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The racial disparity in breast cancer mortality in the 25 largest cities in the United States☆

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ABSTRACT

Introduction: Although the racial disparity in breast cancer mortality is widely discussed there are no studies that analyze this phenomenon at the city level. *Methods*: We used national death files, abstracting those cases for which the cause was malignant neoplasm of the breast (ICD-10 = C50) for the numerators and American Community Survey data for the denominators. The 25 largest cities in the US were the units of analysis. Non-Hispanic Black:non-Hispanic White rate ratios (RRs) were calculated, along with their confidence intervals, as measures of the racial disparity. Seven ecological (city-level) variables were examined as possible correlates. *Results*: Almost all the NHB rates were greater than almost all the NHW rates. All but 3 of the RRs (range 0.78–2.09; median = 1.44) were >1, 13 of them significantly so. None of the RRs < 1 were significant. From among the 7 potential correlates, only median household income ($r = -0.43$, $p = 0.037$) and a measure of segregation ($r = 0.42$, $r = 0.039$) were significantly related to the RR. *Conclusion*: This is the first study that we have been able to locate which examines city-level racial disparities in breast cancer mortality. The results are of concern for several cities and for the field in general. A strategy for reducing this disparity in Chicago is in place and may serve as a model for other cities wanting to initiate a similar process. Clearly it is time to take action.

1. Introduction

Although White women are diagnosed with breast cancer more than Black women, Black women die from it at a much higher rate. For example, from 2000 to 2004 the age-adjusted breast cancer incidence rate for non-Hispanic White (NHW) women in the United States was 132.5 (per 100,000 women) compared to 118.3 for non-Hispanic Black (NHB) women, yielding an NHB:NHW rate ratio (RR) of 0.89. In the same years the mortality rates were 25.0 (age-adjusted, per 100,000 women) for NHW women and 33.8 for NHB women (RR = 1.35) [1]. Evidence shows this paradox exists for women both under 50 and over 50 [2].

These national figures are averages across many geographical units throughout the country. In a previous study we documented the nature of the racial disparity in breast cancer mortality in Chicago and found the NHB:NHW RR = 1.98 in 2005 compared with 1.36 in New York City and 1.38 for the United States during this same year [3]. This very large racial disparity in breast cancer mortality in Chicago created a great deal of attention in the media and the breast cancer community. As a result, the Metropolitan Chicago Breast Cancer Task Force was formed. This area-wide organization consists of over 100 individuals and 74 organizations devoted to eliminating the racial disparity in breast cancer through a multifaceted approach [4].

City-level data thus offer the potential to both understand health problems at the local level and to mobilize constituencies for programs or interventions for improvement. Despite this, we are not aware of any reports of breast cancer mortality analyses for cities other than Chicago. With this in mind, this paper presents race-specific breast cancer mortality rates for the 25 largest cities in the United States, measures the racial disparities for each city, analyzes societal (ecological) risk factors that we hypothesize could play a role in breast cancer disparities and discusses the insights and implications of such an analysis.

2. Methods

The 25 most populous cities were determined using 2005 Census data [5]. Deaths where the cause was malignant neoplasm of the breast (ICD-10 = C50) were included in this analysis. Numerator data for 2005–2007 were abstracted from death files maintained by the Centers for Disease Control and Prevention in Atlanta, Georgia. Population-based denominators for the non-Hispanic White (NHW)

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population were obtained from the American Community Survey 2005–2007 3-year estimates [6]. Population-based denominators for the non-Hispanic Black (NHB) population were not readily available. We thus estimated the population using an age-specific ratio calculated by dividing the number of non-Hispanic Blacks by total Blacks in the 2000 Census and multiplying the proportion by the number of all Blacks in 2005–2007 for each age group. For each of the three data sources, the census, the ACS and the death files the NHB and NHW classifications are defined by self-identification. Hispanic ethnicity is asked first followed by racial identity and then these two variables are cross-tabulated to obtain the racial categories employed in this analysis. Age-adjusted rates per 100,000 population were calculated based on the year 2000 standard US population and represent a 3-year average (2005–2007). Data for Indianapolis breast cancer deaths were missing and thus this analysis includes 24 (rather than 25) cities.

To measure disparity in breast cancer mortality we calculated the NHB:NHW rate ratio for each of the 24 cities. A rate ratio of 1.00 is interpreted as no disparity between the NHB and NHW rate, while a rate ratio greater than 1.00 means the NHB rate is higher than the NHW rate and a rate ratio less than 1.00 means the NHW rate is higher. A rate ratio was considered to be statistically significant if the 95% confidence interval did not contain 1.00. The confidence interval for the rate ratio was calculated using a Taylor series expansion technique [7]. To examine the association between each risk factor and rate ratio, we utilized the PROC CORR procedure in SAS v 9.1, which calculates the Pearson correlation coefficient.

NHB excess deaths stemming from the NHB:NHW disparity were computed for each city by applying the age-specific NHW breast cancer mortality rates to the age-specific NHB population. These were then totaled and subtracted from the NHB observed breast cancer deaths. The difference is the excess breast cancer mortality due to the disparity.

We determined the coefficient of correlation for seven ecological risk factors measured at the city level (i.e., the city is the unit of analysis) with the breast cancer mortality racial rate ratios for these 24 cities. These included the proportion of the population that was non-Hispanic White, proportion that was non-Hispanic Black, size of the population, median household income, proportion that is below the poverty level, the Gini Index, and the NHB:NHW Index of Dissimilarity (IOD) at the census tract level. The IOD measures the evenness of geographic spread between two groups within an area and is frequently used as a measure of racial segregation. In such cases, the Index estimates the proportion of NHB people that would have to move from one census tract to another in order to generate an even distribution of NHB and NHW people or vice versa (i.e., to achieve full integration). The IOD ranges from 0 (perfect integration) to 1 (perfect segregation) [8,9].

The Gini Index is a measure of relative mean difference that examines the dispersion of inequality in a population. In this instance, the Gini Index is used to measure the inequality in income across the population. The measure, based upon the distribution below and above a Lorenz curve, ranges from 0 to 1 with 0 indicating that everyone in the population has equal income and 1 indicating there is total income inequality [10].

The first six risk factors were obtained from the 2005–2007 ACS study. The IOD was based on Census 2000 data and was obtained from the University of Michigan Population Studies Center [11].

2.1. Statistical analysis

SAS v 9.1 was used for all analyses. SigmaPlot 11.0 was used to create Fig. 1.

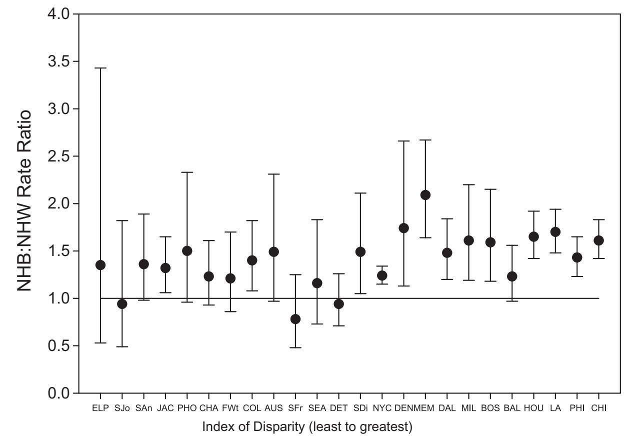

Fig. 1. 3-Year estimates of breast cancer mortality disparity between non-Hispanic Black and non-Hispanic White Women for 24 of the 25 largest cities in the United States, 2005–2007, arranged according to the ascending Index of Disparity.

3. Results

Table 1 presents the age-adjusted breast cancer mortality rates for NHB and NHW women in 2005–2007, and the respective racial rate ratios. The 24 cities are arranged in descending order according to population size. New York, the largest city, had an RR = 1.24 and Denver, the smallest city, had an RR = 1.74. Memphis had the largest RR (2.09) and San Francisco had the smallest (0.78). Those rate ratios that are statistically significant are in bold face in the table. These correspond to the cities in Fig. 1 for which the confidence intervals do not include 1. Note that only three ratios are less than 1 and none significantly so but 13 are significantly greater than 1 and several others are near-significant. As would be expected, there is a significant positive correlation between the NHB rate and the disparity ($r = 0.67$, $p < 0.001$) and a significant negative correlation between the NHW rate and the disparity ($r = -0.53$, $p = 0.008$).

The rate ratio is a function of both the NHW and NHB rates. For example, the RR for Detroit is close to unity because the NHW rate (37.3) is very high among the NHW rates while its NHB rate is about average (for NHB rates) among these cities (35.2). In Memphis the RR is so high (2.09) because the NHB rate is high (44.6) and the NHW rate is low (21.3). The very low RR in San Francisco is due to the NHB rate (19.6), which is the lowest of all the cities. Note that there is a great deal more variation in the NHB rates than the NHW rates. These rates may be compared with the breast cancer mortality goal of Healthy People 2010 of 22.3 [12] and with the U.S. rates presented in Table 1.

There is very substantial variation in these breast cancer mortality rates. The largest of all 48 rates is for NHB people in Houston (47.3) and the smallest is for NHW people in Denver (17.7). Interestingly, the rate for NHB people in San Francisco is almost as small as the NHW rate in Denver but overwhelmingly the rates for NHW women are much lower than the rates for NHB women. In fact, among the 24 cities, only 1 has an NHW rate over 29.0 while 21 have NHB rates above this value. For comparison we note that in 2007 the NHB breast cancer mortality rate for the US overall was 32.2 while it was 23.0 for NHW women [13].

Table 1 also contains the excess annual NHB breast cancer deaths for each city for which the rate ratio was significantly different from 1. The number of such deaths is a function of both the disparity and the NHB population size. Thus, there were 70 such deaths in New York City annually, or 1.3 a week. The number of excess deaths is about the same for Chicago (76), where the disparity is much larger but the population is considerably smaller (Tables 1 and 2).

Table 1
3-Year estimates of breast cancer mortality disparity between non-Hispanic Black and non-Hispanic White Women for 24 of the 25 largest cities in the United States, 2005–2007.

City, State (largest to smallest)	NHB rate[a]	NHW rate[a]	Rate ratio[*]	95% CI	Annual excess NHB deaths[#]
United States	33.2	23.7	**1.40**	1.38–1.42	1722
New York City, NY	31.2	25.2	**1.24**	1.15–1.34	70
Los Angeles, CA	46.5	27.4	**1.70**	1.48–1.94	43
Chicago, IL	37.8	23.4	**1.61**	1.42–1.83	76
Houston, TX	47.3	28.7	**1.65**	1.42–1.92	49
Philadelphia, PA	35.8	25.1	**1.43**	1.23–1.65	38
Phoenix, AZ	32.9	22.0	1.50	0.96–2.33	
San Antonio, TX	36.8	27.0	1.36	0.98–1.89	
San Diego, CA	36.7	24.7	**1.49**	1.05–2.11	5
Dallas, TX	37.5	25.3	**1.48**	1.20–1.84	18
San Jose, CA	27.2	28.9	0.94	0.49–1.82	
Detroit, MI	35.2	37.3	0.94	0.71–1.26	
Indianapolis, IN	–	–	–	–	
Jacksonville, FL	37.1	28.1	**1.32**	1.06–1.65	10
San Francisco, CA	19.6	25.2	0.78	0.48–1.25	
Columbus, OH	36.6	26.1	**1.40**	1.08–1.82	9
Austin, TX	33.1	22.2	1.49	0.97–2.31	
Memphis, TN	44.6	21.3	**2.09**	1.64–2.67	42
Baltimore, MD	31.6	25.7	1.23	0.97–1.56	
Fort Worth, TX	29.8	24.6	1.21	0.86–1.70	
Charlotte, NC	32.3	26.3	1.23	0.93–1.61	
El Paso, TX	24.9	18.4	1.35	0.53–3.43	
Milwaukee, WI	29.6	18.4	**1.61**	1.19–2.20	12
Seattle, WA	30.0	25.9	1.16	0.73–1.83	
Boston, MA	34.6	21.7	**1.59**	1.18–2.15	10
Denver, CO	30.8	17.7	**1.74**	1.13–2.66	4

[*] Bolded rate ratio denotes it is significantly different from 1.00.
[a] Age-adjusted rate is expressed per 100,000 females using the US 2000 Standard Population.
[#] Excess NHB deaths are only calculated for rate ratios that are significantly different from 1.00.

Table 2 presents the line listing for all the cities and contains the seven hypothesized correlates of the RR. The variability or lack thereof in each of these measures is noteworthy. For example, the median household income varies from a low of $29,100 for Detroit (with one of the lowest RRs, 0.94) to a high of $76,400 for San Jose (also with a low RR = 0.94) and $65,500 for San Francisco (also with a low RR = 0.78). The IOD, which here is used as a measure of racial segregation (1 = complete segregation) varies from a high of 86% for Chicago (RR = 1.61) to a low of 35% for El Paso (RR = 1.35) and 41% for San Jose (RR = 0.94). The Gini Index ranges from a low of 0.43 in San Jose (RR = 0.94) to a high of 0.54 in New York (RR = 1.24). This 0.43 is a comparatively elevated Gini Index [14]. Data are similarly displayed for the other four potential correlates.

We also calculated the bivariate correlations of the RR with each of the predictor variables. These are listed at the bottom of Table 2. Of the seven hypothesized risk factors only median household

Table 2
Correlates of the rate ratios for 24 of the 25 largest cities in the United States, 2005–2007.

City, State (largest to smallest)	NHB:NHW BC mortality rate ratio	Population size	% NHW	% NHB	Median household income	% Below poverty level	Index of disparity	Gini Index
New York City, NY	1.24	8,246,310	35.1	23.7	47,581	19	0.629	0.535
Los Angeles, CA	1.70	3,770,590	29.3	9.7	46,292	19	0.732	0.524
Chicago, IL	1.61	2,740,224	30.9	34.7	44,473	21	0.857	0.509
Houston, TX	1.65	2,034,749	28.0	24.0	40,285	21	0.718	0.519
Philadelphia, PA	1.43	1,454,382	39.4	43.1	34,767	24	0.771	0.487
Phoenix, AZ	1.50	1,440,018	48.1	5.2	47,223	17	0.511	0.461
San Antonio, TX	1.36	1,267,984	29.3	6.3	42,217	18	0.490	0.460
San Diego, CA	1.49	1,264,263	48.2	6.7	60,185	13	0.623	0.458
Dallas, TX	1.48	1,187,603	30.6	23.2	40,147	21	0.665	0.533
San Jose, CA	0.94	898,901	31.7	3.1	76,354	10	0.410	0.433
Detroit, MI	0.94	837,711	8.4	82.5	29,109	32	0.603	0.473
Jacksonville, FL	1.32	797,966	58.7	29.9	47,381	13	0.510	0.442
San Francisco, CA	0.78	757,604	44.7	6.7	65,519	12	0.594	0.508
Columbus, OH	1.40	724,095	63.3	26.1	42,031	20	0.585	0.436
Austin, TX	1.49	725,306	49.9	8.3	48,227	18	0.589	0.483
Memphis, TN	2.09	649,443	30.2	62.3	35,181	24	0.652	0.501
Baltimore, MD	1.23	639,493	30.4	63.6	36,304	20	0.715	0.490
Fort Worth, TX	1.21	635,612	44.1	18.0	44,804	17	0.584	0.460
Charlotte, NC	1.23	649,578	50.3	33.2	51,050	12	0.571	0.488
El Paso, TX	1.35	592,627	15.0	2.6	34,626	27	0.347	0.477
Milwaukee, WI	1.61	584,007	40.9	38.4	35,233	24	0.698	0.436
Seattle, WA	1.16	565,809	67.9	7.5	56,319	13	0.602	0.495
Boston, MA	1.59	600,980	50.0	22.2	48,729	20	0.711	0.530
Denver, CO	1.74	576,842	50.5	9.7	43,748	18	0.646	0.504
Correlation Coefficient[*]		0.04	0.02	0.07	**−0.43**	0.29	**0.42**	0.25

[*] Correlations between the rate ratio and the 7 ecological variables. Bolded coefficients are statistically significant ($p < 0.05$).

income ($r = -0.43$, $p = 0.037$) and the IOD ($r = 0.42$, $p = 0.039$) were significantly correlated with the RR.

Fig. 1 displays the rate ratios along the y-axis and the ascending Index of Disparity along the x-axis. As can be seen there is a slightly upward trend in the data suggesting a moderate relationship between these two variables, as is consistent with the $r = 0.42$ noted above.

4. Discussion

As far as we are able to determine, this is the first publication that has looked at city-level NHB:NHW breast cancer mortality disparities. Several insights emerge as a result of this analysis. We examined seven ecological variables as potential correlates of the rate ratio. It should be mentioned that the correlates were single measures at the city level, and not specific to each race within a city. Thus, a single indicator of income may conceal the degree of disparity between races within a city, with the exception of the segregation index. It is also important to emphasize that we are seeking correlates of the disparity and not simply of the rates. We emphasize this point since several of the variables we considered have been found to be predictors of *health* but few, to our knowledge, have been examined as predictors of *health disparities*, though there are some important exceptions [15,16]. In this sense, this analysis makes a unique contribution.

Only two of these seven variables were significantly related to the rate ratio: the median household income (negatively) and the Index of Dissimilarity (positively), a measure of segregation. MHHI was lowest for Detroit ($29,100) and highest for San Jose ($76,400) and then San Francisco ($65,500). Notably, these three had the three lowest RRs, all less than 1.00. Poverty has, of course, frequently been found to be a risk factor for bad health [17,18]. Since Black people are more often poor it may be that poverty on a city level would exacerbate racial disparities although we have not been able to locate any studies of this topic.

The IOD indicates (in this usage) what proportion of NHB people would have to move to another census tract in order to achieve perfect integration with NHW people, or vice versa. This proportion is 86% for Chicago, 77% in Philadelphia and only 35% in El Paso. The reason the IOD is so small in the latter is likely because there are very few non-Hispanic Whites and non-Hispanic Blacks living there. In their classic study of segregation in the United States Massey and Denton found that large cities had an average IOD of 77% in 1980 [19]. Segregation has been linked to poor health for Black people, summarized by several reviews [20,21], and to disparities in health by a prominent analysis of the literature [22].

Notably, the Gini Index was not a significant predictor of the RR. This may represent reality or it may be a function of the fact that this index varies so little across the 24 cities, with a low of 0.43 in San Jose and a high of 0.54 in New York. Some studies have found significant relationships between economic inequality and health [10,23] but others have not [24]. A recent review summarizes this literature [25]. There are several measures of income inequality that could be used for such an analysis but in general they have been found to be highly correlated with one another [26] and the Gini Index is the most commonly employed measure [23]. Once again, we are not aware of any studies that have examined the impact of economic inequality in a geographical unit on racial disparities in that unit.

This disparity, like so many others, is literally a matter of life and death, generating annual NHB excess mortality of 42 in Memphis, 76 in Chicago and 1722 in the United States (Table 1).

4.1. The utility of such an analysis

The racial disparity in breast cancer mortality is widely discussed but geographic variation has generally been left out of this discussion, although there are notable exceptions [24,27]. It certainly would be possible to analyze disparities at other levels (e.g., state, zip code, metropolitan area or rural area) and each would have its advantages. For example, smaller scale analysis can reduce the confounding factors due to different geographic areas and larger scale analyses would cover greater geography. In this case we employed city-level disparities because it had not been done before, because many people identify at that level, and because important actions (interventions) are possible at the city-level, as discussed below in great detail, using Chicago as a case-study.

Since geographic analysis has by and large been omitted so have ecologic variables like the ones included in this analysis. This would seem like an important gap in the literature. For example, in the analysis presented here racial residential segregation (the IOD) is strongly correlated with the breast cancer mortality disparity. In a paper recently published by our group we presented a map of Chicago which indicated the 25 communities (out of 77) with the highest breast cancer mortality rates. They were almost all ($n = 24$) communities that were predominantly Black. We superimposed on this map those communities in which hospitals with American College of Surgeons approved cancer programs were located. There was virtually no overlap, suggesting a disconnect between communities most in need and those where services were geographically located, a disconnect defined by race [4]. Thus, what has been disclosed by the analysis in the current report is vividly illustrated by our map of Chicago. We wonder whether other cities are experiencing the same phenomenon, given the IOD findings here.

Consistent with this analysis is a call for further research guided by several of these findings. For example, cities with smaller disparities (e.g., San Francisco and Detroit) and those with larger disparities (e.g., Memphis and Denver) should look into these anomalous results. They may want to implement analyses of the determinants of these mortality rates involving individual level factors and how they vary by city. These may include incidence rates, proportions attending regular mammographic screening, proportions with health insurance, stage at diagnosis, breast cancer awareness, etc. Among the kinds of questions we can ask here are why the NHW rate is so high in Detroit and why the NHB rate is so low in San Francisco.

In cities in which the RR is particularly high or where individual rates are high, city-wide efforts are surely merited to attempt to reduce the racial disparity in breast cancer mortality. How "high" this RR should be in order to take action is of course subjective but one might use the RR for the US = 1.38 in 2005 [3] or 1.40 in 2007 [13] as an example or refer to Table 1 for other possibilities. For individual rates, the US rate or NHW rate for that location may be used as a gauge to identify what is 'high'. The Task Force mobilization in the Chicago metropolitan area has thus far drawn a great deal of attention, funding and energy [4] and it would likely be helpful to generate efforts in similarly situated cities. Such organizing will hopefully improve equity in breast cancer outcomes. For example, the Task Force organized a demonstration of 500 people demanding increased funding for the Illinois Breast and Cervical Cancer Program which pays for mammograms, pap smears and treatment of these cancers for poor women [28].

Furthermore, the Task Force helped the passage of legislation to increase the Illinois Medicaid reimbursement rate for mammography to the Medicare rate, which represents a tripling of the reimbursement rate (Public Law 95-1045). The State of Illinois also decided to require health care providers, as a condition of receiving that increase, to submit mammography screening quality data to the Chicago Breast Cancer Quality Consortium. The Consortium is a project of the Task Force charged with bringing together health care providers to identify deficits and engage in quality improvement interventions relating to breast cancer screening, diagnosis and treatment.

As a final observation here it should be mentioned that some breast cancers in NHB women may be of a more aggressive type (e.g., higher proportion of triple negatives) for which survival is poorer; but at the same time, the low RRs in some cities such as Baltimore or New York compared to that in other cities point to the fact that even if biological differences in tumor aggressiveness are present, they would not account for between cities differences. This would leave structural (e.g., racism and poverty) and access to care issues (e.g., early detection and treatment) as likely explanations [3,4].

4.2. Methodological considerations

This paper gains strength from the data sources employed. With respect to the national death certificate files that were employed, we have searched the literature and there is overwhelming agreement that the files are generally complete [13]. It is further likely that breast cancer mortality would be one of the least ambiguous death codes, as opposed to heart disease and diabetes, for example [13]. The numerators, drawn from the American Community Survey, are similarly robust, based as they are upon sample sizes in the millions [29].

Despite the fact that we have analyzed three-year average rates from the 24 largest cities in the United States, even these will vary over time and it could be that the next three years of data would produce some noticeably different figures. Thus, the data presented here should be seen as an exemplar of a process rather than a fixed set of rates.

Second, we have only dealt with non-Hispanic Black and non-Hispanic White women in this analysis. Clearly rates for other groups need to be analyzed as well. This begins to involve small numbers for some racial groups, like Native Americans, which would require a different strategy for analysis (e.g., perhaps using 5 or even 10 year averages). In addition, vital records data reveal very low breast cancer mortality rates for Hispanic women [13]. Since mammography rates are lower for this group [30] and other studies reveal less than optimal treatment for Hispanic women [31], the explanation of these low mortality rates almost certainly stems from the fact that many Mexicans return home when they become chronically ill, thus not generating a US death certificate with a diagnosis of breast cancer (sometimes referred to as the "salmon hypothesis") [32,33].

5. Conclusion

National and state breast cancer mortality rates are informative. Yet rates for smaller geographies are necessary to identify disparities at the local level and help facilitate community engagement and organizing for improved health [34]. An ideal local level for breast cancer analysis may be the city since smaller units will have too few events for stable calculations. For the reasons noted above, we recommend that such municipalities compute these rates and rate ratios and open a discussion about disparities in breast cancer mortality in their communities. There is much to be gained and little to lose by doing this.

Conflict of interest statement

None of the three authors have any financial and personal relationships with other people or organizations that could inappropriately influence (bias) our work.

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