Cancer Epidemiology 38 (2014) 118–123

Contents lists available at ScienceDirect

Cancer Epidemiology

The International Journal of Cancer Epidemiology, Detection, and Prevention

journal homepage: www.cancerepidemiology.net

Increasing Black:White disparities in breast cancer mortality in the 50 largest cities in the United States

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ARTICLE INFO

Article history:
Received 29 July 2013
Received in revised form 5 September 2013
Accepted 12 September 2013
Available online 4 March 2014

Keywords:
Breast cancer
Racial disparities
Big cities

ABSTRACT

Introduction: This paper presents race-specific breast cancer mortality rates and the corresponding rate ratios for the 50 largest U.S. cities for each of the 5-year intervals between 1990 and 2009. *Methods*: The 50 largest cities in the U.S. were the units of analysis. Numerator data were abstracted from national death files where the cause was malignant neoplasm of the breast (ICD-9 = 174 and ICD-10 = C50) for women. Population-based denominators were obtained from the U.S. Census Bureau for 1990, 2000, and 2010. To measure the racial disparity, we calculated non-Hispanic Black:non-Hispanic White rate ratios (RRs) and confidence intervals for each 5-year period. *Results*: At the final time point (2005–2009), two RRs were less than 1, but neither significantly so, while 39 RRs were >1, 23 of them significantly so. Of the 41 cities included in the analysis, 35 saw an increase in the Black:White RR between 1990–1994 and 2005–2009. In many of the cities, the increase in the disparity occurred because White rates improved substantially over the 20-year study period, while Black rates did not. There were 1710 excess Black deaths annually due to this disparity in breast cancer mortality, for an average of about 5 each day. *Conclusion*: This analysis revealed large and growing disparities in Black:White breast cancer mortality in the U.S. and many of its largest cities during the period 1990–2009. Much work remains to achieve equality in breast cancer mortality outcomes.

1. Introduction

It is estimated that 232,340 women will be diagnosed with breast cancer this year and 39,620 will die from it [1]. Racial disparities are prominent. For example, the 2006–2010 age-adjusted breast cancer incidence rate for non-Hispanic White (White) women in the United States was 127.4 (per 100,000 women per year) compared to 121.4 for non-Hispanic Black (Black) women [1]. This yields a Black:White rate ratio (RR) of 0.95. For the same period, the mortality rates were 22.1 (age-adjusted, per 100,000 women per year) for White women and 30.8 for Black women (RR = 1.39) [1]. Thus, while White women are more likely to be diagnosed with breast cancer, Black women are more likely to die from it.

A recent analysis by Whitman et al. [2] showed that the Black:White mortality disparity observed at the national level is seen in many of the nation's largest cities as well. The authors reported significant RRs in 13 of the 25 biggest U.S. cities in 2005–2007. Another analysis by Whitman et al. [3] examined the mortality rates for Black and White women during the period 1980–2005 for Chicago, New York City, and the U.S. The authors found that the disparity in breast cancer mortality emerged in the 1990s. The findings from each of these analyses sparked interest in an expanded analysis that would include more cities and points in time. To that end, this paper presents race-specific breast cancer mortality rates and the corresponding rate ratios for the 50 largest U.S. cities for each of the 5-year intervals between 1990 and 2009. Our previous analysis is thus expanded from 25 to 50 cites and from a single time period to 20 years. Special attention is paid to how these disparities changed over this time interval as this has practical implications for interventions related to screening, diagnosis, and treatment.

2. Methods

The 50 most populous cities were determined using 2005 U.S. Census data [4]. Deaths where the cause was malignant neoplasm of the breast (ICD-9 = 174 and ICD-10 = C50) for women were included in this analysis. Numerator data for 1990–2009 were abstracted from death files obtained from the National Center for

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http://dx.doi.org/10.1016/j.canep.2013.09.009

Health Statistics [5]. Five-year average annual rates were calculated for 1990–1994 (T1), 1995–1999 (T2), 2000–2004 (T3), and 2005–2009 (T4).

Population-based denominators for the non-Hispanic White (White) and non-Hispanic Black (Black) populations were obtained from the U.S. Census Bureau for 1990, 2000, and 2010. Population-based denominators for years other than 1990, 2000, and 2010 were estimated using linear interpolation. For each of the two data sources – the census and the death files – Black and White classifications were obtained by cross-tabulating two self-report variables: Hispanic ethnicity and racial identity. Age-adjusted rates per 100,000 population were calculated employing the year 2000 standard U.S. population.

Nine cities were excluded from this analysis. Population data were not available at the city-level for two cities (Louisville/Jefferson County, KY and Nashville/Davidson, TN). An additional seven cities (Albuquerque, NM; Arlington, TX; Colorado Springs, CO; El Paso, TX; Mesa and Tucson, AZ; San Jose, CA) were excluded because either all four time points or time points 1 and 4 (1990–1994 and 2005–2009, respectively) had fewer than 20 Black deaths due to small Black population size. This left 41 cities for analysis. These deletions are in accordance with research showing that mortality rates based on less than 20 deaths can be unreliable [6,7]. There were no cities for which there were fewer than 20 White deaths.

2.1. Statistical analysis

The disparity in breast cancer mortality was measured by calculating the Black:White rate ratio (RR) for each city at each time period. An RR of 1.00 indicates no disparity between the Black and White mortality rates. An RR less than 1.00 indicates that the White rate is higher than the Black rate, while an RR greater than 1.00 indicates that the Black rate is higher than the White rate. An RR was considered statistically significant if the 95% confidence interval did not contain 1.00. Confidence intervals for the RRs were calculated using a Taylor series expansion technique [8]. Chi-square tests were employed to examine the differences in the distributions of the disparities over time. All data were analyzed using SAS v 9.2 [9].

Excess deaths due to the racial disparity in breast cancer mortality are calculated by multiplying the age-specific White mortality rates by the corresponding Black populations in each age category. The sum of these products is the number of Black deaths that would be expected if White death rates were applied to this population. We then subtracted the number of expected deaths from the number of observed deaths to obtain the excess number of deaths for each city.

3. Results

Table 1 presents the age-adjusted breast cancer mortality rates for Black and White women in 1990–1994 (T1), 1995–1999 (T2), 2000–2004 (T3), and 2005–2009 (T4), and the corresponding racial rate ratios and confidence intervals. The cities are arranged in descending order by largest to smallest 2005–2009 rate ratio. The RR in the U.S. was 1.17 at T1 and it grew steadily to 1.40 by T4. The smallest city, Raleigh, had an initial RR of 0.82 (not significant) which grew to 1.46 by T4. The largest city, New York City, had a T1 RR of 1.18, which remained virtually the same at T4 (1.19). Memphis had the largest RR (2.11) at T4, up from 1.27 at T1, and New York City had the smallest (while remaining significant) RR at T4 (1.19).

Bold-faced rate ratios indicate statistical significance. At T4, no rate ratios are significantly less than 1 but 23 are significantly greater than 1. Note that 35 of the 41 cities saw an increase in the Black:White RR between T1 and T4. Furthermore, 24 of the cities (59%), as well as the U.S., saw an increase in the Black:White RR of 0.2 or more, an empirically derived cut point indicative of notable change in this analysis. These observations demonstrate that the Black:White breast cancer mortality disparity worsened in the majority of cities over this 20-year period.

Table 2 displays the within race T4:T1 rate ratios for Blacks and Whites. For example, in the U.S., the Black rate was 37.5 at T1 and 32.6 at T4 (Table 1), yielding a T4:T1 RR = 0.87 (Table 2). At the same time, the T4:T1 RR for Whites was 0.73 (23.3/32.0). In other words, the White rate decreased by about 20% more than the Black rate over this period, resulting in an increase in the Black:White RR from 1.17 at T1 to 1.40 at T4 (Table 1). In Los Angeles the Black rate was 45.1 at T1 and 45.6 at T4, yielding a T4:T1 RR = 1.01. At the same time, the T4:T1 RR for Whites was 0.73 (26.7/36.5). Thus, while the Black rate increased by a very small amount, the White rate decreased by 27%, resulting in an increase in the Black:White RR from 1.24 at T1 to 1.71 at T4. In Chicago, the Black rate was 41.7 at T1 and 36.5 at T4, resulting in a T4:T1 RR = 0.87, while the White rate declined from 38.7 to 24.6 (resulting in a within race RR = 0.64). These changes increased the Black:White RR from 1.08 at T1 to 1.48 at T4.

In Memphis, the Black rate declined slightly from 46.3 to 44.3 (T4:T1 RR = 0.93) while the White rate declined from 36.4 to 21.0 (T4:T1 RR = 0.58). These changes resulted in an increase in the Black:White RR from 1.27 at T1 to 2.11 at T4. Overall, of the 41 cities, 16 showed a decrease of less than 10% for the Black breast cancer mortality rate and a decrease of more than 20% for the White rate, resulting in substantially increased disparities over this 20-year time interval.

Table 2 also contains the number of excess Black deaths due to the racial disparity for each city. This excess number is a function of the size of the disparity and the size of the population of each area. Rates are only calculated for those cities for which the disparity is statistically significant. As can be seen, the annual number of Black excess deaths in the United States at T4 was 1710. In Memphis, which had the largest disparity, the number was 43. Chicago had the largest number of annual excess deaths of any of these cities (61) even though New York City (56) is more than twice as populous (but had a much smaller RR).

Table 3 contains the frequency distributions of the Black:White rate ratios for each interval. Whereas at T1 the majority of cities (78%) displayed an RR of 1.2 or less, by T4 only 37% were in this category. Similarly, while only one city displayed an RR greater than 1.41 at T1, this number had risen to 16 (39%) by T4 and two of these cities displayed an RR greater than 1.70 at this point: Los Angeles (RR = 1.71) and Memphis (RR = 2.11). In addition, the proportion of disparities greater than 1.2 rose from 22% at T1, to 60% at T2, to 58% at T3, and to 63% at T4. A chi-square test comparing the T1 and T4 distributions indicates that they are significantly different ($p < 0.0001$). Comparisons between T1 and T2 and T1 and T3 reveal similarly significant differences in the distributions (Yates' $p < 0.005$ for each).

The time trends for the RRs are presented graphically in Fig. 1. New York City, Los Angeles, Chicago, Memphis, and the U.S. have been selected to illustrate various trends. Note that the T1 RRs for all 4 cities and the U.S. are between 1.0 and 1.3. By T4, only one of these (New York City) maintains an RR less than 1.3. Despite the fact that we observe an increase in the RRs between T1 and T4 for all four cities and the U.S., the slopes of the five lines vary substantially. In the U.S., the RR increases steadily from 1.17 at T1 to 1.40 at T4. In New York City, the RR starts at 1.18 at T1, drops slightly at T2, and then increases slightly at T3 and T4, producing an overall increase of only 0.01. In Los Angeles, the RR at T1 is 1.24; this number increases sharply at T2, decreases at T3, and then jumps again at T4 to 1.71 – a large increase from the T1 RR. Chicago's T1 RR of 1.08 increases steadily for T2 and T3, and drops