



Disparities in Breast Cancer Stage at Diagnosis: Importance of Race, Poverty, and Age

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# Disparities in Breast Cancer Stage at Diagnosis: Importance of Race, Poverty, and Age

## Abstract

This study investigated the association of race, age, and census tract area poverty level on breast cancer stage at diagnosis. The study was limited to women residing in Missouri, aged 18 years and older, diagnosed with breast cancer, and whose cases were reported to the Cancer Registry between 2003 and 2008. The risk, relative risk, and increased risk of late-stage at diagnosis by race, age, and census tract area poverty level were computed. We found that the odds of late-stage breast cancer among African-American women were higher when compared with their white counterpart (OR 1.433; 95% CI, 1.316, 1.560). In addition, the odds of advanced stage disease for women residing in high-poverty areas were greater than those living in low-poverty areas (OR 1.319; 95% CI 1.08; 1.201). To close the widening cancer disparities gap in Missouri, there is the need for effective and programmatic strategies to enable interventions to reach areas and populations most vulnerable to advanced stage breast cancer diagnosis.

## Keywords

Healthcare Disparities; Socioeconomic Factors; Breast Cancer; Stage at Diagnosis

## Cover Page Footnote

This work was partially supported by the Transdisciplinary Research on Energetics and Cancer (TREC) Center at Washington University in St. Louis School of Medicine. The National Cancer Institute at NIH (U54 CA155496) funds the TREC Center.



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## **Disparities in Breast Cancer Stage at Diagnosis: Importance of Race, Poverty, and Age**

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### **ABSTRACT**

This study investigated the association of race, age, and census tract area poverty level on breast cancer stage at diagnosis. The study was limited to women residing in Missouri, aged 18 years and older, diagnosed with breast cancer, and whose cases were reported to the Cancer Registry between 2003 and 2008. The risk, relative risk, and increased risk of late-stage at diagnosis by race, age, and census tract area poverty level were computed. We found that the odds of late-stage breast cancer among African-American women were higher when compared with their white counterpart (OR 1.433; 95% CI, 1.316, 1.560). In addition, the odds of advanced stage disease for women residing in high-poverty areas were greater than those living in low-poverty areas (OR 1.319; 95% CI 1.08; 1.201). To close the widening cancer disparities gap in Missouri, there is the need for effective and programmatic strategies to enable interventions to reach areas and populations most vulnerable to advanced stage breast cancer diagnosis.

**Keywords:** Healthcare Disparities, Socioeconomic Factors, Breast Cancer, Stage at Diagnosis

### **INTRODUCTION**

Breast cancer remains the most commonly diagnosed cancer among United States (U.S.) women and the second most common cause of cancer death among women after lung cancer (American Cancer Society, 2013, 2015a, 2015b; DeSantis et al., 2015). For many decades, the social and epidemiology literature on cancer indicated that African-American women experienced lower incidence rates of breast cancer, but higher mortality rates than white women. Nonetheless, recent evidence concerning disparities in breast cancer has demonstrated that the incidence rates of breast cancer in African-American women now equals white women (American Cancer Society, 2013, 2015a, 2015b; DeSantis et al., 2015; Siegel, Miller, & Jemal, 2017).

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Early detection of breast cancer greatly improves a person's chances of survival (American Cancer Society, 2015a; Siegel et al., 2017). Overall, breast cancer diagnosis in younger women is more difficult than in elderly women. However, African-American women are often diagnosed at a young age when the disease tends to have the worse prognosis. The racial disparities gap in breast cancer diagnosis, mortality, and survival have continued to widen in the U.S. between whites and African-American women. For instance, between 2008 and 2012, the median age for women diagnosed with breast cancer in the U.S. was 61 years. The median age was lower for African-American women (58 years) than white women (62 years) (American Cancer Society, 2015a; DeSantis et al., 2015). Also, from 2008 through 2012 breast cancer mortality rates were almost 43% higher in African-American women than white women (American Cancer Society, 2015a; DeSantis et al., 2015). The median breast cancer death age for all women was 68 years, but 69 years for white women, and 62 years for African-American women (DeSantis et al., 2015).

The reasons for African-American and white women differences in breast cancer outcomes are complex and not well understood. For instance, McGee et al. used the Carolina Breast Cancer study to examine determinants of treatment delay for African-American and white women. Results showed that even though 94% of women meet their target of initiating treatment within 60 days of diagnosis, racial disparities persisted (McGee, Durham, Tse, & Millikan, 2013). In the United Kingdom, Copson et al. examined ethnicity and breast cancer outcomes among young breast cancer patients. Despite equal access to healthcare through the National Health Service, young black women experienced poorer health outcomes compared to other races (Copson et al., 2014). Other studies suggest that, the major barriers contributing to the widening disparity gap may be attributed to socioeconomic, environmental as well as geographical differences rather than biological factors (American Cancer Society, 2013; Feinglass, Rydzewski, & Yang, 2015; Iqbal, Ginsburg, Rochon, Sun, & Narod, 2015; Reeder-Hayes, Wheeler, & Mayer, 2015; Williams, Jeanetta, O'Brien, & Fresen, 2015; Williams & Thompson, 2015).

In addition, race and ethnicity have also been reported to influence a woman's decision to either seek early diagnosis and treatment for breast cancer or adhere to screening guidelines (Aiken, Fenaughty, West, Johnson, & Lockett, 1994; Iqbal et al., 2015; McDonald, Thorne, Pearson, & Adams-Campbell, 1998; Vernon, Vogel, Halabi, & Bondy, 1993). This study aimed to evaluate the association of race, age (individual determinants), and census tract area poverty level (neighborhood level disadvantage/factors) on breast cancer stage at diagnosis.

## **METHODS**

### Study Design, Data Sources, and Population

The University of Missouri Institutional Review Board deemed this study exempt. Female breast cancer summary data on incidence from 2003 to 2008 (N = 29,410) was provided by the Missouri Cancer Registry and Research Center (MRC-ARC) of the Missouri Department of Health and Senior Services. The Missouri Cancer Registry and Research Center is a population-based cancer registry, tasked to collect demographic, tumor, and treatment information on all newly diagnosed cancers among Missouri residents annually. The study was limited to women aged 18 years and older, who were residents of Missouri, and diagnosed with

breast cancer. Data elements obtained from the cancer registry included tumor size, regional lymph node status, the presence or absence of distant metastases for incident cases of breast cancer, age at diagnosis, race (white and African-American), and 2000 census tract area poverty level associated with women's addresses at the time of diagnosis.

#### Measures

The dependent variable, stage at diagnosis was reported as stage 0, stage I, stage II, stage III, stage IV, and unknown. To simplify the analysis, as well as protect the identity of the women, the registry tasked the research team to dichotomize stage at diagnosis into two groups – “early” and “late”. Early stage consisted of stages 0, I and II while late-stage comprised of stages III and IV. The covariates were race, age at diagnosis, and area-level poverty. Race variable was categorized into two groups: white, and African-American. The age variable was classified into four groups: (i) 18-39, (ii) 40-49, (iii) 50-64 and, (iv) 65 years and over.

Socioeconomic status is strongly correlated with health, and wellbeing (Adler & Newman, 2002). However, individual-level socioeconomic status such as income and poverty are not collected by cancer registries. To overcome this challenge, the North American Association of Central Cancer Registries (NAACCR) developed a census tract area-level poverty indicator for assessing the relationship between cancer, and socioeconomic status (Boscoe, 2009). Four categories of poverty rates are used by NAACCR as: (i) <5%, (ii) 5% to < 10%, (iii) 10% to <20%, (iv)  $\geq$ 20% (Boscoe, 2009). Taking the federal definitions for poverty into account, census areas with a poverty rate of  $\geq$ 20% is considered the highest category of poverty (Boscoe, 2009; Krieger, Williams, & Moss, 1997). Again, to ensure privacy and confidentiality of patients, the MCR-ARC collapsed the four main groups into two categories as (i) <10% (low poverty), and (ii)  $\geq$ 10% (extreme poverty). For this study, census tract with area poverty level of  $\geq$ 10% was considered “extreme poverty” neighborhood. We excluded women missing all data or information on stage at diagnosis, race, age, and census tract area poverty from the analysis.

#### Statistical Analysis

To describe the relationship between stage at diagnosis, race and census tract poverty level separately, a two-way table was used. We computed the risk, relative risk, and increased risk of late-stage of presentation by race and poverty. The dependent variable, stage at diagnosis, was measured on a binary scale (“early” or “late”) as a result, it was deemed appropriate to use the logit model to estimate the relationship between stage at diagnosis and the two explanatory variables (race, and 2000 census tract area poverty level). Initially, the entire data set was fitted to the logit model. Second, the data set was divided into four non-overlapping subgroups along the lines of age at diagnosis (18-39, 40-49, 50-64, and 65+ years) and a logit model was fitted for each subgroup. Next, we estimated the odds ratios (ORs), and  $(1 - \alpha)\%$  confidence intervals (CIs) to make inference about the statistical significance of the true odds ratios. RStudio version 0.98.501-© 2009-2013 (RStudio, Inc.) statistical package was used for this analysis.

## **RESULTS**

A total of 29,410 women with breast cancer was recorded by the Missouri cancer registry between 2003 and 2008. Of these, 18,196 (61.87 %) were early, 8,135 (27.66 %) late, and 3,079

(10.47%) were unknown stage. After excluding unknown cases due to missing data, analysis was performed on 26,331 cases.

#### The Effect of Race and Area Poverty on Late-Stage Breast Cancer Presentation

Table 1 shows the distribution of breast cancer disease by race and risk for late-stage diagnosis in Missouri. The table indicates that the risk of late-stage presentation among African-American women and white women were 0.39 and 0.30 respectively. Even though the number of breast cancer diagnosed was higher in white women than in African-American women, the risk of advanced stage presentation was greater among African-American women compared to white women. The risk of reporting late-stage breast cancer diagnosis was 1.30 times greater among African-American women than for white women. This implies there was a 30% increase in the chances of reporting late-stage breast cancer among African-American women relative to white women.

**Table 1**

Risk for Late-Stage Breast Cancer by Race

Race	Stage at Diagnosis		Total	Risk (Late)
	Early	Late		
White	16,610	7,123	23,733	0.30
African-American	1,586	1,012	2,598	0.39
<b>Total</b>	<b>18,196</b>	<b>8,135</b>	<b>26,331</b>	

Table 2 describes the relationship between area poverty level and stage of presentation. Evidence from the table shows that the risk of late-stage disease among women living in a census tract with low-poverty rate (poverty rate <10%) and census tract areas with extreme poverty rate (poverty rate  $\geq$ 10%) were 0.29 and 0.33 respectively. The risk of reporting advanced stage breast cancer was 1.14 times higher among women residing in extreme poverty level census tract than women living in a census tract with low poverty rate. It follows that there was about 14% increase in the chances of reporting late-stage disease among women living in extreme poverty level census tract areas compared to women living in low-poverty level areas.

**Table 2**

Risk for Late-Stage at Diagnosis by Census Tract Poverty Level

Poverty	Stage at Diagnosis		Total	Risk (Late)
	Early	Late		
Less than 10%	9,205	3,772	12,977	0.29
Equal or Greater than 10%	8,991	4,363	13,354	0.33
<b>Total</b>	<b>18,196</b>	<b>8,135</b>	<b>26,331</b>	

Inference of Late-Stage Breast Cancer by Race, Poverty, and Age

Table 3 shows the results of the fitted logit model along the four non-overlapping age groups. We found that the odds of late-stage breast cancer presentation among African-American women were higher compared with their white counterpart (OR 1.433; 95% CI, 1.316, 1.560). In addition, the odds of late-stage at diagnosis among women living in a census tract with extreme poverty rate was greater relative to those residing in census tract areas with low-poverty rate (OR 1.319; 95% CI 1.08; 1.201). The relationship between stage at diagnosis and the two explanatory variables given the entire data set were statistically significant at the 5% level (see table 3).

**Table 3**

Odds Ratio (OR) and Confidence Interval (CI) for Breast Cancer Diagnosis

Age Group	Variable	Estimate	Standard Error	z Value	Odds Ratio	95% CI	
						Lower Limit	Upper Limit
Overall	Intercept	-0.910	0.019	-46.712	0.403	0.388	0.418
	Race	0.360	0.043	8.293	1.433	1.316	1.560
	Poverty	0.130	0.027	4.777	1.139	1.080	1.201
18-39 Years	Intercept	-0.232	0.087	-2.660	0.793	0.668	0.940
	Race	0.015	0.164	0.089	1.015	0.735	1.400
	Poverty	0.163	0.122	1.334	1.177	0.927	1.495
40-49 Years	Intercept	-0.727	0.044	-16.434	0.483	0.443	0.527
	Race	0.313	0.096	3.272	1.367	1.133	1.648
	Poverty	0.210	0.065	3.249	1.234	1.087	1.401
50-64 Years	Intercept	-0.918	0.032	-28.479	0.399	0.375	0.425
	Race	0.299	0.072	4.167	1.348	1.171	1.550
	Poverty	0.138	0.045	3.034	1.148	1.050	1.255
65+ Years	Intercept	-1.063	0.031	-33.789	0.345	0.325	0.367
	Race	0.385	0.074	5.212	1.469	1.270	1.697
	Poverty	0.129	0.043	3.006	1.137	1.046	1.237

(Race: Reference is white; Poverty: Reference is less than 10%)

In terms of specific age group, for 18-39 years, the odds of a late-stage of presentation among African-American women was 1.015 greater than in white women. In the case of neighborhood poverty for the same age group, women residing in extreme poverty level census tract have higher odds (1.177) to be diagnosed with advanced stage of breast cancer than those in a low poverty level census tract. However, our results show no statistically significant relationship (at 5% level) between stage at diagnosis and the two explanatory variables for the 18-39 years' group (see table 3). By the same comparison for ages 40-49, 50-64, and 65 years

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and over, our analysis revealed that African-American women had higher odds of reporting late-stage breast cancer compared to white women. Similarly, women living in extreme poverty level census tract have higher odds of late-stage presentation relative to women residing in a census tract with a low-poverty rate. These relationships were statistically significant at the 5% level. Nonetheless, irrespective of race, observation of the effect of age and census tract poverty on stage at diagnosis showed that the odds of late-stage diagnosis among women aged 18-49 years was higher relative to women aged 50 years and older (see table 3).

## DISCUSSION

Two previous studies have shown a strong relationship between geographical place of residence and race on an increased risk of advanced stage of breast cancer diagnosis (Williams et al., 2015; Williams & Thompson, 2015). However, neither of these earlier studies measured the impact of age and area poverty level on stage at diagnosis. This work contributes to the body of knowledge, by investigating the widening health disparities by considering the effect of individual-level factors (race and age) and neighborhood determinants (census tract area poverty level) on breast cancer late-stage at diagnosis in Missouri from 2003 to 2008.

Our findings revealed that stage of breast cancer diagnosis was associated with race, age, and census tract area poverty level for all participants. According to the 2010 census estimates, African-Americans make up 12.3% of Missouri population. Missouri's pattern of African-Americans matches that of the U.S. as a whole, where African-Americans make up only 13.6% (Missouri Foundation for Health, April 2013). Even though the proportion of African-Americans in Missouri is small relative to whites, the present study indicated that African-American women have a higher proportion of late-stage breast cancer compared to white women (see table 1). This finding is consistent with previous studies which have demonstrated the continuous importance of race and ethnicity in breast cancer stage at diagnosis (DeSantis et al., 2015; Farkas, Greenbaum, Singhal, & Cosgrove, 2012; Missouri Foundation for Health, April 2013; Iqbal et al., 2015; Izano et al., 2014; Klassen, Pankiewicz, Hsieh, Ward, & Curriero, 2015; Lobb, Ayanian, Allen, & Emmons, 2010; McCarthy, Yang, & Armstrong, 2015; Mobley & Kuo, 2015; Robbins, Lerro, & Barr, 2014; Roetzheim et al., 1999; Virnig, Baxter, Habermann, Feldman, & Bradley, 2009; Williams et al., 2015; Williams & Thompson, 2015). Virnig and colleagues examined whether age and sex affected stage at diagnosis and cancer survival. Their findings showed an increased risk of late diagnosis for African-Americans than whites for all major cancers. Similar results were found when tumor types were analyzed (Virnig et al., 2009). These findings continue to show the widening disparity gap in cancer diagnosis and survival between African-Americans and whites in the U.S. For instance, between 2005 and 2009, breast cancer incidence among African-American women in Missouri increased from 147.9 to 169.8, yet incidence among white women remained stable from 2005 to 2009 (Missouri Foundation for Health, April 2013). While factors contributing to the persistent African-American and white disparities in breast cancer care are not clear, some researchers have attributed this to biological and societal inequalities in health (O'Keefe, Meltzer, & Bethea, 2015; Siegel, Miller, & Jemal, 2015; Wallerstein & Duran, 2006).

The difference in ORs of late-stage presentation with regard to age and area poverty level showed an increased risk for women aged 40-49 years followed by the 18-39 age group when



compared to women 50 years and over. Breast cancer screening rates among younger women are generally lower compared to women aged 50 years and older, (American Cancer Society, 2015a; Kerlikowske, 2009; Kheirelseid et al., 2011; Mobley & Kuo, 2015; Narod, 2012). This may have accounted for the higher risk for distant metastasis in this population.

In addition, we found that women aged 18-49 years experienced the highest ORs in terms of area poverty and age on late-stage at diagnosis in Missouri. While this study did not assess insurance status, we hypothesized this finding may be attributed to health insurance among other factors since women aged 65 years and older are eligible for Medicare. Robbins and colleagues investigated the relationship between insurance status and stage at diagnosis among young women aged 15-39 years with cancer using the National Cancer Data from 2004-2010 (Robbins et al., 2014). Results revealed that uninsured women were 1.86 times more likely to be diagnosed at a distant stage (95% CI, 1.79-1.94) (Robbins et al., 2014).

Lastly, our findings on elevated risk were statistically significant among women generally and in particular those of age 40 years and over. This result confirms that breast cancer is rare in younger women; however, it raises the need for well-defined policies/programs to guide younger women who may have risk factors for breast cancer since they fall outside the normal screening guidelines.

## CONCLUSION

Racial/ethnic disparities in health care and outcomes between African-Americans and whites remain a major public health concern. With this in mind, the current study assessed the relationship between individual and neighborhood poverty level characteristics on breast cancer stage at diagnosis. According to the U.S. Census Bureau, in 2011 almost 31% of African-Americans in Missouri fall below the poverty line compared to 13% whites (Missouri Foundation for Health, April 2013). It is evident from our results that disparities in breast cancer stage at presentation continue to vary significantly by race, age, and neighborhood poverty level characteristics among Missouri women. Previous studies have shown that poverty and health are highly correlated (Adler & Newman, 2002; Bank, 2014; Stevens et al., 2014). As a result, individuals living in poverty are more likely to experience more adverse disease complications than those in higher socioeconomic status.

Causes of health disparities are complex, interrelated and involve several factors. Despite these challenges, eliminating disparities in health has been the subject of overarching goal for many institutions and researchers. In its report on *“Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care”*, the Institute of Medicine acknowledged that multi-level approach is required to either eliminate or reduce such disparities (Nelson, 2002). As a short-term goal to bridge the widening breast cancer disparities gap in Missouri, there is the need to increase public education, outreach on cancer preventive services including healthy behavioral lifestyle changes, screening, and follow up with any suspicious mammogram. For many years, groups like Susan G. Komen advocated for routine breast cancer screening for all women age 40 and above. However, the new screening guidelines stating that average-risk women of breast cancer should start screening at 45 years may discourage at risk women not to start screening early (Myers et al., 2015; Oeffinger et al., 2015).

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Equitable access to timely and high-quality care is crucial when facing cancer and other chronic diseases. Sadly, our healthcare system is not designed to facilitate easy access to healthcare services. To ease the problem of access and care coordination, we recommend the introduction of a community-centered approach through the formation of a breast cancer task force. (Bone et al., 2013; Freeman, 2006; Natale-Pereira, Enard, Nevarez, & Jones, 2011). The implementation of this team-based approach helped Metropolitan Chicago and Baltimore see a significant reduction in breast cancer disparities (Bone et al., 2013; Metropolitan Chicago Task Force, 2014).

Additionally, there is urgent need to improve access through the provision of health insurance to reduce the continuing disparities between African-American and whites in the state. One way is the Affordable Care Act (ACA). Missouri is one of the states in the nation that did not expand insurance coverage as part of the ACA reform program. As noted by Ellimoottil & Miller, 2014, healthcare access alone may not eliminate health disparities but has the potential to minimize socioeconomic and racial/ethnic disparities in the cancer care continuum. Only when the state legislature is able to put into action some of these interventions and equitably distribute resources, can we begin to see improvement in breast cancer outcomes and reduction in health disparities between African-American and whites in Missouri.

### Limitations and Bias

The main limitation of this study relates to the lack of individual-level socioeconomic data in cancer registries. Cancer registries do not collect individual level socioeconomic data. This prevented us from determining how much of our observed association could have been explained by individual-level socioeconomic position instead of using neighborhood poverty level. However, one of the major strengths of this study is the use of reliable population-based cancer data to examine the effect of race, age and census tract poverty level on breast cancer stage at diagnosis.

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