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Mind the gap: Racial differences in breast cancer incidence and biologic phenotype, but not stage, among low-income women participating in a government-funded screening program

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Abstract

Background—Breast cancer mortality rates in South Carolina (SC) are 40% higher among African-American (AA) than European-American (EA) women. Proposed reasons include race-associated variations in care and/or tumor characteristics, which may be subject to income effects. We evaluated race-associated differences in tumor biologic phenotype and stage among low-income participants in a government-funded screening program.

Methods—Best Chance Network (BCN) data were linked with the SC Central Cancer Registry. Characteristics of breast cancers diagnosed in BCN participants aged 47–64 years during 1996–2006 were abstracted. Race-specific case proportions and incidence rates based on estrogen receptor (ER) status and histologic grade were estimated.

Results—Among 33,880 low-income women accessing BCN services, repeat breast cancer screening utilization was poor, especially among EAs. Proportionally, stage at diagnosis did not

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ETHICAL STANDARDS:
The work presented here complies with the current laws of the US, in which it was performed. This study has not been presented outside the institutions of the authors. Some of this work was conducted by Ms. Tiffany Baker-Elamin towards her MSPH Thesis.

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differ by race (607 cancers, 53% among AAs), with about 40% advanced stage. Compared to EAs, invasive tumors in AAs were 67% more likely (proportions) to be of poor-prognosis phenotype (both ER-negative and high-grade); this was more a result of the 46% lesser AA incidence (rates) of better-prognosis (ER+ lower-grade) cancer than the 32% greater incidence of poor-prognosis disease (p-values <0.01). When compared to the general SC population, racial disparities in poor prognostic features within the BCN population were attenuated; this was due to more frequent adverse tumor features in EAs rather than improvements for AAs.

Conclusion—Among low-income women in SC, closing the breast cancer racial and income mortality gaps will require improved early diagnosis, addressing causes of racial differences in tumor biology, and improved care for cancers of poor-prognosis biology.

Keywords

Breast cancer; Health disparities; Racial disparities; Low-income population; Cancer screening; Rates and proportions

INTRODUCTION

In South Carolina (SC), as in much of the United States, women of African ancestral origin (African-American: AA) have a 40% higher breast cancer mortality rate than do women of European origin (European-American: EA) [1,2]. AA women are also at greater risk of breast cancer of more advanced stage at diagnosis, and with a biologically more aggressive phenotype, yet AAs have a lower overall breast cancer incidence [1–7]. Behavioral, biological, sociological, and clinical factors are proposed as contributing to the higher incidence of advanced disease in AA women and to poor survival outcomes [8–14]. However, lower socioeconomic status (SES) and associated financial barriers to care are also strongly associated with advanced stage and poor prognosis, thus complicating analyses of racial variations in breast cancer incidence and outcomes [15–18].

The aim of this study was to examine race-associated disparities in two of these factors—tumor biology and stage of presentation. To minimize the confounding effects of socioeconomic variations between AA and EA women, we restricted our analyses to women who participated in a financially equal-access state-wide breast cancer screening program. We were also interested in knowing whether disparities in this cohort were exaggerated or attenuated as compared to disparities in the general SC population which includes women of all income levels - i.e., are differences observed at state-level similar or reduced among low-income women with comparable financial access to breast cancer screening services.

With data from a government-funded breast cancer screening program for low-income women, the SC Best Chance Network, and from the SC Central Cancer Registry, we used two different but complementary epidemiologic approaches to evaluate race-associated disparities: comparisons of breast cancer case proportions, and comparisons of population-based age-adjusted incidence rates. Incidence rates provide a somewhat different picture than do case proportions, as they are based upon entire populations-at-risk rather than restricted to only those women who have been diagnosed with cancer.

METHODS

Study Cohort

The study cohort was derived from the SC Best Chance Network (BCN), an initiative focused on low-income medically-underserved women [19]. Towards reducing income disparities in cancer survival, the 1990 Breast and Cervical Cancer Mortality Prevention Act

created the National Breast and Cervical Cancer Early Detection Program (BCCEDP) within the Centers for Disease Control and Prevention (CDC). This program provides funds to state-level programs designed to meet the CDC's mission of providing the poor with access to services critical for early detection of breast and cervical cancer. SC launched its program in 1991 as the SC BCN, providing services free to low-income (less than 200% of the federal household poverty level), medically uninsured/underinsured women. The partnership includes about 250 private and public health care providers. The program maintains data on women utilizing these services, including breast screening and diagnostic workup. The program also ensures that for most women with newly diagnosed breast or cervical cancer, Medicaid eligibility is awarded to facilitate follow-on treatment for diagnosis and treatment. The program reaches about 10% of the potentially eligible low SES women in South Carolina, and effectively eliminates the race-associated disparities in delays between detection, diagnosis and treatment [20] that have been observed in other settings [21].

The study period covered January 1996, when the SC Central Cancer Registry (SCCCR) was initiated, through December 2006. Women of race other than AA or EA were excluded due to small numbers. Age was restricted to 47–64 years, the BCN-eligible age range common to all years of interest. Services utilization data were obtained from the BCN program.

The SCCCR provided clinicopathologic data on all breast cancers diagnosed in BCN participants who met study age, year and race criteria. The SCCCR includes all cancers in SC residents diagnosed at medical facilities in SC and 16 other states. It is certified by the North American Association of Central Cancer Registries and by the National Program of Cancer Registries (administered by the CDC). In the latest audit relevant to this analysis, the SCCCR had completeness (coverage) and accuracy rates of 96.9% and 96.4% respectively, exceeding the national standards of 95% [22]. Data provided included age and year at diagnosis, stage, histologic type, estrogen receptor (ER) expression status, progesterone receptor (PR) expression status, histologic grade, laterality, plus whether the case was reported by an American College of Surgeons certified facility. Staging categories followed the Surveillance, Epidemiology and End Results (SEER) General Summary Staging System [23]. Her2/neu data were not available. Cases were restricted to ICD-10 codes C50.0–C50.9, and ICDO-3 codes 8000–8983. To interpret our findings in the context of racial disparities in the general SC population, state-level data on all female breast cancers diagnosed in SC residents (same races, ages and years) were obtained with collaboration from the SCCCR.

To evaluate BCN breast services utilization, all screening-related visits within the same calendar year were considered one visit. A visit included a clinical breast exam and/or mammogram, or (rarely) diagnostic workup without screening examinations; the great majority included a mammogram.

Statistical Methods

Descriptive statistics for age and visits were mean, median, standard deviation and range. All other variables were categorical and summarized using frequencies and percents. Racial differences in distributions of clinicopathologic characteristics were evaluated using t-tests, Wilcoxon rank-sum tests, chi-square tests, and Fisher's exact tests as appropriate.

Among invasive cancers, to account for missing histologic grade or ER status a multiple imputation approach [24,25] was used. This produces unbiased estimates if data are missing at random (MAR) [26,27], an assumption implying that missingness is possibly associated with values of other observed variables, but not related to the values of the missing variables themselves. In contrast, complete case analysis (including only those cases with complete ER and grade data) assumes data are missing completely at random (MCAR); complete

cases are assumed to be fully representative (i.e. they form a random sample), a restrictive and often implausible assumption. Finally, multiple imputation yields greater efficiency since the number of cases available for analysis is increased. We constructed ten multiply-imputed datasets from a model containing all available data, and for each dataset estimated case numbers and incidence rates for various combinations of ER status and grade. Resulting estimates were averaged. Percentage imputed data did not differ by race. Given the rigorous imputation method, plus the high concordances between lower grade and positive ER status, and between negative ER status and high grade, any bias is minor and unlikely to alter the overall conclusions [4,26,27].

We estimated race-specific incidence rates for each stage and, among invasive cancers, biologic phenotype as defined by ER status and histologic grade. To calculate person-years-at-risk (denominator), we assumed that each woman who received BCN breast services remained eligible during the entire 1996–2006 period while her age remained within 47–64 years. Each BCN participant therefore contributed between <1.0 person-years-at-risk (e.g. if age 64 in 1996, or age 47 in 2006) and 11.0 person-years-at-risk (e.g. if age 54 or younger in 1996), independent of the number of BCN screenings received. Data on any losses/gain of BCN eligibility status during the study period (due to changes in income or health insurance coverage) were not available, so we also assumed that each participant remained eligible throughout, within the age criterion. Total person-years-at-risk was corrected for SC race-specific all-cause female mortality for these ages and time period [28,29]. Incidence rates were age-adjusted to the US 2000 Standard Population [30], presented as cases per 100,000 person-years-at-risk for ages 47–64, and compared using standard registry methods [31]. Race-associated differences within each population (BCN and state-level) were summarized as AA/EA ratios.

BCN and state-level rates were not compared directly, due to methodological differences in person-years-at-risk determination. Instead, within each population the total AA invasive cancer rate was compared to the total EA invasive cancer incidence rate, and the proportions contributed by each phenotypic subtype within and between populations graphically evaluated.

All analyses other than multiple imputation were conducted using Intercooled Stata Version 9.2 statistical software (StataCorp, http://www.stata.com). Multiple imputation was performed using the MICE package [32] in R, version 2.13.1 [33]. Subsequent analyses of multiply-imputed data sets were performed using SAS, version 9.2. All statistical tests were 2-tailed, and p-values less than 0.05 were deemed statistically significant.

This study was approved by the Medical University of South Carolina Institutional Review Board (IRB), the University of South Carolina IRB, the SC BCN and the SCCCR.

RESULTS

For simplicity, comparisons presented are statistically significant unless otherwise indicated, with p-values stated only for clarity (additional p-values are in Tables).

Screening Utilization in the BCN

Overall, 19,629 AA and 14,251 EA low-income women in South Carolina participated in the BCN breast cancer screening program, accounting for 82,338 visits (Table 1). Mean ages at first (54 years) and last (55 years) visit did not vary significantly between races. Mean number of BCN screening visits was 2.1 per AA and 1.9 per EA participant, with median of 1 visit in each racial group ($p<0.001$). Fewer than half of all women attended two or more visits within the study period: 49% of AAs and 43% of EAs.

Among the 48% of participants for whom screening history prior to first BCN visit was recorded, EA women reported a significantly poorer history: 17% less likely to have received screening within the previous 12–24 months (44% of EA women vs 53% of AAs), and 70% more likely to have been unscreened for over 5 years (19% vs 11% respectively). A similar pattern was observed among women diagnosed with breast cancer, although not statistically significant.

Breast Cancer Cases in the BCN

Seventy-nine percent of the 607 breast cancers diagnosed among the BCN cohort (321 AA cases, and 286 EA cases) were detected within the BCN program, the remaining diagnosed prior to first using BCN services or otherwise outside the program (Table 1). Almost half of all cancers were diagnosed at first BCN visit.

Stage at diagnosis—Stage did not differ significantly between race groups, with about 16% of cases diagnosed as carcinoma in situ, and about 41% of cases diagnosed at advanced stage (regional or distant; Table 2). Similarly, incidence rates of in situ cancer diagnosed within the BCN did not vary significantly by race (Table 3). AAs had a lesser incidence of invasive cancer compared to EA women: the AA/EA incidence rate ratio (RR) was 0.79 ($p<0.05$), and fairly consistent across localized, regional and distant stages.

Biologic phenotype—Within the BCN, biologic parameters differed significantly by race (Table 2, Figure 1A). Of 511 invasive cancers, those in AAs were more likely to have a less favorable biologic phenotype, with proportionately 52% more ER negative cancers, 32% more high-grade cancers, and 67% more cancers both ER negative and high-grade (ER−/G3: 38% in AAs vs 23% in EAs).

Age-adjusted incidence rates shed a different light on the racial disparity observed using case proportions (Table 3, Figure 1B,C). Within the BCN, the AA significantly *higher proportion* of invasive cancers with poor-prognosis phenotype was in the context of a significantly *lesser incidence rate* of better-prognosis breast cancer. That is, the16 *more* ER −/G3 cancers per 100,000 person-years among AAs compared to EAs (RR=1.32, not statistically significant) was overwhelmed by the 48 *fewer* ER+/lower-grade cancers (RR=0.54).

Comparisons with state-level breast cancer statistics

Among SC residents of all incomes (state-level data), advanced stage was 1.35-fold more frequent among AA women (39% of all AA cases vs 29% of all EA cases; $p<0.001$). In terms of incidence rates, *in situ* disease was less frequent in AAs (AA/EA RR=0.82; $p<0.001$; Table 3). Similarly, the invasive cancer RR was 0.92, composite of an AA lesser incidence of localized disease (RR=0.73) but greater incidence of advanced disease (RR=1.21; all p-values <0.001). That is, at state-level a profound race-associated disparity in stage was apparent, a pattern not seen in the low-income BCN cohort.

Also at the state-level, AA women had an incidence rate for ER+/lower grade cancer that was 0.56 that of EA women (Table 3; Figure 1C), a pattern very similar to the BCN. At the same time, at state-level, AA women had a greater incidence of poor prognosis ER−/G3 breast cancer compared to EAs (RR=1.73; p-values <0.001), greater than the difference in the BCN (RR=1.32, $p>0.05$). Using population-specific proportional incidence rates (Figure 1C), EAs within the BCN had a lesser proportion of ER+ cancer (and therefore a greater proportion of ER− disease) than did EAs at state-level. ER+ cancer was less frequent among AAs of either population, especially in the BCN, and ER− cancer was more frequent. But race-associated differences in ER− disease were attenuated within the BCN compared to

those at state-level. That is, the EAs within the BCN had proportionately more ER− cancer than at state-level, roughly intermediate between AAs at state-level and AAs in the BCN.

DISCUSSION

We evaluated racial variations in breast cancer among low-income women of South Carolina, ages 47 to 64 years, who participated in the financially equal-access BCN program during 1996–2006. Our work is the first to estimate race-associated variations in incidence rates as well as case proportions for breast cancer among low-income EA and AA women by both stage and biologic phenotype. Our study has two major findings.

First, among low-income women in the BCN program who were diagnosed with breast cancer, no significant racial differences in advanced stages of breast cancer at presentation were noted. This is in marked contrast to women of similar ages in the general SC population, among whom AAs were 1.35-fold more likely than EAs to present with advanced stage breast cancer. Our findings support the observations of others [34,35] that, among lower SES women with equal financial access to screening services, cancer stages at presentation are similar among EA and AA women. In interpreting this finding, several factors should be considered.

While this lack of racial difference would appear to be good news, a closer look suggests otherwise. The goal of screening is to decrease the likelihood of presenting with advanced disease, and to thereby improve survival. The American Cancer Society (ACS) recommends annual mammogram and clinical breast exam for all women age 40 years and over [2], although other groups such as the US Preventive Services Task Force have recommended routine screening every 1–2 years, and only for women ages 50–69 years [36]. Among women without health insurance, disproportionately large numbers are AA, providing an explanation for high rates of advanced stage cancers at presentation among AA women in general (in the absence of programs like the BCN) [18,37-42] and associated higher mortality. According to the ACS, 57% of poor US women ages 50–64 during 1998–2005 had been screened within the previous 2 years, with a similar rate in South Carolina [38]. However, only about 48% of BCN participants (53% of AAs and 44% of EAs for whom data were available) reported any breast cancer screening within 24 months prior to first BCN visit, within or outside the BCN program, and fewer than half of all participants returned for even one repeat BCN screening during the study period. Moreover, among women diagnosed with breast cancer within the BCN program, any screening within the previous 2 years was reported by only 44% (47% of AAs, 41% of EAs).

Surprisingly, then, the lack of racial disparity in stage at diagnosis observed within the BCN can best be interpreted as resulting from low rates of prior screening among participating EA women (compared to the expected rate based on ACS data), rather than from much improved screening rates among AA women. Lobb et al. [34], analyzing 1999–2005 data from the Massachusetts Breast and Cervical Cancer Early Detection Program (a BCN parallel) concluded that the Massachusetts program appeared to mitigate the disadvantages of living in high-poverty neighborhoods on stage at diagnosis. This was apparently not achieved in the SC BCN cohort, where proportions of advanced stage cancers *in AA women and in EA women* were similar to the high proportions (about 40%) of advanced stage breast cancers at presentation reported for AA women in the SC general population, most of whom are of low SES.

The apparently low screening participation rates among the BCN cohort suggests that even after financial barriers to mammography screening are removed, other significant barriers to accessing screening services remain. Women of low SES may not receive adequate

education on the importance of regular screening. Barriers such as travel, childcare and time off work may all dissuade women from seeking screening, issues particularly salient among the poor residing in disadvantaged minority communities, and in a predominantly rural state such as South Carolina. Further, spatial access to health care facilities has been increasingly recognized as influencing health services participation, and poor spatial access has been linked to higher rates of late-stage diagnosis of breast cancer [43–44]. This underlies the foundation of the National Patient Navigator Program, an NCI-sponsored initiative in nine large cities in the US (although no small cities or rural areas are included, and hence any results cannot be extrapolated to SC).

Second, with respect to breast cancer biologic phenotype, the larger difference between race groups in the BCN was in incidence rates of better-prognosis, not poor-prognosis cancer: the greater likelihood of a poor-prognosis phenotype among AA women was largely due to the comparatively fewer better-prognosis ER positive cancers (Figure 1). Moreover, the considerably greater AA incidence of all ER negative cancer and especially the poor-prognosis ER−/G3 phenotype observed at state level (RR=1.73, $p<0.01$) appears attenuated within the low-income BCN cohort (RR=1.32, $p>0.05$), largely due to higher relative incidence of ER−/G3 cancer among EAs in the BCN than at state-level. This should, perhaps, not be surprising because trends in racial differences in breast cancer ER status are subject to contextual socioeconomic influences [45]. Various risk factors have been proposed for high rates of ER negative breast cancers, including early menarche and age at first pregnancy, multiparity, minimal/absent breast feeding, increased waist-to-hip ratio, social deprivation and a poor quality diet low in fruits, vegetables, phytoestrogens, isoflavones, lignans, fiber, folate and calcium [46]. The prevalence of these factors putatively predisposing to ER negative cancer [47–50] is greater among lower SES women, perhaps more similarly in each race group, thus providing a possible explanation for a smaller racial gap in ER-negative cancers in the economically more homogeneous BCN population than in the state as a whole.

Some limitations of our study should be noted. We did not have data on type of community (rural versus urban) or other factors which may affect screening behavior [51,52] or cancer risk. Adams et al., studying a similar BCN population, found AA women with positive breast cancer screening tests were 12% less likely than EAs to complete their workup after a suspicious finding [53]. This might tend to reduce the incidence rate among AAs within the BCN cohort, to the extent that any breast cancer diagnosis was deferred until after age 64. We also assumed continuous eligibility for each BCN participant, without accounting for any possible interruption due to increased income or improved health insurance status. Data are not available from the BCN, but interruptions in eligibility may have been more frequent among EA participants who tend to have a somewhat higher self-reported annual household income than do AA participants [20]. This may have contributed to the lower repeat screening rate observed in EA participants in the BCN, compared to AAs (but not the lower *prior* screening rate). The (primarily EA) women with interrupted BCN eligibility may also have been at lower risk of ER negative breast cancer and/or at higher risk of ER positive disease by virtue of their somewhat higher SES. This would suggest that the true AA and EA incidence rates for the various biologic phenotypes may be more similar than we have estimated.

While strategies effectively promoting regular breast cancer screening among all low-income women must be developed and implemented, these alone will not be sufficient to close the racial and income gaps in incidence of poor-prognosis cancers and associated survival rates in SC. As reported in another study of a similar BCN population, even with equal financial access to breast services and subsequent treatment of diagnosed cancers, AA women with poor-prognosis breast cancer are at increased risk of mortality compared to EA

women and this cannot be attributed to any post-detection delays in care [20]. Therefore, closing these gaps will also require addressing causes of racial and socio-economic differences in tumor biology, and improved detection and care for poor-prognosis disease generally, as AA women in SC are disproportionately affected by these cancers and by low income.

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ABBREVIATIONS

AA	African-American
BCCEDP	Breast and Cervical Early Detection Program
BCN	Best Chance Network
CDC	Centers for Disease Control and Prevention
EA	European-American
ER	estrogen receptor
ER−	ER negative
ER+	ER positive
G	grade
IRB	Institutional Review Board
MAR	missing at random
MCAR	missing completely at random
PR	progesterone receptor
RR	incidence rate ratio (AA/EA)
SC	South Carolina
SCCCR	SC Central Cancer Registry
SEER	Surveillance, Epidemiology and End Results
SES	Socio-economic status
US	United States

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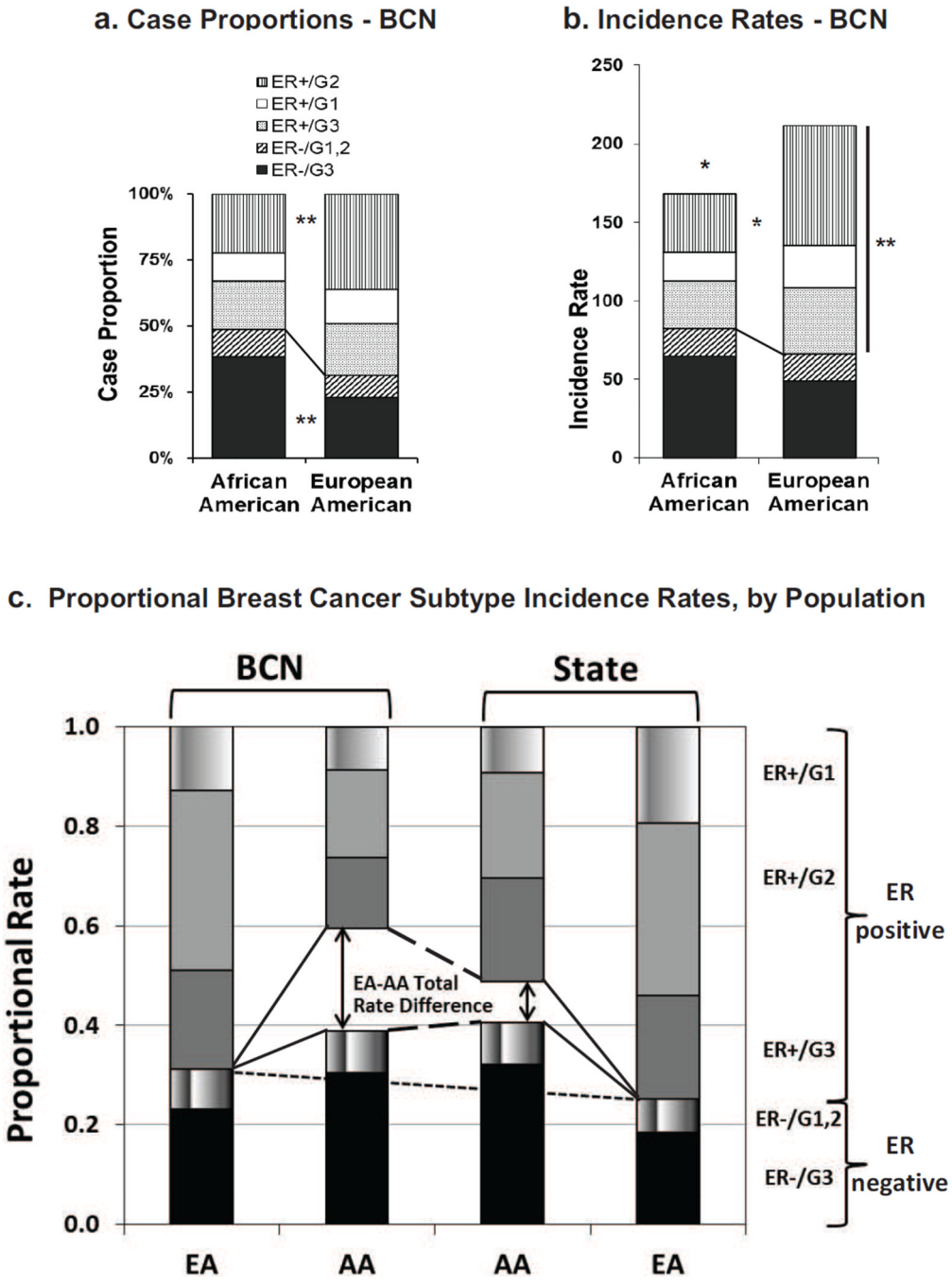

Fig. 1. Race-associated differences in invasive breast cancer biologic phenotypes

a,b: Within the BCN, case proportions (a) and age-adjusted incidence rates (b) demonstrate different perspectives on racial disparities. Rates are cases per 100,000 person-years-at-risk over ages 47–64. Asterisks indicate statistical significance of race-group comparisons for specific breast cancer phenotypic subtypes: * = $p<0.05$; ** = $p<0.01$.

c: Proportional subtype incidence rates are race-specific, proportional to the total European-American invasive breast cancer incidence rate within each population (BCN or state-level). Gaps in the bars for African-Americans, between ER positive and ER negative subtypes, represent race-associated differences in total incidence within each population. Lines indicate differences in ER positive and ER negative proportions: *solid lines* for race-

associated differences within each population, *long-dashed lines* for differences between African-Americans in the two populations, and *short-dashed dashed* lines for differences between European-Americans in the two populations.
AA = African-American; EA = European-American; ER = estrogen receptor; G = histologic grade;

Table 1

Demographic characteristics and breast program utilization by Best Chance Network participants 1996–2006, ages 47–64 years

	African American		European American		p-value[1]
A. Participants:	**N = 19,629 women (49,270 visits)**		**N = 14,251 women (33,068 visits)**		
Age at first BCN visit (years)					
Mean ± SD	54.2 +/− 5.1		54.6 +/− 5.1		**<0.001**
Median (range)	53.3 (47.0 – 64.9)		53.9 (47.0 – 64.9)		
Age at last BCN visit (years)					
Mean ± SD	55.9 +/− 5.4		55.9 +/− 5.3		0.835
Median (range)	55.4 (47.0–64.9)		55.5 (47.0 – 64.9)		
BCN visits per participant					
Mean ± SD	2.1 +/− 1.6		1.9 +/− 1.4		
Median (range)	1 (1 – 11)		1 (1 –11)		**<0.001**
	N	**%**	**N**	**%**	
1 visit only	10,095	51.4	8,128	57.0	**<0.001**
2 visits	4,264	21.7	3,112	21.8	
3 visits	2,208	11.2	1,391	9.8	
4 visits	1,275	6.5	706	5.0	
5(+) visits	1,787	9.1	914	6.4	
Screening prior to first BCN visit					
≤ 12 months	2,318	20.5	1,420	17.2	**<0.001**
13 to 24 months	3,683	32.6	2,204	26.8	
25 to 36 months	2,292	20.3	1,532	18.6	
37 to 60 months	1,725	15.2	1,482	18.0	
61 to 120 months	1,294	11.4	1,602	19.4	
Not recorded	8,317	42.4	6,011	42.2	
B. Breast Cancers Diagnosed	**N=321**		**N=286**		
Screening prior to diagnosis					
≤ 12 months	19	9.2	15	8.9	0.601
13 to 24 months	78	37.7	54	32.0	
25 to 36 months	36	17.4	26	15.4	

	African American		European American		p-value[1]
37 to 60 months	33	15.9	31	18.3	
61 to 120 months	41	19.8	43	25.4	
Not recorded	114	35.5	117	40.9	
Detection relative to BCN visit:					
At first BCN visit	146	45.5	147	51.4	0.242
At a subsequent BCN visit	109	34.0	80	28.0	
Outside the BCN program	66	20.6	59	20.6	

[1] p-values exclude participants or cases with unrecorded data for the relevant field.

Table 2

Characteristics of breast cancers diagnosed in Best Chance Network participants 1996–2006, ages 47–64 years

	African American (AA)		European American (EA)		p-value[1]	AA/EA Ratio
	N	%[2]	N	%[2]		
All Cases:	**N = 321**		**N = 286**			
Stage: *In situ*	57	17.8	39	13.6	0.165	1.30
Invasive	264	82.2	247	86.4		0.95
Early (*In situ* + Localized)	184	59.0	161	58.1	0.834	1.01
Advanced (Regional + Distant)	128	41.0	116	41.9		0.98
***In Situ* Cases**	**N = 57**		**N = 39**			
Age at Diagnosis: Mean ± SD	56.0 +/− 4.3 years		56.9 +/− 4.3 years		0.301	--
Median (range)	55 (48–64)		58 (49–63)			
Invasive Cases	**N = 264**		**N = 247**			
Age at diagnosis: Mean ± SD	54.8 +/− 5.0 years		55.3 +/− 4.9 years		0.277	--
Median (range)	54 (47–64)		55 (47–64)			
Stage: Localized	127	48.1%	122	49.4%	0.988	0.97
Regional	114	43.2	103	41.7		1.04
Distant	14	5.3	13	5.3		1.01
Unstaged	9	3.4	9	3.6		0.94
Estrogen Receptor (ER)						
Positive	77	51.7	97	68.3	**0.004**	0.76
Negative	72	48.3	45	31.7		1.52
Unknown/Unavailable	115	43.6	105	42.5		
Histologic Grade						
G1: Well-differentiated	29	12.3	30	13.8	**0.009**	0.90
G2: Moderately	72	30.6	94	43.1		0.71
G3: Poorly	134	57.0	94	43.1		1.32
Unknown/Unavailable	29	11.0	29	11.7		
ER/Grade Subtype (using imputed data)						
ER+/any grade	135.1	51.2	170.0	68.8	**0.002**	0.74
ER−/any grade	128.9	48.8	77.0	31.2		1.57

	African American (AA)		European American (EA)		p-value[1]	AA/EA Ratio
	N	%[2]	N	%[2]		
ER+/Grade 1	28.3	10.7	32.1	13.0	**0.007**	0.82
ER+/Grade 2	58.8	22.3	89.4	36.2		0.62
ER+/Grade 3	48.0	18.2	48.5	19.6		0.93
ER−/Grade 1 or 2	27.9	10.6	20.4	8.3		1.28
ER−/Grade 3	101.0	38.3	56.6	22.9		1.67
ER+/Grade 1 or 2 (vs other)	87.1	33.0	121.5	49.2	**<0.001**	0.67
ER−/Grade 3 (vs other)	101.0	38.3	56.6	22.9	**0.003**	1.67

[1] p-values are for the distributions of cases among categories. Cases with unknown values are excluded, except for stage.

[2] Percentages among categories of known values in each column add to 100%.

Table 3

Invasive breast cancer age-adjusted incidence rates among Best Chance Network (BCN) participants and South Carolina state-level rates, for women ages 47–64 years during 1996–2006. Rates have been standardized to the European-American total rate in the BCN and in the state-level data.

	Best Chance Network			State-Level
	African American (AA) Rate (95% CI)	European American (EA) Rate (95% CI)	AA/EA Rate Ratio (95% CI)	AA/EA Rate Ratio (95% CI)
Stage (no imputation)				
In situ	34.7 (25.7, 43.8)	32.2 (22.0, 42.3)	1.08 (0.72, 1.62)	0.82 (0.75, 0.89) **
Localized	81.4 (67.1, 95.7)	104.2 (85.4, 122.9)	0.78 (0.60, 1.01)	0.73 (0.70. 0.77) **
Regional	72.1 (58.7, 85.4)	88.1 (70.8, 105.3)	0.82 (0.62, 1.08)	1.14 (1.07, 1.22) **
Distant	8.9 (4.2, 13.6)	11.4 (5.1, 17.8)	0.78 (0.36, 1.69)	1.79 (1.48, 2.16) **
Stage Unknown	5.5 (1.9, 9.2)	7.8 (2.6, 12.9)	0.72 (0.28, 1.86)	1.19 (0.96, 1.46)
Early (*In situ* + Localized)	116.1 (99.2, 133.0)	136.3 (115.0, 157.6)	0.85 (0.69, 1.06)	0.76 (0.72, 0.79) **
Advanced (Regional + Distant)	80.9 (66.8, 95.1)	99.5 (81.2, 117.9)	0.81 (0.63, 1.05)	1.21 (1.14, 1.29) **
All Invasive Cases	167.9 (147.5, 188.3)	211.4 (184.7, 238.1)	0.79 (0.66, 0.95) *	0.92 (0.88, 0.96) **
ER/Grade in Invasive Cancers only (imputed data)				
ER+/any grade	85.6 (69.4, 101.8)	145.4 (121.8, 169.1)	0.59 (0.46, 0.76) **	0.69 (0.65, 0.72) **
ER−/any grade	82.3 (66.2, 98.3)	66.0 (48.8, 83.2)	1.25 (0.91, 1.71)	1.61 (1.50, 1.73) **
ER+/Grade 1	18.5 (10.5, 26.6)	27.1 (14.9, 39.2)	0.69 (0.37, 1.28)	0.48 (0.44, 0.53) **
ER+/Grade 2	36.9 (26.3, 47.5)	76.4 (59.4, 93.4)	0.48 (0.33, 0.70) **	0.61 (0.57, 0.65) **
ER+/Grade 3	30.2 (20.6, 39.8)	42.0 (28.8, 55.3)	0.72 (0.46, 1.13)	1.00 (0.92, 1.10)
ER−/Grade 1 or 2	17.8 (9.4, 26.1)	17.2 (7.1, 27.2)	1.04 (0.50, 2.13)	1.27 (1.10, 1.48) *
ER−/Grade 3	64.5 (50.9, 78.1)	48.8 (34.4, 63.3)	1.32 (0.93, 1.87)	1.73 (1.59, 1.89) **
ER+/Grade 1 or 2	55.4 (42.7, 68.1)	103.4 (83.3, 123.5)	0.54 (0.39, 0.73) **	0.56 (0.53, 0.60) **

CI = Confidence interval;

* =p < 0.05;

** =p < 0.01