findings were not observed in other studies based in the US or
the UK. For example, Roseland et al. [10] noted no differences in mortality for patients diagnosed with stages I–III breast cancer in Michigan when data was stratified by race. In another retrospective single centre study in London, UK by Bowen et al. [11], no significant difference in overall survival was noted by race.

A number of social and demographic factors have been proposed to contribute to these findings, including differences in age at diagnosis [12–14], geographic location [14], socioeconomic status [4, 12], as well as individual and regional differences in breast cancer screening [15]. In addition to these factors, a number of studies have demonstrated differences in tumour biology and have suggested that these differences may also contribute to differences in breast cancer prognosis between Black and White women. In particular, later cancer stage at time of diagnosis [5], larger tumour size [6], and higher incidence of triple negative breast cancers [8, 16] amongst Black women have been noted in a number of studies in both the UK and the US.

This paper sets out to conduct a narrative review of the existing literature regarding the differences in certain demographic and biological features of breast cancer at the time of diagnosis, including age, tumour size, grade, hormone receptor status, and lymph node involvement, between Black and White women in the UK, Canada and the US. These features in particular are known to be associated with breast cancer prognosis, with poorer prognosis for patients with larger tumours at the time of diagnosis, triple negative hormone status, and axillary lymph node involvement [17–19].

Investigating the association of race and racism on these features of malignant breast tumours is particularly challenging in the Canadian context, where there is a lack of surveillance data that examines health outcome disparities among racialized groups, particularly amongst Black women. Surveillance data that includes information about race and ethnicity is collected in the US through organizations like the Surveillance, Epidemiology, and End Results (SEER) Program and the National Cancer Database (NCDB). In the UK, with a centralized publicly funded healthcare system that is more similar to the Canadian model of healthcare, race data is similarly collected through the National Health Service (NHS). Reviewing the existing UK and US literature can provide general trends in the characteristics of breast tumours in women belonging to these racialized groups, and may shed some light on the etiology of the aforementioned differences in diagnosis and prognosis. The implications of the findings of this narrative review are key for improved equity in breast cancer prevention, screening, and diagnosis and can guide future endeavours in research regarding breast cancer in the Canadian context.

Methods

A research librarian conducted electronic database searches of Ovid MEDLINE, Ovid EMBASE, Ovid EMB Reviews, CINAHL, and Web of Science. Searches were limited to English language reports and peer-reviewed literature from Canada, the US and the UK, published between 2005 and 2016. Search terms and keywords used with these bibliographic databases included but were not limited to: “African American”, “Black”, “Caribbean”, “non-White”, “breast neoplasms”, “carcinoma, lobular”, “tumour”, “age factors”, “delayed diagnosis”, “neoplasm grading”, “neoplasm invasiveness”, and “health status disparities”. For the Ovid MEDLINE search, similar terms were combined using the Boolean operator OR and separate concepts were combined using the Boolean operator AND. This initial search yielded a total of 6,434 results, which were reduced to 3215 entries following the removal of duplicate publications using EndNote.

Two authors (SG, JO) reviewed titles and abstracts of these publications to identify those that met inclusion criteria for full-text review (see Fig. 1). Eligibility was determined using the research question and was limited to articles reporting breast cancer characteristics at the time of diagnosis for Black women compared to White women. Articles that included other racialized groups in addition to Black and White women were also included. This preliminary screen identified 108 publications for full-text review. Details of the study design, population, time period, variables, outcomes, age at diagnosis, tumour type, stage of tumour, and prognosis were abstracted to a Microsoft Excel spreadsheet by the authors. Of these, one article could not be accessed through the University of Toronto library system and a further 29 publications were deemed irrelevant, upon review. As such, the final number of publications included in this narrative literature review was 78 [2–14, 20–81].

Results

Description of Studies

Almost all of the studies included in this study were conducted in the US, with two of the included studies conducted in the UK, and no studies from Canada met the inclusion criteria (see Table 1). There was a great deal of geographical variation within the US, with study locations including New York, California, Florida, Georgia, Utah, and Illinois. The studies included were published between 2005 and 2016, including patients diagnosed with breast cancer between 1975 and 2014.
Most of the included studies were retrospective and observational studies. There were eight prospective studies included, with an additional two studies utilizing prospective databases. The sample sizes varied widely in the included studies and ranged from a few hundred participants to hundreds of thousands of participants. Thirty-three of the included studies utilized data collected nationally by the SEER Program and the NCDB in the US. The remaining 45 studies utilized data from single centres, or multiple centres within a specific geographical region.

One of the studies included from the UK was a retrospective observational study conducted using data from a single East London hospital, enrolling a total of 445 participants [11]. The second UK study was a prospective cohort study, obtaining data from the medical records of 2956 patients at 127 hospitals across the UK [8].
| References             | Location                                      | Sample size                                                                 | Study design                          | Study population                                                                                      | Results                                                                 | How race data was obtained                  |
|-----------------------|-----------------------------------------------|------------------------------------------------------------------------------|---------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------|
| **Diagnosis at younger age (Black women)** |                                |                                                                              |                                       |                                                                                                      |                                                                        |                                             |
| Anderson et al. [43]  | United States                                 | n = 440,653<br>Black: 34,478  White: 381,122                              | Retrospective                        | Women diagnosed with invasive breast cancer                                                            | Black women – 57.6 years vs. White women – 62.6 years (p < 0.001)       | From SEER database                          |
| Barcenas et al. [5]   | United States                                 | n = 1178<br>Black: 489  White: 670  Asian/Pacific Islander: 12  Other/unknown: 7 | Retrospective                        | Women diagnosed with breast cancer                                                                   | Black women significantly more likely to be diagnosed at a younger age vs. white women (p = 0.00278) | Not reported                               |
| Bharat et al. [35]    | United States                                 | n = 3,596<br>Black: 496  White: 2917  Other/unknown: 183                    | Prospective database, with retrospective analysis | Women treated for invasive breast cancer or DCIS                                                     | Women diagnosed at a younger age ≤ 40 years were more likely to be Black (OR 2.25, 95% CI 2.17–2.53) | Not reported                               |
| Bowen et al. [11]     | United Kingdom                                | Black: 102  White: 191                                                      | Retrospective                        | Women diagnosed with invasive breast cancer, age ≥ 16 years                                           | Black women – 46 years<br>White women – 67 (p = 0.001)                  | Self-report                                 |
| Chen and Li [68]      | United States                                 | Black: 10,874  Non-hispanic white: 72,623  hispanic white: 9,944  Asian/Pacific islander: 8,068  American Indian/Alaska Native: 555 | Retrospective                        | Women aged ≥ 20 years                                                                                  | 20–49 years: Black women – 26.9%  vs. White women – 17.6%  50–64 years: Black women – 40.4% vs. 37.3% | From SEER database                          |
| Cunningham et al. [20] | United States, South Carolina and Ohio         | South Carolina<br>Black: 5,498  White: 18,420  Ohio<br>Black: 6,528  White: 64,713 | Retrospective                        | Women of European or African descent aged greater than 15 years diagnosed with invasive breast cancer | After age adjustment black women diagnosed 1–2 years earlier on average than white women | From medical records                       |
| References          | Location | Sample size | Study design | Study population                                      | Results                                                                                       | How race data was obtained                        |
|---------------------|----------|-------------|--------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------|
| DeSantis et al. [4] | United States | n = 193,969 | Retrospective | Black and white women (aged between 20 and 99 years) | Black women were more likely to be diagnosed at a younger age                                | From hospital records                             |
| Gnerlich et al. [32]| United States | n = 243,012 | Retrospective | Women diagnosed with primary breast cancer            | Black women diagnosed < 40 years – 14.1% vs. > 40 years – 8%                                 | From SEER database                                 |
|                     |          | Black: 24,483 |              |                                                       | White women diagnosed < 40 years – 75.6% vs. > 40 years – 84.7% (p < 0.001)                  |                                                  |
|                     |          | White: 169,486 |              |                                                       |                                                                                               |                                                  |
|                     |          | Other/Unknown: 18,207 | |                                                       |                                                                                               |                                                  |
|                     |          | Black: 20,389 |              |                                                       |                                                                                               |                                                  |
|                     |          | White: 204,416 |              |                                                       |                                                                                               |                                                  |
|                     |          | Other/Unknown: 18,207 | |                                                       |                                                                                               |                                                  |
| Iqbal et al. [66]   | United States | Black: 38,751 | Retrospective | Women diagnosed with first invasive breast cancer     | Median age: Black women – 57 years vs. white women – 61 years                                | From SEER database                                 |
|                     |          | Non-hispanic white: 208,675 | |                                                       | Stage I: Black women – 37.0% vs. White women – 50.8% (OR 0.56, 95% CI 0.64–0.67, p < 0.001) |                                                  |
|                     |          | Hispanic white: 34,928 |              |                                                       |                                                                                               |                                                  |
|                     |          | Chinese: 4937 |              |                                                       |                                                                                               |                                                  |
|                     |          | Japanese: 3751 |              |                                                       |                                                                                               |                                                  |
|                     |          | South Asian: 2191 |              |                                                       |                                                                                               |                                                  |
|                     |          | Other Asian: 2191 |              |                                                       |                                                                                               |                                                  |
|                     |          | Other: 5998 |              |                                                       |                                                                                               |                                                  |
| Kwan et al. [13]    | United States | Black: 155 | Prospective | Women diagnosed with early stage invasive breast cancer, aged 18–70 years | Black women diagnosed < 50 years – 27.7%                                                     | Self-report                                      |
|                     |          | White: 1943 |              |                                                       | White women diagnosed < 50 years – 20% (p < 0.0001)                                          |                                                  |
|                     |          |              |              |                                                       |                                                                                               |                                                  |
| References                  | Location                  | Sample size                  | Study design | Study population                                      | Results | How race data was obtained |
|-----------------------------|---------------------------|------------------------------|--------------|-------------------------------------------------------|---------|-----------------------------|
| Lund et al. [80]            | United States             | Black: 814                   | Retrospective| Women diagnosed with primary invasive breast cancer   | ≤ 50 years: Black women – 31.7% vs. White women – 21.7% | From Atlanta SEER registry and Georgia Comprehensive Cancer Registry |
|                             |                           | White: 967                   |              | Mean age: Black women – 56.9 vs. White women – 61.2 years | Stage III: Black women – 11.8% vs. White women – 6.8% |
|                             |                           |                              |              | White women – 60 years (no statistical analysis)       | Stage IV: Black women – 7.7% vs. White women – 2.7% (p < 0.001) |
| McBride et al. [7]          | United States             | n=256,174                    | Retrospective| Women diagnosed with stage I–IIIa invasive breast cancer| T1: Black women – 52.2% vs. white women – 65.9% | From SEER database |
|                             |                           | Black: 21,861                |              | T2: Black women – 40.4% vs. white women – 30.1%       | T3: Black women – 7.4% vs. white women – 4.0% (p < 0.0001) |
|                             |                           | White: 234,313               |              |                                                     | From Arkansas tumor registry files |
| Monzavi-Karbassi et al. [64]| United States, Arkansas   | Black: 208                   | Retrospective| Black and white women receiving breast cancer treatment| <50 years: Black women – 46.2% vs. white women – 30.6% (p < 0.001) | From Arkansas tumor registry files |
|                             |                           | White: 869                   |              | Stage II: Black women – 43.8% vs. White women – 41.1% (p < 0.001) |
|                             |                           |                              |              | Stage III: Black women – 18.8% vs. White women – 12.8% (p < 0.001) |
|                             |                           |                              |              | Stage IV: Black women – 10.6% vs. White women – 4.7% (p < 0.001) |
| Moran et al. [9]            | United States             | Black: 207                   | Retrospective| Women diagnosed with early stage breast cancer         | ≤ 40 years: Black women – 20% White women – 12% (p=0.016) | Self-report |
|                             |                           | White: 2164                  |              |                                                       | – | From SEER database |
| Robbins et al. [87]         | United States             | Black: 5815                  | Retrospective| Women diagnosed with invasive cancers, aged ≤ 84 years   | Mean age: Black women – 60.3 years vs. White women – 61.1 years (p < 0.001) | – | From SEER database |
|                             |                           | White: 38,301                |              |                                                       | – | |
| References          | Location                  | Sample size                  | Study design | Study population                                                                 | Results                                                                 | How race data was obtained |
|---------------------|---------------------------|------------------------------|--------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------|
| Roberts et al. [63] | United States, North      | Black: 609                   | Retrospective| Women diagnosed with ER⁺, stage I or II and HER2⁻ breast cancer                    | Black women – 55.5 years vs. white women – 57.7 years (p = 0.003)            | Self-report                 |
|                     | Carolina                  | White: 859                  |              |                                                                                   |                                                                                                      |                             |
| Sachdev et al. [78] | United States, Tennessee  | Black: 88                    | Retrospective| Women diagnosed and receiving treatment for triple negative invasive breast cancer  | Median age: Black women – 49.5 years vs. white women – 55 years (p = 0.024)                            | From medical records       |
|                     |                           | White: 36                   |              |                                                                                   | No significant difference in stage at diagnosis (p = 0.21)                  |                             |
| Sassi et al. [49]   | United States             | Black: 23,689                | Retrospective| Women diagnosed with breast cancer                                                 | Black women – 58.6 years vs. white women – 63.3 years (no statistical analysis) | Not reported                |
|                     |                           | White: 311,842               |              |                                                                                   |                                                                                                      |                             |
| Schootman et al. [27]| United States             | Black: 2101                  | Retrospective| Women > 66 years diagnosed with distant metastases from primary breast cancer     | Black women more likely to be diagnosed with distant metastases from primary breast cancer at younger ages than White women | From SEER database         |
|                     |                           | White: 32,387                |              |                                                                                   |                                                                                                      |                             |
|                     |                           | Other: 1320                  |              |                                                                                   |                                                                                                      |                             |
| Short et al. [77]   | United States             | Black: 99                    | Retrospective| Women newly diagnosed with breast cancer                                          | Mean age: Black women – 48.9 years vs. White women – 52.9 years (p = 0.001) | From medical charts        |
|                     |                           | White: 476                   |              |                                                                                   | Stage IV: Black women – 6.1% vs. White women – 3.2% (p < 0.05)               |                             |
|                     |                           |                              |              |                                                                                   | After adjustment, diagnosis with later stage cancer OR 1.71, 95% CI 1.09–2.76, (p = 0.02)            |                             |
| Swede et al. [62]   | United States, Connecticut| n = 416                      | Retrospective| Women diagnosed and receiving treatment for breast cancer                          | Black women – 54.8 years vs. 58.4 years (p = 0.007)                          | From patient chart         |
|                     |                           | Black: 202                   |              |                                                                                   | SEER stage, distant: Black women – 5.0% vs. White women – 1.4% (p = 0.04)      |                             |
|                     |                           | White: 214                   |              |                                                                                   |                                                                                                      |                             |
| Tao et al. [6]      | United States, California | Black: 9738                  | Retrospective| Women diagnosed with invasive breast cancer                                       | Mean age: Black women – 58.8 years vs. White women – 62.3 years (p < 0.05) | From medical record        |
|                     |                           | White: 93,760                |              |                                                                                   | Stage III: Black women – 15.4% vs. White women – 11.0%                       |                             |
|                     |                           |                              |              |                                                                                   | Stage IV: Black women 7.5% vs. White women – 4.6% (p < 0.05)                  |                             |
| References          | Location          | Sample size | Study design | Study population                                      | Results | How race data was obtained |
|---------------------|-------------------|-------------|--------------|-------------------------------------------------------|---------|-----------------------------|
| Thomas et al. [60]  | United States     | Non-hispanic black: 33,301 Non-hispanic white: 241,236 Non-hispanic Asian/Pacific Islander: 9508 Hispanic: 15,782 | Retrospective | Women diagnosed with invasive breast cancer           | < 30 year: Black women – 1.3% vs. white women – 0.5% (p < 0.001) | Stage I: Black women – 58.6% vs. white women – 68.2% (p < 0.001) | From National Cancer Database |
| Vicini et al. [75]  | United States, Michigan | n = 699 Black: 39 White: 660 | Retrospective | Women diagnosed with invasive breast cancer           | ≤ 50 years: Black women – 49% vs. white women – 26% (p = 0.002) | Stage IIB: Black women – 31% vs. White women – 10% (p < 0.001) | Self-report |
| Woods et al. [2]    | United States     | n = 5751 Black: 632 White: 5119 | Retrospective | Women diagnosed with breast cancer                    | Black women – 56.4 years vs. white women – 58.6 years (p < 0.01) | Black women less likely to be diagnosed with Stage I tumour (OR 0.80, 95% CI 0.67–0.96, p = 0.02) and more likely to be diagnosed with Stage 3 tumour (OR 1.50, 95% CI 1.11–2.01, p = 0.01) vs. white women | From patient, patient chart or treating physician |
| Yang et al. [23]    | United States, Florida | n = 935 Black: 130 White: 777 Asian/Pacific Islander/ Native American: 13 Not reported: 15 | Retrospective | Women diagnosed with inflammatory breast cancer       | Black women were diagnosed < 45 years (28.5%) vs. white women (18.3%) (p = 0.003) | No significant difference in tumour stage at diagnosis between black and white women (p = 0.260) | From cancer registry and hospital records |

**Incidence rate ratio**

| References          | Location          | Sample size | Study design | Study population                                      | Results | How race data was obtained |
|---------------------|-------------------|-------------|--------------|-------------------------------------------------------|---------|-----------------------------|
| Baquet et al. [42]  | United States     | n = 171,372 Black: 15,877 White: 155,495 | Retrospective | Women diagnosed with breast cancer                    | Significantly higher incidence among Black women < 40 years, incidence rate ratio – 1.16, 95% CI 1.10–1.23 | Advanced stage: Black women – 9.0% vs. white women – 5.3% (p < 0.0001) Regional stage: Black women – 34.2% vs. 27.8% (p < 0.001) | From SEER database |
| References       | Location               | Sample size | Study design | Study population                                                                 | Results                                                                 | How race data was obtained                                                                 |
|------------------|------------------------|-------------|--------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Joslyn et al. [55] | United States          | n = 363,801 | Retrospective| Women diagnosed with invasive breast cancer, aged ≥ 10 years                       | Cross-over effect: significantly higher incidence rate of breast cancer for black women < 40 years (20–39 years, 95% CI > 1.0) and significantly lower incidence rate > 50 years (50+ years, 95% CI < 1.0) compared to white women | From North American Association of Central Cancer Registries Breast Cancer Research Dataset |
| Aggarwal et al. [69] | United States, Indiana | Black: 325  White: 675 | Retrospective| Women diagnosed with breast cancer, ≥ 65 years                                       | Mean age: Black women – 74.5 years vs. white women – 74.0 years (p = 0.29)            | Self-report                                                                                 |
| Chu et al. [22]   | United States          | Black: 252  White: 123 | Prospective  | Low income Black and White women with Stage 0-III, ER-breast cancer, receiving standardized treatment | Mean age of diagnosis was not significantly different between black women, 55 years vs white women 59 years (p = 0.29) | No significant difference in stage at diagnosis between black and white women (p = 0.29)    |
| Copson et al. [8] | United Kingdom         | n = 2,915   | Prospective  | Women diagnosed and receiving treatment for breast cancer, aged ≤ 41 years         | Median age: Black women – 36 years vs. white women – 36 years (p = 0.463)            | Self-report                                                                                 |
| References          | Location               | Sample size         | Study design | Study population                                      | Results                                                                 | Stage                                                                 | How race data was obtained |
|---------------------|------------------------|---------------------|--------------|-------------------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------|
| Crowe et al. [57]   | United States          | Black: 313 White: 2012 | Prospective  | Women diagnosed with invasive breast cancer with available 2000 census tract data | Median age – 57 years, no significant difference (p=0.37)               | Stage I: Black women – 43% vs. white women – 54% Stage II: Black women – 44% vs. white women – 38% Stage III: Black women – 8% vs. white women – 6% Stage IV: Black women – 5% vs. white women – 3% (p=0.002) | Self-report               |
| George et al. [67]  | United States          | Black: 304 White: 330 | Retrospective| Black and white women ≤ 85 years                      | No significant difference in age at diagnosis < 55 years: Black women – 46.4% vs. white women – 52.1%, p = 0.1487 | –                                                                      | From medical records      |
| Jiagge et al. [82]  | United States, Ghana and Ethiopia | Black: 272 White: 321 Ghanaian: 234 Ethiopian: 94 | Retrospective | Women diagnosed with invasive breast cancer           | Significantly lower for Ghanaian women – 49 years and Ethiopian women – 43 years vs. African American women – 60 years and White women – 62 years (p <0.001) | No significant difference in stage at diagnosis (p=0.4986)            | Not reported               |
| Lund et al. [39]    | United States          | Black: 176 Non-Black: 23 | Retrospective| Women diagnosed with invasive breast cancer           | Black women – 58 years Non-Black women – 57 years (p = 0.967)           | –                                                                      | Self-report               |
| Maloney et al. [50] | United States          | n=52 Black: 36 White: 16 | Retrospective| Women diagnosed with breast cancer, uninsured and below poverty line | No significant difference between age at diagnosis for Black women – 56.1 years and white women – 56.2 years (p = 0.98) | –                                                                      | Not reported               |
Table 1 (continued)

| References | Location          | Sample size         | Study design                       | Study population                                                                 | Results                                                                 | How race data was obtained |
|------------|-------------------|---------------------|------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------|
| Marti et al. [38] | United States     | n = 215             | Prospective database, retrospective analysis | Women diagnosed with invasive breast cancer or DCIS, of low socioeconomic status | Invasive breast cancer: Black women – 56 years, White women – 53 years (p = 0.009) | Not reported               |
|             |                   | Black: 29, White: 31, Asian: 53, Hispanic: 102 |                      | DCIS: Black women – 51 years, White women – 63 years (p = 0.08)                | No significant difference in stage at diagnosis for both invasive breast cancer (p = 0.74) and DCIS (p = 0.80) | |
| Rizzo et al. [28] | United States     | Black: 93, Non-Black: 14 | Retrospective | Women diagnosed with stage III breast cancer | Black women – 55 years, Non-Black women – 53.1 years (p = 0.63) | No significant difference in stage at diagnosis (p = 0.39) From medical records |
| Roseland et al. [10] | United States | Black: 818, White: 1569 | Retrospective | Women diagnosed with Stage I, II or III breast cancer | No significant difference in age at diagnosis (p = 0.3314) | Not reported               |
| Stark et al. [37] | United States     | n = 1263, Black: 441, White: 822 | Retrospective | Women diagnosed with primary invasive breast cancer | Black women – 60.3 years, White women – 62.4 years (p = 0.051) | Stage IV: Black women – 7.8%, White women – 3.1% (p = 0.002) Self-report |
| Diagnosis at older age (Black women) | | | | | | |
| Chagpar et al. [74] | United States, Kentucky | n = 1903, Black: 469, White: 1,145 | Retrospective | Women diagnosed with hormone receptor positive breast cancer | Median age: Black women – 57 years vs. White – 55 years (p = 0.032) | Not reported               |
| Nassar et al. [30] | United States     | Black: 217, White: 141 | Retrospective | Women diagnosed with primary ductal carcinoma in situ with focal invasion > 1 mm | Black women – 60 years, White women – 56 years (p = 0.001) | From medical records and SEER database |
| Stage only | | | | | | |
| Chlebowski et al. [58] | United States | n = 156,570, Diagnosed with breast cancer: 39,382, Black: 242, White: 3455, Other: 202, Unknown: 39 | Prospective | Post-menopausal women aged 50–79 years | – | No significant difference in tumour stage at diagnosis (p = 0.39) Self-report |
Age at Diagnosis

Forty-four of the 78 articles included in this narrative review analyzed differences in age at diagnosis stratified by race (Table 1). Race was significantly associated with age at diagnosis in the thirty-two of these papers, and Black women were generally found to be diagnosed with breast cancer at a younger age than White women.

Method of reporting age varied substantially, with 28 of the articles reviewed using the median or mean age at diagnosis to analyze differences by race. Other methods of analysis include comparison of the incidence rate of breast cancer by age group [42, 55] and analysis of the proportion of breast cancer by race within given age brackets. The range of mean age at diagnosis for Black and White women were similar, ranging from 36 years [8] to 74.5 years [69]. However, Black women were younger than their White counterparts at diagnosis in thirty of the studies reviewed. A similar trend was noted in the incidence of breast cancer in younger age brackets. Black women were more likely to be diagnosed before the age of 50 [9, 32, 60, 75], and a higher incidence of breast cancer was noted amongst Black women before the age of 40 [42, 55].

Twelve of the articles reviewed found no statistically significant difference in average age at diagnosis by race. Most of these papers reported an average age at diagnosis between 50 and 65 years of age for both Black and White women [22, 28, 37–39, 50, 57, 82]. Additionally, two studies found that Black women were more likely to be diagnosed at an older age than White women [30, 74]. Of significance, Nassar et al. [30] looked at the age of diagnosis for ductal carcinoma in situ (DCIS), finding that Black women were diagnosed at a significantly older age (60 years) compared to White women (56 years; p < 0.001). However, another article in this review also looked at incidence of DCIS by race and noted that Black women were more likely to be diagnosed with DCIS at a younger age (≤ 40 years old) than White women [35].

Stage at Diagnosis

Breast cancer staging describes the degree of metastasis and disease progression. The reviewed literature reported breast cancer stage at the time of diagnosis either using a scale from 0 to IV or by describing tumour stage as local, regional or distant. Sixteen publications reported a significant difference in breast cancer stage between Black and White women, whilst no significant difference was observed in nine studies (Table 1).

Black women were significantly less likely to be diagnosed at earlier stages (I and II) of breast cancer compared to White women [2, 14, 66, 69]. An additional six studies found that a greater proportion of Black women were diagnosed
with stage II, III, or IV breast cancers compared to White women [6, 7, 64, 71, 75, 80]. Warner et al. [71] found that 20% and 6% of Black women were diagnosed with stage III (n = 344/1718) and IV (n = 103/1718) breast cancers, compared to 11% and 4% of White women (n = 1947/17,696; n = 708/17,696) (p < 0.0001). Furthermore, the odds of Black women being diagnosed with stage III or IV tumours was significantly greater than White women (OR 1.34, 95% CI 1.16–1.56). Similarly, Stark et al. [37] and Short et al. [77] found that a greater proportion (4.7% and 2.5%) of Black women were diagnosed with stage IV breast cancer compared to White women.

Two studies described breast cancer stage based on localization of the tumour and in both instances, differences were observed between Black and White women. Black women were significantly more likely to present with distant breast cancers compared to White women [5, 62]. However, it is important to note that nine studies reported no significant difference in stage at diagnosis between Black and White women [12, 22, 28, 39, 47, 58, 70, 78, 82].

Tumour Size

Twenty-seven articles included in this review analyzed tumour size at diagnosis. Of these articles, twenty articles indicated a significant difference in tumour size by race (Table 2). There was heterogeneity in the method of reporting tumour size. Fourteen articles used ranges of measurements similar to those found in the TNM classification system, the most commonly used system for tumour classification and gold standard of measurement. For this classification system, size was reported as ≤ 2 cm (T1), 2–5 cm (T2), or ≥ 5 cm (T3 or greater). Of the remaining studies, ten compared results by mean size (cm).

Using different size cut-off points for comparison, Black women tended to be diagnosed with larger tumours compared to White women. Based on the TNM classification system, Black women were more likely to be diagnosed with larger (T3 or greater) tumours [22] and were significantly more likely to be diagnosed with tumours ≥ 5 cm compared to White women [4, 5, 81]. Using a lower measurement of ≥ 2 cm, a large proportion of women diagnosed with larger tumours were Black [43, 54, 67, 68, 80]. Eight of the studies looking at the relationship between race and tumour size at diagnosis found significant differences in mean and median tumour size at diagnosis, with Black women being diagnosed with significantly larger tumours [8, 38, 43, 74]. Average tumour size for Black women ranged from 1.7 [75] to 3.0 cm [28]. For White women, tumour size ranged from 1.2 [30] to 2.6 cm [38].

Seven studies found no significant difference in tumour size at diagnosis between Black and White women. Method of reporting tumour size was similar to the studies described above. Crowe et al. [57] and Stead et al. [25] found no significant difference in tumour size using the TNM classification system (p > 0.05). Furthermore, Maloney et al. [50] and Swede et al. [62] found no significant difference in mean tumour size at diagnosis between Black and White women (p > 0.05).

Tumour Grade

Grading of tumours describes the degree of differentiation of tumour cells, with poorly differentiated tumour cells carrying a worse prognosis. In the reviewed literature, tumours were assigned a grade of I (low), II (intermediate), or III (high). Low grade tumours were well differentiated tumours, carrying a more favourable prognosis, while high grade tumours were poorly differentiated. Twenty-eight articles included in this review reported tumour grade/tumour differentiation at the time of diagnosis (Tables 2 and 3). Of these articles, six studies reported no significant difference in tumour grade at the time of diagnosis based on race [8, 22, 30, 39, 74, 78]. Despite the lack of statistical significance, Copson et al. [8] observed that there was a greater proportion of Black women (n = 77/118, 68.1%) diagnosed with grade III tumours compared to White women (n = 1586/2690, 60.4%). Similar findings were reported by Baquet et al. [42], where 43.6% of Black women (n = 6922/15,877) were diagnosed with poorly differentiated breast cancer compared to 29.7% of White women (n = 46,182/155,495). However, the authors did not indicate whether this finding was statistically significant.

Of the articles reviewed, 21 found a significant difference between Black and White women in tumour grade at the time of diagnosis. These studies found that Black women were more likely to be diagnosed with poorly differentiated (grade III) tumours than White women. After adjusting for age, DeSantis et al. [4] found that the odds of Black women being diagnosed with a poorly differentiated tumour was 2.6 times greater than that of White women (OR 2.6, 95% CI 2.4–2.7). In addition, some studies reported that a smaller proportion of Black women were diagnosed with grade I tumours compared to White women. For example, Stark et al. [37] observed that at time of diagnosis 45.2% of Black women (n = 344/771/18) and 48.1% were diagnosed with grade I tumours compared to White women (n = 118, 68.1%) diagnosed with grade III tumours compared to White women (n = 1586/2690, 60.4%). Similar findings were reported by Baquet et al. [42], where 43.6% of Black women (n = 6922/15,877) were diagnosed with poorly differentiated breast cancer compared to 29.7% of White women (n = 46,182/155,495). However, the authors did not indicate whether this finding was statistically significant.

Lymph Node Involvement

Twenty-one of the reviewed studies analyzed differences between Black and White women in relation to lymph node involvement (Table 3). Sixteen of these studies considered
| References          | Location         | Sample size                                      | Study design | Study population                                                                 | Results                                                                 | How race data was obtained |
|---------------------|------------------|--------------------------------------------------|--------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------|
| Ambrosone et al. [36] | United States    | Cases: 1119 Black: 559 White: 560 Control: 858 Black: 412 White: 446 | Multi-center case–control | Women diagnosed with invasive breast cancer or primary DCIS, aged 20–75 years | Tumour size<br>Poorly differentiated tumours:<br>Black women – 51.6% White women – 32% (p < 0.05) | Self-report |
| Anderson et al. [43] | United States    | n = 440,653 Black: 34,478 White: 381,122         | Retrospective | Women diagnosed with invasive breast cancer | Tumour grade<br>Significantly higher incidence of high grade tumours for black women, IRR = 1.1 (95% CI 1.1–1.2) | From SEER database |
| Baquet et al. [42]  | United States    | n = 171,372 Black: 15,877 White: 155,495         | Retrospective | Women diagnosed with breast cancer | Tumour grade<br>Poorly differentiated: Black women – 43.6% White women—29.7% (no p value) | From SEER database |
| Bowen et al. [11]   | United Kingdom   | n = 293 Black: 102 White: 191                   | Retrospective | Women diagnosed with invasive breast cancer, age ≥ 16 years | Tumour size<br>No significant difference in tumour size at diagnosis (p=0.2) | Self-report |
| Chagpar et al. [74] | United States    | n = 1,205 Black: 262 White: 927 Other: 16       | Retrospective | Women diagnosed with hormone receptor positive breast cancer | Tumour size<br>Median diameter:<br>Black women – 1.9 cm White women – 1.7 cm (p = 0.009) | From Kentucky Cancer Registry |
| Chen and Li [68]    | United States    | n = 102,064 Black: 10,874 White: 72,623 Other: 18,567 | Retrospective | Women aged ≥ 20 years | Tumour size<br>≥ 5.0 cm:<br>Black women – 13.4% White women – 8.2% (no p value) | From SEER database |
| Chlebowski et al. [58] | United States | n = 156,570 Diagnosed with breast cancer: 3,938 Black: 242 White: 3,455 Other: 202 Unknown: 39 | Prospective | Post-menopausal women aged 50 – 79 years | Tumour size<br>No significant difference in tumour size at diagnosis (p = 0.12) | Poorly differentiated: Black women – 43% White women – 25% Well differentiated: Black women – 13% White women – 25% (p < 0.001) | Self-report |
| References                  | Location         | Sample size       | Study design | Study population                                                                 | Results                                                                 | Tumour size          | Tumour grade     | How race data was obtained |
|-----------------------------|------------------|-------------------|--------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------|-----------------|-----------------------------|
| Chu et al. [22]             | United States    | n = 375 White: 123 Black: 252 | Prospective  | Low income Black and White women with Stage 0–III, ER negative breast cancer receiving treatment | No significant difference in mean tumour size at diagnosis (p = 0.19) | No significant difference in tumour grade at diagnosis (p = 0.32) | From database    |                |                             |
| Copson et al. [8]           | United Kingdom   | n = 2956 Black: 106 White: 2690 | Prospective  | Women diagnosed and receiving treatment for breast cancer, aged ≤ 41 years         | Median diameter: Black women – 2.6 cm White women – 2.2 cm (p = 0.0103) | Grade 3: Black women – 68.1% White women – 60.4% (non sig) | Self-report       |                |                             |
| Crowe et al. [57]           | United States    | n = 2325 Black: 313 White: 201 | Prospective  | Women diagnosed with invasive breast cancer with available 2000 census tract data | No significant difference in tumour size at diagnosis (p = 0.08)        | –                    | –               | Self-report       |                             |
| Cunningham et al. [20]      | United States    | n = 95,159 Black: 12,026 White: 83,133 | Retrospective | Women of European or African descent aged greater than 15 years diagnosed with invasive breast cancer | – | Grade 1: Black women – 10–14% White women – 21–22% p < 0.001 Grade 3: Black women – 52–58% White women – 37–39% | From medical records |                |                             |
| DeSantis et al. [4]         | United States    | n = 193,969 Black: 24,483 White: 169,486 | Retrospective | Black and white women (aged between 20 and 99 years) | Black women diagnosed with larger tumours (OR 1.87, 95% CI 1.80–1.95) | Black women diagnosed with less differentiated tumours (OR 2.55, 95% CI 2.44–2.66) | From hospital records |                |                             |
| George et al. [67]          | United States    | n = 634 Black: 304 White: 334 | Retrospective | Black and White women ≤ 85 years | > 2.0 cm: Black women – 39.8% White women – 22.7% (p < 0.0001) | Poorly differentiated: Black women – 42.4% White women – 28.2% (p = 0.0005) | From patient chart |                |                             |
| Hahn et al. [47]            | United States    | n = 829 Black: 250 White: 579 | Retrospective | Women diagnosed with unilateral invasive breast cancer | – | No significant difference in grade at diagnosis between Black and White women | Self-report        |                |                             |
### Table 2 (continued)

| References      | Location       | Sample size         | Study design | Study population                                      | Results                                                                 | How race data was obtained |
|-----------------|----------------|---------------------|--------------|-------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------|
| Hance et al. [56] | United States | n = 180,224         | Retrospective| Women diagnosed with breast cancer                     | Black women are at a lower risk of diagnosis with a lower grade cancer (T1–T3) compared to white women (RR:0.80, 0.79–0.82) | From SEER database          |
|                 |                | Black: 14,196       |              |                                                       |                                                                         |                             |
|                 |                | White: 155,820      |              |                                                       |                                                                         |                             |
| Iqbal et al. [66] | United States | n = 373,563         | Retrospective| Women diagnosed with first invasive breast cancer      | Distant: Black women – 1.5% White women – 1.0% (p < 0.001)               | From SEER database          |
|                 |                | Black: 38,751       |              |                                                       |                                                                         |                             |
|                 |                | White: 268,675      |              |                                                       |                                                                         |                             |
| Jiagge et al. [82] | United States | Black: 272          | Retrospective| Women diagnosed with invasive breast cancer            | Grade I: African American – 12.3% White women – 24.9% Grade II: African American – 37.3% White women – 41.3% Grade III: African American – 50.4% White women – 33.7% (p < 0.0001) | From medical records       |
|                 |                | White: 321          |              |                                                       |                                                                         |                             |
|                 |                | Ghanaian patients: 234 |              |                                                       |                                                                         |                             |
|                 |                | Ethiopian patients: 94 |              |                                                       |                                                                         |                             |
| Katz et al. [81] | United States | n = 1341            | Retrospective| Women diagnosed with breast cancer                     | > 5.0 cm: Black women 19.1% White women – 8.7% (p < 0.0001)              | Self-report                 |
|                 |                | Black: 430          |              |                                                       |                                                                         |                             |
|                 |                | White: 911          |              |                                                       |                                                                         |                             |
| Kenney et al. [40] | United States | n = 184             | Retrospective| Women with invasive breast cancer                      | < 50 years: Black women – 3.1 cm ≥ 50 years: Black women – 2.3 cm (p < 0.05) | Self-report                 |
|                 |                | Black: 70           |              |                                                       |                                                                         |                             |
|                 |                | White: 98 Other: 16 |              |                                                       |                                                                         |                             |
| Lund et al. [39] | United States | n = 190             | Retrospective| Women diagnosed with invasive breast cancer            | No significant difference in grade at diagnosis (p = 0.099)              | Self-report                 |
|                 |                | Black: 167          |              |                                                       |                                                                         |                             |
|                 |                | White: 16           |              |                                                       |                                                                         |                             |
|                 |                | Other: 7            |              |                                                       |                                                                         |                             |
| References           | Location   | Sample size | Study design           | Study population                                                                 | Results                        | Tumour size | Tumour grade | How race data was obtained                                    |
|----------------------|------------|-------------|------------------------|-----------------------------------------------------------------------------------|-------------------------------|-------------|--------------|---------------------------------------------------------------|
| Lund et al. [80]     | United States | n = 1842    | Retrospective          | Women diagnosed with primary invasive breast cancer                                | 2.1–5.0 cm: Black women – 33.7% | –           |              | From Atlanta SEER registry and Georgia Comprehensive Cancer Registry |
|                      |            | Black: 814  |                        | White women 22.9%                                                                  | White women ≥ 5.0 cm: Black women – 9.6% | (p < 0.001) |              |                                                                |
|                      |            | White: 967  |                        |                                                                                   | White women – 3.6%           |              |              |                                                                |
| Maloney et al. [50]  | United States | n = 52      | Retrospective          | Women diagnosed with breast cancer, uninsured and below poverty line               | No significant difference in size of tumour at diagnosis (p = 0.91)         | –           |              | From database                                                 |
| Marti et al. [38]    | United States | n = 215     | Prospective database, retrospective analysis | Women diagnosed with invasive breast cancer or DCIS, of low socioeconomic status | Black women – 3.0 cm         | –           |              | From medical records                                          |
| McBride et al. [7]   | United States | n = 256,174 | Retrospective          | Women diagnosed with Stage I–IIa invasive breast cancer                          | Black women – 2.5 cm         | Incidence of high grade tumours: Black women – 45.7% | –           | From SEER database                                            |
|                      |            | Black: 21,861 White: 234,313 |                        | White women – 1.6 cm (p < 0.0001)                                                | White women – 31.9% (p < 0.0001) |              |              |                                                                |
| Monzavi-Karbassi et al. [64] | United States | n = 1077   | Retrospective          | Black and white women receiving breast cancer treatment                          | –                             | Grade III: Black women 41.8% | –           | From Arkansas tumour registry                                 |
|                      |            | Black: 208  |                        |                                                                                   | White women – 4.8%           | Grade IV: Black women – 35.0% |              |                                                                |
|                      |            | White: 869  |                        |                                                                                   | White women 2.1%             | (p = 0.02) |              |                                                                |
| Moran et al. [9]     | United States | n = 2371    | Retrospective          | Women diagnosed with early stage breast cancer                                   | T2 (2.1–5 cm): Black women – 32% | –           |              | Self-report                                                   |
|                      |            | Black: 207  |                        |                                                                                   | White women – 18% (no p value) |              |              |                                                                |
|                      |            | White: 2,164|                        |                                                                                   |                                |              |              |                                                                |
| Morris et al. [44]   | United States | n = 199,504 | Retrospective          | Women diagnosed with breast cancer                                               | –                             | Black women more likely to be diagnosed with high grade tumours (p < 0.001) | –           | From SEER database and hospital records                       |
| References          | Location       | Sample size       | Study design | Study population                                                                 | Results                                                                 | How race data was obtained                  |
|---------------------|----------------|-------------------|--------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------|
| Nassar et al. [30]  | United States  | n = 358           | Retrospective| Women diagnosed with primary ductal carcinoma in situ with focal invasion > 1 mm  | Black women – 1.83 cm                                                   | From SEER database and hospital records     |
|                     |                | Black: 217        |              | White women – 1.15 cm (p = 0.001)                                                 | No significant difference in tumour grade at diagnosis                  |                                             |
| Rizzo et al. [28]   | United States  | n = 107           | Retrospective| Women diagnosed with stage III breast cancer                                       | High grade: Black – 44.3% Non-black 14.2% (p = 0.04)                    | From SEER database and patient chart        |
|                     |                | Black: 93 Non-black: 14 |              |                                                                                   |                                                                         |                                             |
| Roberts et al. [63] | United States  | n = 1468          | Retrospective| Women diagnosed with ER+, stage I or II and HER2− breast cancer                   | T2 (2.1–5 cm): Black women 32.3% non-Black women – 22.4% (p < 0.001)   | Self-report                                 |
|                     |                | Black: 609 Non-Black: 859 |              | Grade III: Black women – 24.9% non-Black women – 15.6% (p < 0.001)                |                                                                         |                                             |
| Roseland et al. [10]| United States  | n = 2387          | Retrospective| Women diagnosed with Stage I, II or III breast cancer                             | 2.1–5.0 cm: Black women – 32% White women – 28% > 5.0 cm:               | From several databases                      |
|                     |                | Black: 818 White: 1569 |              | Grade II: Black women – 28% White women – 13%                                    | Black women 9% vs. White women – 4% (p < 0.001)                          |                                             |
| Sachdev et al. [78] | United States  | n = 124           | Retrospective| Women diagnosed and receiving treatment for triple negative invasive breast cancer | No significant difference in tumour grade at diagnosis (p = 0.99)         | From medical records                        |
|                     |                | Black: 88 White: 3 |              |                                                                                   |                                                                         |                                             |
| Stark et al. [37]   | United States  | n = 1263          | Retrospective| Women diagnosed with primary invasive breast cancer                              | Black women – 2.34 cm                                                   | Self-report                                 |
|                     |                | Black: 441 White: 822 |              | Grade I: Black women – 19.6% White women – 30.3%                                |                                                                         |                                             |
|                     |                |                      |              | Grade II: Black women – 45.2% White women – 29.3% (p < 0.001)                    |                                                                         |                                             |
| Stark et al. [76]   | United States, Ghana | Black: 581 White: 1008 Ghanaian women: 75 | Retrospective| Women diagnosed with breast cancer                                                | –                                                                       | Self-report                                 |
|                     |                |                      |              | Grade III: African American – 44.9% White – 29.3% (p = 0.007)                     |                                                                         |                                             |
| References      | Location      | Sample size                                      | Study design      | Study population                                           | Results                                                                                                                                  | How race data was obtained                  |
|-----------------|---------------|-------------------------------------------------|-------------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Stead et al. [25] | United States | n=415 White: 148 Black: 177 Hispanic: 43 Other: 47 | Retrospective     | Women diagnosed with invasive breast cancer               | No significant difference in tumour size at diagnosis (p=0.64)                                                                      | Self-report                                 |
| Swede et al. [62] | United States | n=416 Black: 202 White: 214                     | Retrospective     | Women diagnosed and receiving treatment for breast cancer | No significant difference in tumour size at diagnosis (p=0.22) Grade III/IV: Black women – 50.3% White women – 42.7% (p = 0.04) | From tumour registry                        |
| Tao et al. [6]   | United States | n=103,498 Black: 9,738 White: 93,760           | Retrospective     | Women diagnosed with invasive breast cancer               | T2 (2.01–5 cm): Black women – 34.5% White women – 29.1% (p<0.05)                                                                    | From medical record                        |
| Thomas et al. [60] | United States | n=299,827 Black: 33,301 White: 241,236 Other: 25,290 | Retrospective     | Women diagnosed with invasive breast cancer               | Black women – 2.54 cm White women – 2.07 cm (p=0.001) Grade III: Black women – 52% White women – 29% (p=0.006)                  | From National Cancer Database               |
| Vicini et al. [75] | United States | n=699 Black: 39 White: 660                     | Retrospective     | Women diagnosed with invasive breast cancer               | Black – 1.7 cm White – 1.4 cm (p=0.032) Grade III: Black women – 52% White women – 29% (p=0.006)                                  | Self-report                                 |
| Yang et al. [12]  | United States | n=63,472 White: 57,435 Black: 4,804 Hispanic: 5,553 | Retrospective     | Women diagnosed with invasive breast cancer               | Black women had significantly larger tumours (p < 0.001) Higher grade tumours: Black women – 58.1% White women – 36.8% (p < 0.001) | From cancer registry and hospital records  |
| Yang et al. [23]  | United States | n=935 Black: 130 White: 777 Other: 13 Unknown: 15 | Retrospective     | Women diagnosed with inflammatory breast cancer            | No significant difference in tumour size at diagnosis (p=0.214) Higher grade tumours: Black women – 92.4% White women – 78.1% (p=0.003) | From cancer registry and hospital records  |
reported nodal involvement as either positive (i.e. at least one lymph node was involved) or negative (i.e. no lymph node involvement). Three studies reported nodal involvement as the average number of positive lymph nodes for Black and White participants [7, 8, 62].

Eleven of the studies reviewed found no significant difference in lymph node involvement by race. Of those studies that found a significant difference in nodal involvement by race, nine indicated a greater likelihood of positive lymph node involvement amongst Black women [4, 5, 7, 10, 57, 80]. Only one study reported a significantly greater likelihood of positive nodal involvement amongst White women with inflammatory breast cancer relative to Black women [12]. Of note, 46.8% of White women (n = 364/777) and 60.0% of Black women (n = 78/130) did not have lymph node involvement [12].

**Tumour Type**

Thirty-five out of the 78 reviewed publications assessed the expression of hormone receptors at the time of diagnosis for Black and White women (Table 4). The majority of studies presented findings on the expression of estrogen receptor (ER) and progesterone receptor (PR) and the expression of human epidermal growth factor receptor 2 (HER2) was discussed to a lesser extent. Ten studies reported that there was no significant difference in the expression of ER, PR and HER2, eight studies provided findings on the positive expression of ER and PR and seventeen studies presented results in relation to the negative expression of ER and PR. Twenty studies discussed the occurrence of triple negative breast cancer for Black and White women.

**No Significant Difference**

As mentioned above, ten studies found no significant difference in the expression of hormone receptors (ER and PR) and HER2 between Black and White women. Lund et al. [39] observed that the frequency of hormone receptor and HER2 expression did not differ between Black and White women (ER, p = 0.109; PR, p = 0.156; HER2, p = 0.765). Furthermore, Rizzo et al. [28] found that the frequency of triple negative breast cancer was not significantly different (p = 0.540). Findings from Chagpar et al. [74] indicate that there was no significant difference in the ER+ and PR+ tumours for Black and White women, 97.7% (n = 256/469) vs. 97.6% (n = 903/1415), (p = 0.682) and 86.0% (n = 222/469) vs 86.0% (n = 784/1415) (p = 0.873). Four studies found no significant difference in the frequency of HER2 expression for Black and White women [8, 9, 37, 67].

**Positive Hormone Receptor Expression**

With regards to the positive expression of ER or PR, four studies observed that a smaller proportion of Black women than White women presented at the time of diagnosis with ER+ or PR+ tumours [2, 54, 58, 75]. In Vicini et al. [75], 44% of Black women (n = 16/39) were diagnosed with ER+ tumours, whereas 82% of White women (n = 430/660) presented with ER+ tumours (p < 0.001). The same study found that 42% (n = 15/39) of Black women and 65% (n = 343/660) of White women were diagnosed with PR+ tumours (p = 0.004). Crowe et al. [57] and Short et al. [77] explored the expression of ER+/PR+ tumours in newly diagnosed women in the US. Both studies found that fewer Black women (n = 190/313; n = 40/99) were diagnosed with ER+/PR+ tumours than White women (n = 1541/2012; n = 267/476) (67.0% vs 82.0%, p < 0.001; 56.3% vs 75.4%, p = 0.001). Using all three markers of hormone receptor expression, Parise et al. [29] assessed differences between Black and White women using the California Cancer Registry. Findings indicate that Black women had a lower odds of being diagnosed with ER+/PR+/HER2+ (OR 0.80, 95% CI 0.70–0.91) and ER+/PR+/HER2− (OR 0.69, 95% CI 0.63–0.76) tumours when compared to White women.

**Negative Hormone Receptor Expression**

Seventeen of the reviewed articles compared the frequency of the absence of ER and PR expression on breast cancer tumours for Black and White women. Eleven studies found a significant difference in the proportion of Black and White women who presented with either ER−, PR−, or ER−/PR− tumours at the time of diagnosis. Findings indicate that the frequency of ER−, PR−, or ER−/PR− tumours was greater for Black women compared to White women. For example, Stead et al. [25] found that a significantly greater proportion of Black women (n = 52/177, 30%) were diagnosed with hormone receptor negative tumours than White women (n = 19/148, 13%) (p < 0.001). Moreover, Trivers et al. [16] and DeSantis et al. [4] found that Black women had a higher odds than White women of being diagnosed with hormone receptor negative (ER−/PR−) tumours (OR 1.90, 95% CI 1.05–3.46, and OR 2.11, 95% CI 2.04–2.18). Stark et al. [37] further observed differences in ER and PR expression. For ER+ tumours, the proportion diagnosed was 35.7% for Black women (n = 157/441) and 22.1% for White women (n = 182/822), for PR− tumours the proportions were 45.2% vs 30.1%, and for ER+/PR− tumours the proportions were 35.0% vs 21.3% (p < 0.001). A study reporting only ER− tumour status, found that a greater proportion of Black women were diagnosed with ER− tumours (n = 101/272, 37.1%) than White women (n = 63/321, 19.8%) (p < 0.0001) [82]. Similarly, Rizzo et al. [28] observed a significant
### Table 3  Summary of tumour grade and lymph node involvement at diagnosis for black and white women

| References       | Location                  | Sample size | Study design | Study population                                                                 | Results                                                                                       | Lymph nodes                            | How race data was obtained |
|------------------|---------------------------|-------------|--------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------|---------------------------|
| Ambrosone et al. [36] | United States             | Cases: 1119 Black: 559 White: 560 Control: 858 Black: 412 White: 446 | Multi-center case–control | Women diagnosed with invasive breast cancer or primary DCIS, aged 20 – 75 years | Poorly differentiated tumours: Black women – 51.6% White women – 32% (p < 0.05)                  | Poorly differentiated tumours: Black women – 51.6% White women – 32% (p < 0.05) | Self-report               |
| Barcenas et al. [5]    | United States             | n= 1,178 Black: 489 White: 670 Asian/Pacific Islander: 12 Other/Unknown: 7 | Retrospective | Women diagnosed with breast cancer                                                | Higher proportion of Black women diagnosed with high grade tumours (58.1% Black vs. 36.8% White) (p < 0.001) | Not reported                        | Not reported              |
| Bowen et al. [11]     | United Kingdom            | Black: 102 White: 191 | Retrospective | Women diagnosed with invasive breast cancer, age ≥ 16 years                        | Grade I: Black women – 6% vs. White women – 12% (p = 0.02)                                      | No significant difference in lymph node involvement at time of diagnosis | Self-report               |
| Chagpar et al. [74]   | United States, Kentucky   | n= 1,903 Black: 469 White: 1,145 | Retrospective | Women diagnosed with hormone receptor positive breast cancer                     | No significant difference in tumour grade at diagnosis                                        | No significant difference in lymph node involvement at time of diagnosis | From Kentucky Cancer Registry |
| Chlebowski et al. [58] | United States             | n= 156,570 Diagnosed with breast cancer: 3938 Black: 242 White: 3,455 Other: 202 Unknown: 39 | Prospective | Post-menopausal women aged 50 – 79 years                                         | Poorly differentiated: Black women – 43% vs. White women – 25%                                | –                         | Self-report               |
| Chu et al. [22]       | United States             | Black: 252 White: 123 | Prospective  | Low income Black and White women with Stage 0-III, ER- breast cancer, receiving standardized treatment | No significant difference in tumour grade at diagnosis between Black and White women (p=0.32) | No significant difference in nodal involvement at diagnosis between Black and White women (p=0.49) | From database             |
| Copson et al. [8]     | United Kingdom            | n=2915 Black: 118 White: 2690 Asian: 87 | Prospective | Women diagnosed and receiving treatment for breast cancer, aged ≤ 41 years        | Grade III: Black women – 68.1% vs. White women – 60.4% (NS)                                  | Positive node involvement: Black women – 56.1% vs. White women – 50.8% (NS) | Self-report               |
| References                  | Location                        | Sample size                      | Study design | Study population                                                                 | Results                                                                                     | Lymph nodes | How race data was obtained |
|-----------------------------|---------------------------------|----------------------------------|--------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------|---------------------------|
| Crowe et al. [57]           | United States                   | Black: 313 White: 2012           | Prospective  | Women diagnosed with invasive breast cancer with available 2000 census tract data |                                                                                              |             | Self-report               |
| Cunningham et al. [20]      | United State, South Carolina and Ohio | South Carolina Black: 5498 White: 18,420 Ohio Black: 6528 White: 64,713 | Retrospective | Women of European or African descent aged greater than 15 years diagnosed with invasive breast cancer | Black women diagnosed with Grade III tumours (52–58% vs 37–39% white women) and black women less likely to be diagnosed with grade I tumours (10–14% vs 21–22% p < 0.001) |             | From medical records     |
| DeSantis et al. [4]         | United States                   | n = 193,969 Black: 24,483 White: 169,486 | Retrospective | Black and White women (aged between 20 and 99 years)                                | Black women diagnosed with less differentiated tumours (OR 2.55, 95% CI 2.44–2.66)         |             | From medical records     |
| George et al. [67]          | United States                   | Black: 304 White: 330            | Retrospective | Black and White women ≤ 85 years                                                   | Poorly differentiated: Black women – 42.4% vs. White women – 28.2% (p = 0.0005)            |             | From medical records     |
| Iqbal et al. [66]           | United States                   | Black: 38,751 Non-Hispanic White: 268,675 Hispanic White: 34,928 Chinese: 4937 Japanese: 3751 South Asian: 2191 Other Asian: 14,332 Other: 5,998 | Retrospective | Women diagnosed with first invasive breast cancer                                  | Distant: Black women – 1.5% vs. White women – 1.0% (p < 0.001)                           |             | From SEER database        |
| References | Location | Sample size | Study design | Study population | Results | How race data was obtained |
|------------|----------|-------------|--------------|------------------|---------|--------------------------|
| **Jiagge et al. [82]** | United States, Ghana and Ethiopia | Black: 272, White: 321, Ghanaian: 234, Ethiopian: 94 | Retrospective | Women diagnosed with invasive breast cancer | Grade I: African American 12.3% vs. White women 24.9% Grade II: African American women 37.3% vs. White women 41.3% Grade III: African American women 50.4% vs. White women 33.7% (p < 0.0001) | From medical records |
| **Lund et al. [39]** | United States | Black: 176, Non-Black: 23 | Retrospective | Women diagnosed with invasive breast cancer | No significant difference in grade at diagnosis between Black and non-Black women (p = 0.099) | Self-report |
| **Lund et al. [80]** | United States | Black: 814, White: 967 | Retrospective | Women diagnosed with primary invasive breast cancer | Positive node involvement: Black women 39.7% vs. White women 31.1% (p < 0.001) | From Atlanta SEER registry and Georgia Comprehensive Cancer Registry |
| **Maloney et al. [50]** | United States | n=52, Black: 36, White: 16 | Retrospective | Women diagnosed with breast cancer, uninsured and below poverty line | No significant difference in lymph node involvement at diagnosis for Black women 19.4% vs. White women 43.8% (p = 0.068) | From database |
| **McBride et al. [7]** | United States | n=256,174, Black: 21,861, White: 234,313 | Retrospective | Women diagnosed with Stage I – IIa invasive breast cancer | Incidence of high grade tumours: Black women 45.7% vs. White women 31.9% (p < 0.0001) Greater node involvement for Black women 4.3 vs. White women 4.0 (p < 0.0001) | From SEER database |
| References         | Location          | Sample size          | Study design | Study population                                                                 | Results                                                                                           | How race data was obtained                      |
|--------------------|-------------------|----------------------|--------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------|
| Monzavi-Karbassi et al. [64] | United States, Arkansas | Black: 208 White: 869 | Retrospective | Black and White women receiving breast cancer treatment                             | Grade III: Black women 41.8% vs. White women 4.8%                                                      | From Arkansas tumor registry files               |
| Moran et al. [9]   | United States     | Black: 207 White: 2,164 | Retrospective | Women diagnosed with early stage breast cancer                                      | – Node 2: Black women 4% vs. White women 1% (p = 0.0001)                                           | Self-report                                     |
| Nassar et al. [30] | United States     | Black: 217 White: 141 | Retrospective | Women diagnosed with primary ductal carcinoma in situ with focal invasion > 1 mm | No significant difference in tumour grade at diagnosis                                              | From SEER database and hospital records          |
| Rizzo et al. [28]  | United States     | Black: 93 Non-Black: 14 | Retrospective | Women diagnosed with stage III breast cancer                                       | High grade: Black – 44.3% vs. Non-Black 14.2% (p = 0.04)                                         | From SEER database and patient chart            |
| Roberts et al. [63] | United States, North Carolina | Black: 609 White: 859 | Retrospective | Women diagnosed with ER*, stage I or II and HER2- breast cancer                   | Grade III: Black women – 24.9% vs. non-Black women – 15.6% (p < 0.001)                             | Self-report                                     |
| Roseland et al. [10] | United States     | Black: 818 White: 1569 | Retrospective | Women diagnosed with Stage I, II or III breast cancer                              | Poorly differentiated: Black women – 45% vs. White women – 32% (p < 0.0001)                         | Not reported                                    |
| Sachdev et al. [78] | United States, Tennessee | Black: 88 White: 36 | Retrospective | Women diagnosed and receiving treatment for triple negative invasive breast cancer | Poorly differentiated: Black women – 45% vs. White women – 32% (p < 0.0001)                         | Medical records                                 |
| Schootman et al. [27] | United States     | Black: 2101 White: 32,387 Other: 1,320 | Retrospective | Women > 66 years diagnosed with distant metastases from primary breast cancer     | –                                                                                                  | From SEER database                              |
| References       | Location                        | Sample size | Study design | Study population                                                                 | Results                                                                                                                                                                                                 | How race data was obtained |
|------------------|---------------------------------|-------------|--------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Stark et al. [37] | United States                   | n=1263      | Retrospective| Women diagnosed with primary invasive breast cancer                                | Grade I: Black women – 19.6% White women – 30.3% Grade III: Black women – 45.2% White women – 29.3% (p < 0.001)                                                                                             | Self-report               |
|                  |                                 | Black: 441  |              |                                                                                  | No significant difference in lymph node involvement between Black and White women (p = 0.08)                                                                                                             |                           |
|                  |                                 | White: 822  |              |                                                                                  |                                                                                                                                                                                                         |                           |
| Stark et al. [76] | United States, Ghana            | Black: 581  | Retrospective| Women diagnosed with breast cancer                                                 | Grade III: African American women – 44.9% vs. White women – 29.3% (p = 0.007)                                                                                                                          | Self-report               |
|                  |                                 | White: 1008 |              |                                                                                  | No significant difference in lymph node involvement at diagnosis (p = 0.856)                                                                                                                           |                           |
|                  |                                 | Ghanaian women: 75 |          |                                                                                  |                                                                                                                                                                                                         |                           |
| Sturtz et al. [70]| United States                   | n=160       | Retrospective| Black and White women diagnosed with triple negative breast cancer                | –                                                                                                                                                                                                        | Self-report               |
|                  |                                 | Black: 62   |              |                                                                                  | No significant difference in lymph node involvement at diagnosis (p = 0.007)                                                                                                                           |                           |
|                  |                                 | White: 98   |              |                                                                                  |                                                                                                                                                                                                         |                           |
| Swede et al. [62]| United States, Connecticut      | n=416       | Retrospective| Women diagnosed and receiving treatment for breast cancer                         | Grade III/IV: Black women – 50.3% vs. White women – 42.7% (p = 0.04)                                                                                                                               | From patient chart        |
|                  |                                 | Black: 202  |              |                                                                                  | No significant difference in the mean number of positive axillary nodes observed for black women and white women (6.67 vs. 3.35) (p= 0.11)                                                             |                           |
|                  |                                 | White: 214  |              |                                                                                  |                                                                                                                                                                                                         |                           |
| Thomas et al. [60]| United States                   | Non-hispanic black: 33,301 | Retrospective| Women diagnosed with invasive breast cancer                                       | Poorly differentiated: Black women – 47.9% vs. White women – 29.8% (p < 0.001)                                                                                                                         | From National Cancer      |
|                  |                                 | Non-hispanic white: 241,236 |              |                                                                                  |                                                                                                                                                                                                         | database                  |
|                  |                                 | Non-hispanic Asian/Pacific Islander: 9508 |          |                                                                                  |                                                                                                                                                                                                         |                           |
|                  |                                 | Hispanic: 15,782 |            |                                                                                  |                                                                                                                                                                                                         |                           |
| Trivers et al. [16]| United States                   | n=476       | Retrospective| Women diagnosed with unilateral incident invasive breast cancer, aged 20–54 years | –                                                                                                                                                                                                        | Self-report               |
|                  |                                 | Black: 116  |              |                                                                                  | No significant difference in lymph node involvement was observed between Black women and White women (p = 0.50)                                                                                         |                           |
|                  |                                 | White: 360  |              |                                                                                  |                                                                                                                                                                                                         |                           |
stage specific difference in the frequency of Black women (n = 47/93, 50.5%) with PR− tumours as compared to White women (n = 3/14, 21.5%) (p = 0.04). Finally, Anderson et al. [43] estimated the incident rate of ER− tumours using SEER databases and found a significantly higher incidence rate among Black women compared to White women (IRR = 1.4, 95% CI 1.4–1.4).

Triple Negative

Twenty of the articles included in this review explored the incidence of triple negative breast tumours, or tumours that are negative for estrogen, progesterone, or amplified HER2 receptors, by race. Seventeen of these articles found a significant difference in the incidence of triple negative tumours amongst women with breast cancer by race, with a significantly higher likelihood of triple negative tumours amongst Black women with breast cancer. For example, in one study conducted by Trivers et al. [16], Black women were significantly more likely to be diagnosed with triple negative tumours than White women (OR 2.41, 95% CI 1.81–3.21).

In the UK, Copson et al. [8] similarly found a significantly higher incidence of triple negative breast cancer amongst Black women relative to White women (n = 30/118, 26.1% vs n = 478/2690, 18.6%, p < 0.05).

Interestingly, only three studies found no significant difference in triple negative tumours by race. For example, Bowen et al. [11] found no significant difference in the likelihood of triple negative tumours by race (p = 0.2) amongst women diagnosed with breast cancer in the UK. In a retrospective study by Lund et al. [39] using data obtained from the SEER Atlanta database, a greater proportion of Black women were diagnosed with triple negative tumours in comparison to non-Black women (n = 49/167, 29.3% vs n = 3/23, 13%), though this difference was not statistically significant (p = 0.05). This study was small, including only 23 non-Black women in a sample size of 190 patients. In contrast, a larger retrospective study by Lund et al. [31] using data from the SEER Atlanta database found that Black women in the US were significantly more likely to be diagnosed with triple negative tumours than White women (OR 1.9, 95% CI 1.2–2.9), even after adjusting for the patient’s age and income, as well as the stage and grade of the breast tumour.

HER2 Expression

As described above, only ten of the studies included in this narrative review analyzed HER2 expression by race. Overall, no significant difference in HER2 expression was found by race in any of the included studies. The POSH Study, a multi-centre prospective study examining the outcomes of breast cancer in younger women in the UK, found no significant difference in HER2 status by race or ethnicity.
| References          | Location       | Sample size                     | Study design                      | Study population                                                                 | Results                                                                                       | How race data was obtained |
|---------------------|----------------|---------------------------------|-----------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------|
| Ambrosone et al.    | United States | Cases: 1119 Black: 559 White: 560 | Multi-center case–control         | Women diagnosed with invasive breast cancer or primary DCIS, aged 20–75 years      | ER−: Black – 34.4% White – 22.2% (p < 0.05)                                      | Self-report                |
|                     |                | Control: 858 Black: 412 White: 446 |                                   |                                                                                  | PR−: Black – 48.3% White – 33.6% (p < 0.05)                                      |                             |
| Anderson et al.     | United States | n = 440,653 Black: 34,478 White: 381,122 | Retrospective                    | Women diagnosed with invasive breast cancer                                       | ER−: significantly higher incidence for Black women, IRR = 1.4, 95% CI 1.4–1.4 | From SEER database        |
| Baquet et al.       | United States | n = 171,372 Black: 15,877 White: 155,495 | Retrospective                    | Women diagnosed with breast cancer                                                | Black women significantly more likely to be diagnosed with ER−/PR−/HER2− (p < 0.0001) | From SEER database        |
| Bauer et al.        | United States | n = 51,074 Black: 2587 White: 36,671 Other: 11,816 | Retrospective                    | Women diagnosed with primary invasive breast cancer                               |                                                                                      |                             |
| Bowen et al.        | United Kingdom| n = 293 Black: 102 White: 191 | Retrospective                    | Women diagnosed with invasive breast cancer, age ≥ 16 years                         | ER−: Black – 39% White – 21% OR 2.36 (95% CI 1.06–5.00) (p = 0.03)                | Self-report                |
|                     |                |                                 |                                   |                                                                                  |                                                                                      |                             |
| References          | Location         | Sample size | Study design | Study population                                                                 | Results                                                                 | How race data was obtained               |
|---------------------|------------------|-------------|--------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------|
| Brown et al. [41]   | United States    | n = 61,309  | Retrospective| Women diagnosed with primary invasive breast cancer                               | –                                                                        | Compared to other breast cancers, Black women were diagnosed with a greater proportion of triple negative tumours (10.7%) (p < 0.001) and double negative tumours (7.2%) (p < 0.05) | Medical record                          |
|                     |                  | black: 3272 |              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | white: 43,398 |              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | Other: 14,639 |              |                                                                  |                                                                          |                                          |                                          |
| Chen and Li [68]    | United States    | n = 102,064 | Retrospective| Women aged ≥ 20 years                                                           | –                                                                        | Black – 22.6% White – 10.7%             | From SEER database                      |
|                     |                  | Black: 10,874 |              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | White: 72,623 |              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | Other: 18,567 |              |                                                                  |                                                                          |                                          |                                          |
| Copson et al. [8]   | United Kingdom   | n = 2956    | Prospective  | Women diagnosed and receiving treatment for breast cancer, aged ≤ 41 years     | –                                                                        | Black – 26.1% White – 18.6% (p = 0.043) | Self-report                             |
|                     |                  | Black: 106   |              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | White: 2690  |              |                                                                  |                                                                          |                                          |                                          |
| Crowe et al. [57]   | United States    | n = 2325    | Prospective  | Women diagnosed with invasive breast cancer with available 2000 census tract data | ER+/PR+: Black—n = 67 White—n = 82 (p < 0.001)                           | –                                        | Self-report                             |
|                     |                  | Black: 313   |              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | White: 201   |              |                                                                  |                                                                          |                                          |                                          |
| Cunningham et al.   | United States    | n = 95,159  | Retrospective| Women of European or African descent aged greater than 15 years diagnosed with invasive breast cancer | ER−: Black – 37–40% White – 22–23% PR−: Black – 47–50% White – 33–35% (p < 0.001) | –                                        | From medical records                    |
| [20]                |                  | Black: 12,026|              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | White: 83,133|              |                                                                  |                                                                          |                                          |                                          |
| DeSantis et al. [4] | United States    | n = 193,969 | Retrospective| Black and White women (aged between 20 and 99 years)                       | Black women more likely to be diagnosed with ER/PR negative tumours (OR 2.29, 95% CI 2.22–2.37) | Black women more likely to be diagnosed (OR 2.29, 95% CI 2.04–2.18) | From hospital records                   |
|                     |                  | black: 24,483|              |                                                                  |                                                                          |                                          |                                          |
|                     |                  | White: 169,486|             |                                                                  |                                                                          |                                          |                                          |
Table 4 (continued)

| References     | Location        | Sample size     | Study design | Study population                                      | Results | HER2 | Triple negative | How race data was obtained |
|----------------|-----------------|-----------------|--------------|------------------------------------------------------|---------|------|-----------------|---------------------------|
|                |                 |                 |              |                                                      |         |      |                 |                           |
| George et al.  | United States   | n = 634         | Retrospective| Black and White women ≤ 85 years                     | –       | –    | Black – 20.1%   | From patient chart        |
| [67]           |                 | Black: 304      |              |                                                      |         |      | White – 9.1%    |                           |
|                |                 | White: 334      |              |                                                      |         |      | (p < 0.0001)    |                           |
| Hahn et al.    | United States   | n = 829         | Retrospective| Women diagnosed with unilateral invasive breast cancer| Black    | –    | –               | Self-report                |
| [47]           |                 | Black: 250      |              |                                                      | women   |      | –               |                           |
|                |                 | White: 579      |              |                                                      |         |      | (data not provided) |                           |
| Hance et al.   | United States   | n = 180,224     | Retrospective| Women diagnosed with breast cancer                    | For lower grade tumours (non-T4), a greater age-specific incidence rate of ER- tumours was not noted amongst black women compared to white women at all ages | –    | –               | From SEER database        |
| [56]           |                 | Black: 14,196   |              |                                                      |         |      | Black – 17.2%   |                           |
|                |                 | White: 155,820  |              |                                                      |         |      | White – 8%      |                           |
| Iqbal et al.   | United States   | n = 373,563     | Retrospective| Women diagnosed with first invasive breast cancer     | –       | –    | ≤ 2.0 cm tumours, triple negative: Black – 17.2% | From SEER database        |
| [66]           |                 | Black: 38,751   |              |                                                      |         |      | White – 8%      |                           |
|                |                 | White: 268,675  |              |                                                      |         |      | (p = 0.5088)    |                           |
| Jiagge et al.  | United States   | Black: 272      | Retrospective| Women diagnosed with invasive breast cancer           | ER−:    | –    | Black – 37.1%   | From medical records      |
| [82]           |                 | White: 321      |              |                                                      | Black   |      | White – 19.8%   |                           |
|                |                 | Ghanaian patients: 234 |          |                                                      | (p < 0.0001) |      | (p < 0.0001)    |                           |
|                |                 | Ethiopian patients: 94 |          |                                                      |         |      |                  |                           |
| Kenney et al.  | United States   | n = 184         | Retrospective| Women with invasive breast cancer                     | ER+ :   | –    | Black – 70.8%   | Self-report                |
| [40]           |                 | Black: 70       |              |                                                      | Black   |      | White – 73.2%   |                           |
|                |                 | White: 98 Other: 16 |          |                                                      | (p > 0.05) |      | (p > 0.05)      |                           |
|                |                 |                 |              |                                                      | PR+ :   | –    | Black – 70.8%   |                           |
|                |                 |                 |              |                                                      | Black   |      | White – 73.2%   |                           |
|                |                 |                 |              |                                                      | (p > 0.05) |      | (p > 0.05)      |                           |
|                |                 |                 |              |                                                      | HER2+ : | –    | Black – 20.8%   |                           |
|                |                 |                 |              |                                                      | Black   |      | White – 34.8%   |                           |
|                |                 |                 |              |                                                      | (p > 0.05) |      | (p > 0.05)      |                           |
| References         | Location       | Sample size | Study design    | Study population                                                                 | Results                                           | How race data was obtained                           |
|--------------------|----------------|-------------|----------------|----------------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------------|
| Kwan et al. [13]   | United States  | n = 2544    | Prospective    | Women diagnosed with early stage invasive breast cancer, aged 18 – 70 years       | ER/PR: Black 28.4% White 10.5% (p < 0.0001)      | Self-report                                             |
| Lund et al. [39]   | United States  | n = 190     | Retrospective  | Women diagnosed with invasive breast cancer                                      | No significant difference by race. ER: p = 0.109  | No sig diff in likelihood of having triple negative tumour by race (OR 3.1, 0.8–11.6) | Self-report                                             |
| Lund et al. [80]   | United States  | n = 1,842   | Retrospective  | Women diagnosed with primary invasive breast cancer                              | ER−: Black 32.8% White 17.7% (p < 0.001)         | Black – 22.6% White – 10.4% (p < 0.001) From Atlanta SEER registry and Georgia Comprehensive Cancer Registry |
| Lund et al. [31]   | United States  | n = 476     | Retrospective  | Women diagnosed with unilateral incident invasive breast cancer, aged 20 – 54 years | No significant difference in likelihood of ER−/ PR− tumours by race (OR: 1.3, 0.6–2.6) | Black – 46.6% White – 21.8% p < 0.001 Self-report                                             |
| Maloney et al. [50]| United States  | n = 52      | Retrospective  | Women diagnosed with breast cancer, uninsured and below poverty line              | No significant difference by race. ER: p = 0.59  | No significant difference by race HER2: p = 0.85 From database |
| Marti et al. [38]  | United States  | n = 215     | Prospective    | Women diagnosed with invasive breast cancer or DCIS, of low socioeconomic status | No significant difference in ER/ PR expression by race (p > 0.05) | No significant difference in HER2 expression by race (p = 0.56) From medical records |
| McBride et al. [7] | United States  | n = 256,174 | Retrospective  | Women diagnosed with Stage I–IIa invasive breast cancer                          | ER−/PR−: Black 27.2% White 14.6% – – – From SEER Database |                                                                                           |
| References       | Location  | Sample size | Study design | Study population                                                                 | Results                                                                 | How race data was obtained               |
|------------------|-----------|-------------|--------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------|
| Moran et al. [9] | United States | n = 2371 Black: 207 White: 2164 | Retrospective | Women diagnosed with early stage breast cancer                                  | ER<sup>+</sup>: Black – 54% White – 36% (p = 0.0001) PR<sup>+</sup>: Black – 58% White – 47% (p = 0.0097) | Black women – 21% White women – 8% (p < 0.0001) | Self-report                           |
| Morris et al. [44] | United States | n = 199,504 Black: 16,853 White: 162,768 | Retrospective | Women diagnosed with breast cancer                                              | ER<sup>+</sup>: Black – 51.9% White – 63.1% (p = 0.0003) | Black – 20.8% White – 10.4% (p < 0.0001) | From SEER database and hospital records |
| O’Brien et al. [79] | United States | n = 1149 Black: 518 White: 631 | Retrospective | Women diagnosed with invasive breast cancer                                     | ER<sup>-</sup>: Black – 51% White – 32% PR<sup>-</sup>: Black – 55% White – 36% | –                                      | Self-report                           |
| Parise et al. [29] | United States | n = 54,523 | Retrospective | Women diagnosed with primary invasive breast cancer                              | Black women—less likely to be diagnosed with ER+/PR+ tumours OR: 0.80 (95% CI 0.70–0.91) | Black women significantly more likely to be diagnosed OR 1.88 (95% CI 1.69–2.09) | From medical record                   |
| Rizzo et al. [28] | United States | n = 107 Black: 93 Non-black: 14 | Retrospective | Women diagnosed with stage III breast cancer                                    | No significant difference in ER status (p = 0.25)                                      | –                                      | From SEER database and patient chart   |
| Roseland et al. [10] | United States | n = 2387 Black: 818 White: 1569 | Retrospective | Women diagnosed with Stage I, II or III breast cancer                            | ER<sup>+</sup>/PR<sup>-</sup>: Black – 30% White – 19% (p < 0.0001)                  | –                                      | From several databases               |
| Short et al. [77] | United States | n = 575 Black: 99 White: 476 | Retrospective | Women newly diagnosed with breast cancer                                         | ER<sup>+</sup>/PR<sup>-</sup>: Black – 56% White – 75% (p = 0.001)                      | –                                      | From patient chart                    |
### Table 4 (continued)

| References     | Location     | Sample size | Study design | Study population                                                                 | Results                                   | How race data was obtained |
|----------------|--------------|-------------|--------------|-----------------------------------------------------------------------------------|-------------------------------------------|---------------------------|
| Schootman et al. [27] | United States | n = 3757 Black: 347 White: 3295 Other: 115 | Retrospective | Women > 66 years diagnosed with distant metastases from primary breast cancer       | ER#: Black: 18.5% White: 12.6% PR#: Black: 26.3% White: 22.5% (no significance data) | From SEER database |
| Stark et al. [37]   | United States | n = 1263 Black: 441 White: 822 | Retrospective | Women diagnosed with primary invasive breast cancer | ER#: Black – 35.7% White – 22.1% PR#: Black – 45.2% White – 30.1% ER-/PR#: Black – 35.0% White – 21.3% (p < 0.001) | Black women more likely to be diagnosed with triple negative tumours (OR 1.72, 1.17-2.54) (p = 0.006) |
| Stead et al. [25]  | United States | n = 415 White: 148 Black: 177 Hispanic: 43 Other: 47 | Retrospective | Women diagnosed with invasive breast cancer | ER-/PR#: Black – 30.9% White – 17.6% (p < 0.0001) | Black – 30% White – 13% (p = 0.0002) |
| Sturtz et al. [70] | United States | n = 160 Black: 62 White: 98 | Retrospective | Black and White women diagnosed with triple negative breast cancer | – | Black – 28% White – 12% (p < 0.001) |
| Swede et al. [62]  | United States | n = 416 Black: 202 White: 214 | Retrospective | Women diagnosed and receiving treatment for breast cancer | – | Black – 25.7% White – 16.4% (p < 0.01) |
| Tao et al. [61]    | United States | n = 103,498 Black: 9738 White: 93,760 | Retrospective | Women diagnosed with invasive breast cancer | – | Black – 20% White – 10% (HR 1.21, 95% CI 1.06 – 1.37) |
| Thomas et al. [60] | United States | n = 299,827 Black: 33,301 White: 241,236 Other: 25,290 | Retrospective | Women diagnosed with invasive breast cancer | – | Black – 24.2% White – 11.4% (p < 0.001) |

ER/PR HER2 Triple negative
| References          | Location | Sample size | Study design | Study population                                                                 | Results                                                                 | How race data was obtained                  |
|---------------------|----------|-------------|--------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------|
| Trivers et al. [16] | United States | n = 476 Black: 116 White: 360 | Retrospective | Women diagnosed with unilateral incident invasive breast cancer, aged 20–54 years | Black women more likely to be diagnosed with ER-/PR- tumours (OR: 1.90, 1.05–3.46, 95% CI) | Self-report                                 |
| Vicini et al. [75]  | United States | n = 699 Black: 39 White: 660 | Retrospective | Women diagnosed with invasive breast cancer                                         | ER*: Black – 44% White – 82% (p < 0.001) PR*: Black – 42% White – 65% (p = 0.004) | Self-report                                 |
| Woods et al. [2]    | United States | n = 5751 Black: 632 White: 5119 | Retrospective | Women diagnosed with breast cancer                                                  | ER*: Black – 64.3% White – 78.5% (p < 0.01) PR*: Black – 52.3% White – 65.5% (p < 0.01) | From patient, patient chart or treating physician |
| Yankaskas et al. [54]| United States | n = 1691 Black: 380 White: 1311 | Retrospective | Women diagnosed with breast cancer, aged ≥ 25 years                                | ER*: Black – 57.8% White – 74.0% (p < 0.001) PR*: Black – 50.8% White – 66.3% (p < 0.001) | Self-report                                 |
Diagnosed with breast cancer at a later stage of disease and studies that found that Black women were more likely to be screened for mammography. This is consistent, therefore, with other cancer and typically found during breast cancer screening.

DCIS, or ductal carcinoma in situ, is an early stage of breast cancer and typically found during breast cancer screening.

Younger age at diagnosis has been consistently linked with higher risk of high-risk cancer features.

Age at diagnosis differed significantly by race, and Black women were overrepresented in younger age groups. Younger age at diagnosis has been consistently linked with more aggressive breast cancers, especially when diagnosis is before 40 years of age. As described above, the method of describing age at diagnosis varied between studies. Most studies looked at the median or mean age at diagnosis for comparison. While statistically significant differences were found, many of these studies reported an average age at diagnosis that was above the age of 50 years. There may be limited clinical application of those findings, given that most breast screening programs begin at the age of 50. In comparison, studies comparing incidence of breast cancer in younger age brackets found that Black women were overrepresented in breast cancer diagnoses before the age of 50.

Interestingly, two of the included studies found that Black women were more likely to be older at age of diagnosis. Nassar et al. [30, 43] and Chagpar et al. [74] found that Black women were more likely to be diagnosed with DCIS at a significantly older age (60 years) compared to White women (56 years, p < 0.001). DCIS, or ductal carcinoma in situ, is an early stage of breast cancer and typically found during breast cancer screening with mammography. This is consistent, therefore, with other studies that found that Black women were more likely to be diagnosed with breast cancer at a later stage of disease and less likely to be diagnosed at an earlier stage, as described above. Chagpar et al. [74] also found that Black women were more likely to be diagnosed at a later age (57 years) compared to White women (55 years, p < 0.05), but they also found that Black women were diagnosed with larger tumours (19 mm vs 17 mm, p < 0.009) at the time of diagnosis. In this single centre study, it can be speculated that Black women in this population were diagnosed with later stage disease at an older age and does not necessarily point to earlier disease in White women.

Fewer studies included stage at diagnosis in their analysis. Nonetheless, in sixteen of those studies which included tumour stage at diagnosis, differences were noted by race. Black women were significantly more likely to be diagnosed at earlier stages of cancer (Stage I–II) and were significantly more likely to be diagnosed at a later stage (Stage III–IV). Similarly, Black women were also significantly more likely to have larger, poorly differentiated tumours at the time of diagnosis. Several explanations have been proposed in the literature for these differences. Newman [84] highlighted in the review the role of socioeconomic status in diagnosis of later stage breast cancer in Black women in the United States, despite similar uptake of screening mammography. Barriers to accessing healthcare may result in a delay of tissue diagnosis from the time of an abnormal screening test, for example, resulting in a later stage of disease at the time of diagnosis. However, Newman also argues that race cannot be seen as a substitute for socioeconomic status, pointing to differences in prevalence of more aggressive breast cancer subtypes (e.g. triple negative) by race. Continued research is needed to further elucidate the interaction between race, biology and socioeconomic factors to better interpret the differences in stage at diagnosis by race.

In terms of hormone receptor status, Black women were significantly more likely to be diagnosed with triple negative breast cancer relative to White women. They were also found to be more likely to have estrogen and progesterone receptor negative tumours, but no significant differences in HER2 receptor expression was found by race in any of the included studies. Triple negative breast tumours are not responsive to conventional and currently available targeted therapies and are associated with an overall poorer prognosis.

There are some who speculate that this may contribute to the differences in disease prognosis and recurrence by race, along with other tumour characteristics, treatment modalities and certain social factors. Given the importance of targeted therapies in breast cancer management, further research into this area is warranted.

Several limitations of the studies included in this review are noted. The etiology of differences in tumour characteristics for Black and White women appears to be multifactorial, and not fully understood at this time. However, several factors are known to be associated with breast cancer.
prognosis. These include the tumour traits included in this study, cancer screening uptake and availability [15], socioeconomic status [4, 12], and geography [14]. While many of the included studies included these factors in their analysis, there was significant variation between studies regarding which factors were included and how factors were controlled for.

Interestingly, a number of studies that included certain social and demographic factors found that the impact of race on the prevalence of high-risk cancer features persisted. In a large scale retrospective study using data collected from the National Cancer Database, DeSantis et al. [4] found that Black women were significantly more likely to be diagnosed with metastatic breast cancer relative to White women even after controlling for the independent effects of health insurance status and educational attainment (OR 1.54, 95% CI 1.45–1.63). Similarly, Woods et al. [2] found that Black participants were significantly less likely to have stage I cancer (OR 0.80, 95% CI 0.67–0.96, p = 0.02) at the time of diagnosis, and were significantly more likely to have stage III cancer (OR 1.50, 95% CI 1.11–2.01, p = 0.01) compared to White women, even after controlling for family history, health insurance, smoking, marital status, and whether the participant had reached menopause. Whilst no publications specific to differences in breast cancer prognosis for Black and White women in Canada were identified in this review, a recent Canadian study by Lofers et al. [85] found that immigrant women from Latin America and the Caribbean had a later stage of breast cancer at the time of diagnosis compared to non-immigrants, despite similar access to primary care in two Canadian provinces. It was speculated that there may be a component of genetic susceptibility to aggressive breast cancers amongst women of West African ancestry, given similar findings in studies of African American women in the US [85]. It is, however, challenging to tease these features apart, especially given the lack of race-based data collected in Canada or provided in this study.

In other studies included in this review, the effect of race diminished or was eliminated once social and demographic factors were accounted for. In a retrospective study using data from the SEER Detroit and Los Angeles databases by Lantz et al. [52], Black women were initially found to be significantly less likely to be diagnosed at an earlier stage of breast cancer (Stage I) relative to White women. However, after controlling for age, study site, education, income, and method of detection, no significant difference was found by race (OR 0.79, 95% CI 0.57–1.10). In another smaller single centre retrospective study, no significant difference in age of diagnosis, tumour size, lymph node involvement, or hormone receptor status was found once SES was controlled for [50]. While the current narrative review focused on the incidence of high-risk tumour features by race, it has also highlighted the importance of accounting for social and demographic factors when assessing the impact of these high-risk tumour features on the disparities observed in breast cancer prognosis by race.

Finally, the majority of the studies included in this review did not describe how race information was obtained from participants. Amongst those studies that did describe how this information was obtained, there was significant variability. Methods included self-report [53, 54] and inference based on the race/ethnicity of the participant’s parents, birthplace, surname, or maiden name [41]. The importance of method of reporting race was highlighted in a retrospective study by Boehmer et al. [86], where they compared self-reported race to administrative race data in the context of a dental procedure. They found that administrative data was more likely to be incorrect for individuals who belong to a racial or ethnic group other than White. Future studies investigating breast cancer outcomes by race should make note of the method of reporting of race, as well as the number of individuals for whom race/ethnicity data is missing.

Overall, the literature currently demonstrates significant differences in the prevalence of high-risk breast cancer features by race in the US, and in a few more recent studies conducted in the UK. Given the unique social and political histories of each of these countries, generalizability of these findings to the Canadian context is somewhat limited. Furthermore, as Black is an umbrella term that includes a great deal of diversity, the composition of Black communities differs in each of these countries. Likewise, the impact of health insurance and differing modalities of healthcare delivery on breast cancer outcomes cannot be underestimated. Nonetheless, the findings of this review reinforce the importance of collecting race data in order to identify the impact of structural racism on health outcomes and better inform health screening practices, management guidelines, and to detect and reduce inequity in healthcare outcomes within the Canadian healthcare system.

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Compliance with Ethical Standards

Conflict of interest There is no conflict of interest to report for any of the authors.

Ethical Approval All authors have reviewed the submitted manuscript and approve the manuscript for submission.

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