JAMA Surgery | Review

Health Disparities and Triple-Negative Breast Cancer in African American Women
A Review

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IMPORTANCE Variation in cancer incidence and outcome has well-documented correlations with racial/ethnic identity. In the United States, the possible genetic and ancestral hereditary explanations for these associations are confounded by socioeconomic, cultural, and lifestyle patterns. Differences in the breast cancer burden of African American compared with European/white American women represent one of the most notable examples of disparities in oncology related to racial/ethnic identity. Elucidating the source of these associations is imperative in achieving the promise of the national Precision Medicine Initiative.

OBSERVATIONS Population-based breast cancer mortality rates have been higher for African American compared with white American women since the early 1980s, largely reflecting declines in mortality that have been disproportionately experienced among white American patients and at least partly explained by the advent of endocrine therapy that is less effective in African American women because of the higher prevalence of estrogen receptor–negative disease. The increased risk of triple-negative breast cancer in African American women as well as western, sub-Saharan African women compared with white American, European, and east African women furthermore suggests that selected genetic components of geographically defined African ancestry are associated with hereditary susceptibility for specific patterns of mammary carcinogenesis. Disentangling health care access barriers, as well as reproductive, lifestyle, and dietary factors from genetic contributions to breast cancer disparities remains challenging. Epigenetics and experiences of societal inequality (allostatic load) increase the complexity of studying breast cancer risk related to racial/ethnic identity.

CONCLUSIONS AND RELEVANCE Oncologic anthropology represents a transdisciplinary field of research that can combine the expertise of population geneticists, multispecialty oncologists, molecular epidemiologists, and behavioral scientists to eliminate breast cancer disparities related to racial/ethnic identity and advance knowledge related to the pathogenesis of triple-negative breast cancer.

JAMA Surg. 2017;152(5):485-493. doi:10.1001/jamasurg.2017.0005
Published online March 29, 2017.

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What Is Oncologic Anthropology?

The robust racial and ethnic diversity of the American population has been a source of tremendous strength as well sensitivity and tension dating back to colonial-era history. The oncology community faces unique challenges in addressing this diversity, since the cancer burden is well known to vary by racial/ethnic identity, and elucidating the cause of these associations will clearly be imperative in the national Precision Medicine Initiative. The concept of race implies identification based on ancestry and is therefore closely associated with population genetics. However, societal groupings and economic patterns that are highly correlated with race have led to the suggestion that racial identity in the United States is a sociopolitical construct.[1-3] Ethnic identity implies characterization based on culture. Although race and ethnicity are not interchangeable, they often feature common hereditary, dietary, environmental, lifestyle, and socioeconomic conditions—all of which can influence the epidemiologic associations with cancer. The complex interplay of these factors is arguably most notable in breast cancer (BC), where differences in disease incidence and outcome are particularly striking between communities of individuals who self-identify as African American and Americans with predominantly European/white descent, often referred to as white Americans. Similarities in BC phenotypes among African American and western sub-Saharan African women contrasted against differences with east African women furthermore suggest that ancestral population migration patterns contribute to BC epidemiology.[4,5] This review summarizes the socioeconomic and cultural context in which disparities arise; it also explores the expanding volume of studies correlating both germline and somatic BC-related genetics with geographically defined African ancestry. We introduce the

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Table 1. Breast Cancer in African American and White American Women[8,9]

Characteristic	African American	White American
Population-Based Incidence Rates, per 100 000		
Overall, age standardized	122.9	124.4
Age stratified, y		
35-39	70.6	59.9
40-44	118.2	122.2
45-49	180.4	188.1
50-54	231.6	220.3
55-59	270.7	260.4
60-64	332.0	332.4
65-69	399.5	428.7
Population-Based Mortality Rates, per 100 000		
Overall, age standardized, y	28.2	20.3
Age stratified		
35-39	10.2	5.8
40-44	22.1	11.5
45-49	30.7	18.3
50-54	47.3	27.3
55-59	57.4	36.6
60-64	71.3	49.2
65-69	80.4	62.2
Stage Distribution at Diagnosis, %		
Localized	53	64
Regional	35	28
Distant	8	5
Unknown	4	3
5-Year Cause-Specific Survival, %		
All stages	80	89
Localized	93	96
Regional	78	87
Distant	24	34
Population-Based Incidence Rates, TNBC	27.2	14.4

Abbreviation: TNBC, triple-negative breast cancer.

nomenclature *oncologic anthropology* to describe this transdisciplinary field of research.

Breast Cancer Incidence and Mortality Rates in African American and White American Women: Implications for Mammography Screening

The 2015 American Cancer Society review of trends in population-based BC incidence and mortality among African American compared with white American women featured data from the Surveillance, Epidemiology, and End Results (SEER) Program as well as the North American Association of Central Cancer Registries.[6] Historically, incidence rates were parallel for African American and white American women, but with lower lifetime rates for African American women. However, during the most recent 5-year interval of data collection (2008 through 2012), the incidence of BC rose steadily for African American women (by 0.4% per year) while remaining stable for white American women, and the incidence rates then converged, with 2013 rates of 122 per 100 000 for African American women and 124 per 100 000 for white American women.[6-8] The median age at BC diagnosis for African American women is 58 years compared with 62 years for white American women,[6] and population-based BC incidence rates for women younger than 40 to 44 years are higher among African American women[7] (**Table 1**).

In contrast to these incidence trends, population-based BC mortality rates were comparable for African American and white American women until the early 1980s, at which time a mortality gap developed. This outcome disparity has increased over the past 30 years, and current BC mortality is 42% higher for African American compared with white American women.[6] As presented in Table 1, the mortality disparity is present for all ages and stages at diagnosis.[7] Advances in BC risk stratification by biomarker expression provide biologically plausible explanations for the observed mortality trends. The African American patients have an approximately 2-fold higher frequency as well as population-based incidence rate of estrogen receptor (ER)–negative BC that has been documented during the past 2 decades and persists after adjustments for age and stage at diagnosis.[10] Tamoxifen citrate was approved by the US Food and Drug Administration as adjuvant BC systemic therapy in 1977; it is likely that the resulting population-based reductions in BC mortality did not become apparent until the early 1980s. Since African American patients with BC benefit less from adjuvant endocrine therapy, the mortality gap appearing in this time frame may reflect race-related differences in ER-positive disease.[11]

The terminology *triple-negative breast cancer* (TNBC) identifies invasive tumors that are negative for ER as well as the progesterone receptor (PR) and *ERBB2*. Approximately 80% of TNBC cases have the gene expression profile of the biologically aggressive basal BC intrinsic subtype, and patients with TNBC by definition are not candidates for endocrine therapy or treatment with targeted anti-*ERBB2* agents. Triple-negative BC is therefore an adverse prognostic feature and indicates the likelihood of more limited systemic therapeutic options. Triple-negative BC is also a marker of hereditary susceptibility for BC, regardless of family history; it occurs in a disproportionately high rate among younger women; it is more likely to metastasize to the brain compared with non-TNBC; and, although TNBC responds briskly to neoadjuvant chemotherapy, patients who do not achieve a complete response have a disproportionately high relapse and mortality rate (the "TNBC paradox").[12]

The unique epidemiology and biology of TNBC have resulted in substantial research attention, despite the fact that, overall, only 15% of BCs in the United States have the triple-negative phenotype. In contrast, a landmark report by Carey et al[13] from the Carolina Breast Cancer Study found that 39% of tumors diagnosed in premenopausal African American patients were TNBC, prompting questions regarding the role of TNBC in BC disparities. Two-fold higher population-based incidence rates of TNBC in African American compared with white American women in all age categories have since been confirmed by others,[9,14] including the 2015 *Annual Report to the Nation on the Status of Cancer*,[9] documenting TNBC incidence rates of 27.2 per 100 000 and 14.4 per 100 000 women, respectively. Akinyemiju et al[15] demonstrated from a SEER-based analysis that, as expected, African American patients with TNBC have a worse outcome compared with African American patients with non-TNBC. It is therefore likely that rising BC incidence rates in African American women coupled with the increased risk for TNBC

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contribute to the progressively widening BC mortality gap between African American and white American women.[6]

The younger age distribution for BC in African American compared with white American women, as well as the increased risk of TNBC, which is observed in younger as well as older patients, is particularly relevant in the context of mammography screening guidelines. Current screening mammography utilization rates are similar, approximately 81% for African American and approximately 76% for white American women.[6] The US Preventive Services Task Force recommends that average-risk American women initiate screening mammography at age 50 years. Initiation of screening mammography at 40 years had been the US Preventive Services Task Force recommendation until 2009, and the National Comprehensive Cancer Network continues to recommend initiation at 40 years. The American Cancer Society recommends the availability of screening mammography at 40 years, but suggests that initiation is imperative by 45 years. Screening mammography proponents and disparities researchers express concern that delayed initiation of mammographic screening could have a disproportionately adverse effect on the BC burden of African American women, thereby worsening the mortality disparity.[16]

Influence of Socioeconomic Disparities and Race as a Sociopolitical Construct on Breast Cancer Outcome

Breast cancer outcome disparities between African American women and white American women can be attributed to socioeconomic disadvantages that are more prevalent in the African American community. Recent data from the US Census Bureau reveal that poverty rates are more than twice as high in African American compared with white American communities (25.8% vs 11.6%).[17] Furthermore, although overall uninsured rates have declined from 16.0% in 2010 to 11.5% in 2014, disparities in this socioeconomic status metric persist, with 11.9% of the African American population being uninsured compared with 8.2% of the white American population.[18] Differences in BC stage distributions support the theory that mortality disparities are mediated at least in part by diagnostic and treatment delays associated with health care access barriers. African American patients with BC are diagnosed with regional disease in approximately one-third of the cases compared with one-quarter of white American patients, and localized disease is detected in approximately one-half vs two-thirds, respectively.[7] Ward et al[19] conducted an analysis of 5-year survival from any cancer diagnosis and found that the poorest communities within each racial/ethnic population subset had worse outcomes, confirming that poverty is an adverse prognostic factor regardless of racial/ethnic identity. Correlations between minority racial identity and socioeconomic status have prompted many public health experts to suggest that race is a sociopolitical construct rather than a true biological or genetic characteristic.[1-3]

Socioeconomic disadvantages are also reflected by differences in the patterns of cancer care delivered. Inequities have been reported in the frequency of African American patients utilizing each component of comprehensive, multidisciplinary BC care.[20] Studies have demonstrated disproportionately low use of guideline-concordant locoregional treatment, adjuvant radiotherapy, lymphatic mapping with sentinel lymph node biopsy, adjuvant systemic therapy, breast reconstruction, and clinical trial participation among African American patients. Tammemagi et al[21] found that comorbidities (eg, diabetes and hypertension) were important factors in survival differences between African American and white American patients. Hershman et al[22] furthermore demonstrated that ethnicity-associated neutropenia (the lower average but clinically irrelevant baseline white blood cell counts seen in African American patients) was significantly associated with inadequate delivery of adjuvant BC chemotherapy in African American patients. Treatment disparities can result from African American patients being more likely to receive care in underresourced public and safety-net hospitals. Flawed communication between patients and health care professionals and biases leading to discriminatory practices in the health care system may also contribute to disparate outcomes.

In contrast to data suggesting that African American identity is a sociopolitical construct acting as a feature that confounds the true causal association between financial hardship and BC outcome disadvantages, other lines of evidence indicate that African American identity is independently associated with outcome. A 2006 meta-analysis of socioeconomic status–adjusted BC survival among more than 14 000 African American patients compared with more than 76 000 white American patients revealed that African American identity was associated with a statistically significant nearly 30% higher mortality hazard.[23] The standardized care delivered through clinical trial participation theoretically represents an effective strategy for disentangling race/ethnic identity from socioeconomic status in oncology outcomes. Nonetheless, a pooled analysis of Southwest Oncology Group adjuvant therapy trials[24] found that equal treatments delivered in the context of these clinical trials resulted in equal outcomes, except for hormonally driven diseases, such as breast and prostate cancer, where African American patients had persistent survival disadvantages.

Several features characterizing differences in the BC burden of African American compared with white American population subsets are unlikely to be explained by socioeconomic status, such as the younger age distribution, higher rates of high-grade pathologic findings, and the higher frequency of male BC in the African American population.[5,6] As noted previously, the incidence of TNBC is also higher in African American women.[9,14] Although it has been suggested that poverty might be a risk factor for ER-negative tumors and TNBC,[2,25] a 2015 population-based study from the SEER program demonstrated that socioeconomic status was not associated with hormone receptor–negative tumors or TNBC.[26]

Established BC risk factors may have a differential effect on phenotype. For example, multiparity tends to reduce the lifetime risk of ER-positive disease, but may increase the likelihood of TNBC.[12] However, international patterns of TNBC fail to consistently demonstrate comparable frequencies of TNBC among populations likely to have similar childbearing patterns.[5] Lactation appears to protect against TNBC as well as non-TNBC, and utilization varies between population subsets; obesity has an additionally complex interplay with BC disparities.[2,27] African American women appear to have a disproportionately increased likelihood of ER-negative disease and TNBC among cohorts facing increased BC risk related to hormone replacement therapy and prior benign fibrocystic and/or hyperproliferative breast biopsies.[28,29] Further research is warranted regarding correlations between reproductive factors and TNBC in women with African ancestry.

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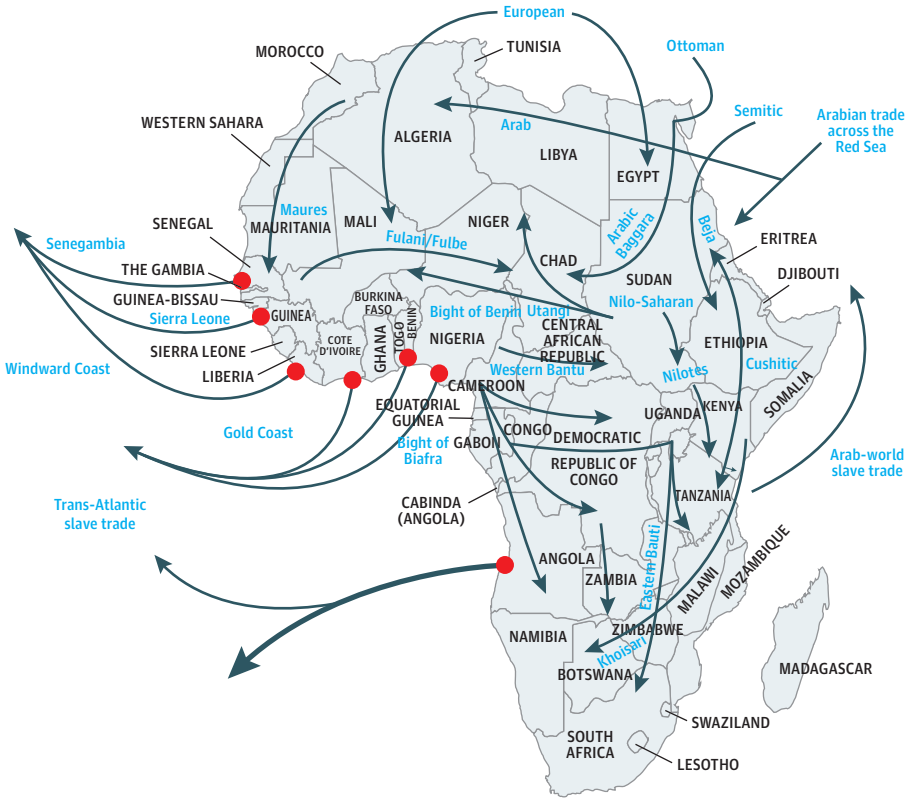
Figure 1. The African Diaspora—Population Migration Patterns



Names in blue refer to alternative nomenclature describing regions, language groups, and populations associated with the migration patterns denoted by the arrows. Adapted from Campbell et al.[45]

Associations between racial/ethnic identity, socioeconomic status, and BC burden are clearly complex. Compounding these interactions is a growing body of literature demonstrating that lifetime stresses related to both racial/ethnic identity and poverty may influence tumor biology. Williams et al[3] recently conducted a comprehensive review of these issues, including a provocative discussion of allostatic load, which refers to the biological dysregulation that affects multiple organ systems as a consequence of cumulative lifetime stresses. Poverty and exposure to racial, residential, and/or occupational discrimination contribute to these stresses, prompting speculation that allostatic load may be related to the epidemiology of BC.

Breast cancer disparities may also be mediated by the influence of epigenetics, where an individual's genes are manipulated by environmental factors without affecting the actual DNA sequence. For example, methylation and histone modification of germline DNA can alter gene expression and subsequent BC risk. Studies have revealed that epigenetic patterns vary by racial/ethnic identity, racial admixture, socioeconomic status, and stress pathways.[3,30]

African Ancestry, Population Genetics, and TNBC

The human genome is a vast collection of genetic material: more than 3 billion bases of DNA and 25 000 to 30 000 protein-coding genes. Although any 2 randomly selected individuals are expected to share 99.9% identical DNA, the remaining 0.1% clearly accounts for tremendous heterogeneity across several domains of the human experience, including disease risk.[31] Hereditary susceptibility for BC through generational passage of mutations in genes, such as *BRCA1* and *BRCA2*, is well documented, and selected (founder) mutations cluster within specific communities of shared ancestral heritage. Founder mutations of *BRCA* associated with Ashkenazi Jewish background are prominent examples, but many others exist.[32] Furthermore, the TNBC phenotype itself is associated with an increased risk for harboring a *BRCA1* mutation, independent of family history. Founder mutations of *BRCA* have been identified among African American and Bahamian Caribbean individuals,[33,34] and a study from Nigeria[35] reported an elevated frequency of *BRCA1* and *BRCA2* mutations (7.1% and 3.9%, respectively) among a population of Nigerian patients with BC, unselected by age, family history, or BC phenotype. A study from South Africa confirmed an association between TNBC and *BRCA* mutation carrier status in black as well as white South Africans.[36] However, the full extent to which as yet uncharacterized founder mutations in the *BRCA* genes or in other genes associated with BC pathways might contribute to the increased risk of TNBC in the African American population remains unclear.

Americans in the contemporary United States represent genetic admixtures from several ancestral populations, including Native Americans predating the colonial era, European settlers, and Africans who arrived largely through forced migration from the trans-Atlantic slave trade. African American identity through

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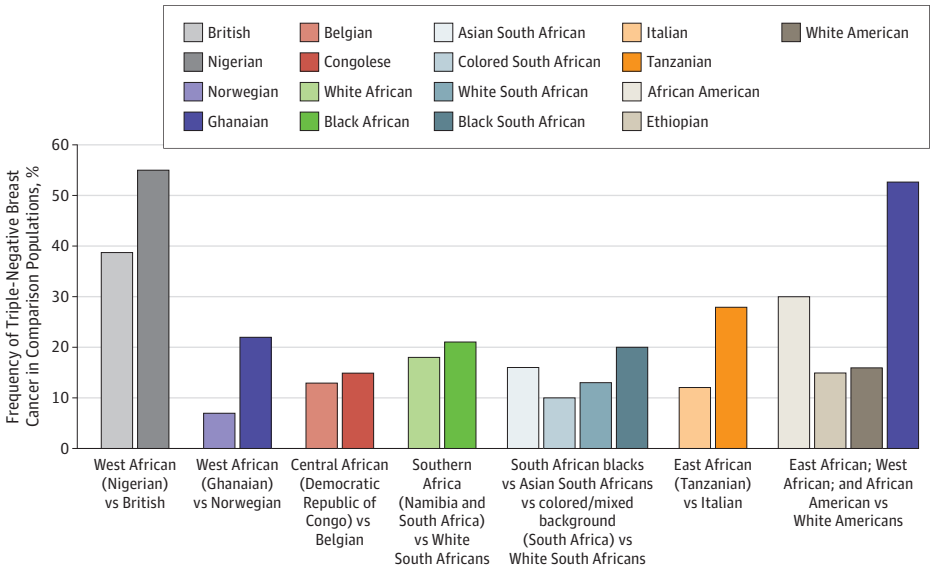
Figure 2. Triple-Negative Breast Cancer in Diverse Populations

A Studies comparing breast cancer phenotype frequencies in internationally diverse patients, including African comparison populations

Source	African Ancestry Comparison Population/Region	Non-African Ancestry Comparison Population
Agboola,[47] 2014	West African (Nigerian)	United Kingdom British
Adjei et al,[48] 2014	West African (Ghanaian)	Norwegian
Luyeye Mvila,[49] 2015	Central African (Democratic Republic of Congo)	Belgian
Dickens et al,[50] 2014	Southern African (Namibia and South Africa)	White South Africans
McCormack et al,[51] 2013	Southern African blacks and colored/mixed background (South Africa)	White South Africans
Amadori et al,[52] 2014	East African (Tanzanian)	Italian
Jiagge et al,[4] 2016	East African; West African; and African American	White American

B Frequency of triple-negative breast cancer in African vs non-African patient populations



Frequency of triple-negative breast cancer.

self-report therefore represents a combination of true African ancestral heritage and an individual's societal and community ties. Geographically defined ancestry can be quantified through ancestry informative marker genotyping data. The quantified extent of African ancestry varies substantially among individuals who self-report as being African American. Studies of African American communities throughout the United States estimate that contributions from European ancestry range from 3.5% in the relatively isolated Gullah-speaking South Carolina Sea Islanders to 35% in Seattle, Washington.[31]

The African American community is a minority, accounting for approximately 12% of the US population. Studies of BC genetics related to African ancestry therefore face an immediate disadvantage in terms of sample sizes—a challenge that is magnified by genetic admixture. Single-institution studies and even multicenter partnerships are often underpowered to determine biologically significant genetic features. Nonetheless, a report from the Black Women's Health Study successfully correlated a quantified extent of global African ancestry with a TNBC-associated single-nucleotide polymorphism.[37]

The African American Breast Cancer Epidemiology and Risk (AMBER) Consortium was established as a strategy to overcome the sample size obstacle described above.[38] The AMBER Consortium is a collaboration of the 4 largest programs of BC research involving African American women: the Carolina Breast Cancer Study, the Women's Circle of Health Study, the Black Women's Health Study, and the Multiethnic Cohort Study. This powerful data set includes epidemiologic data and tissue specimens representing several thousand African American patients with BC and controls. AMBER has published extensively on BC risk factors, demonstrating that obesity, reproductive history, and vitamin D metabolism may have significant interactions related to BC risk in African American women. The AMBER Consortium completed an exome-wide analysis of rare variants in 3629 BC cases in African American individuals (approximately one-third ER-negative) compared with 4658 controls and identified a novel gene (*FBXL22*) as well as a gene previously identified in genome-wide association studies of European ancestry populations (*PDE4D*) as being associated with ER-negative tumors and TNBC.[39]

The AMBER Consortium investigators collaborated with the Genome-Wide Association Study of Breast Cancer in the African Diaspora—the ROOT Study and the African American Breast Cancer Consortium, with the identification of 3q26.21 as a novel susceptibility locus for ER-negative BC among African American

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Table 2. Reported Frequencies of ERN or TNBC in Africa

Region, Source	Country	Phenotype Reported	Frequency, %
EastAfrica			
Trinkaus et al,[53] 2011	Kenya	Basal-like (TNBC and CK 5/6 and/or EGFR)	23
Bird et al,[54] 2008	Kenya	TNBC	44
Nyagol et al,[55] 2006	Kenya	TNBC	28
Nalwoga et al,[56] 2007	Uganda	Basal-like (TNBC and CK 5/6)	34
Roy and Othieno,[57] 2011	Uganda	TNBC	36
Mbonde et al,[58] 2000	Tanzania	ERN	67
Burson et al,[59] 2010	Tanzania	ERN	49
Kantelhardt et al,[43] 2014	Ethiopia	ERN	35
Sayed et al,[60] 2014	Kenya	TNBC	20
Galukande et al,[61] 2014	Uganda	TNBC	34
Rambau et al,[62] 2014	Tanzania	TNBC	38
North Africa			
Fourati et al,[63] 2014	Tunisia	TNBC	23
Rais et al,[64] 2012	Morocco	TNBC	17
Bennis et al,[65] 2012	Morocco	Basal-like (TNBC and CK 5/6)	13
El-Hawary et al,[66] 2012	Egypt	TNBC	29
Salhia et al,[67] 2011	Egypt	Basal-like (TNBC and CK 5/6)	11
Cherbal et al,[68] 2015	Algeria	TNBC	20
Aiad et al,[69] 2014	Egypt	TNBC	8
West Africa			
Huo et al,[70] 2009	Nigeria, Senegal	Basal-like (TNBC and CK 5/6)	27
Ly et al,[71] 2012	Mali	TNBC	46
Der et al,[72] 2015	Ghana	TNBC	58
Ohene-Yeboah and Adjei,[73] 2012	Ghana	TNBC	43
Nwafor and Keshinro,[74] 2015	Nigeria	TNBC	29
Proctor et al,[75] 2015	Ghana	TNBC	61

Abbreviations: CK, cytokeratin; EGFR, epidermal growth factor receptor; ERN, estrogen receptor–negative; TNBC, triple-negative breast cancer.

women.[40] Most recently, a consortium of 18 study cohorts has been funded by the National Institutes of Health to pool resources as the Breast Cancer Genetic Study in African-Ancestry Populations, representing the largest study to date of BC in African American women.[41]

Studies of BC among international populations with African heritage have strengthened arguments that geographically defined ancestry influences the risk of TNBC. Accurate population-based data on BC in African countries are sparse, but the BC burden appears to be rising.[42] Immunohistochemistry resources are limited in the low- and middle-income countries of Africa, and data on biomarker expression are often unavailable. However, investigators from various sites have reported elevated TNBC frequencies in comparison with the 15% prevalence observed in women of European ancestry, ranging from 23% to 82% of all cases.[5,42]

Deeper probing into the BC burden of Africa, stratified by phenotype as well as region, reveals intriguing and hypothesis-generating patterns. Most studies demonstrating higher frequencies of TNBC in Africa have represented western sub-Saharan Africa with less known about BC in east Africans. However, low frequencies of ER-negative BC have been reported in Ethiopia[43] and in Ethiopian patients with BC residing in the United States.[44] Jiagge et al[4] recently published the first direct comparison of African American, white American, Ghanaian/West African and Ethiopian/East African patients with BC. This study found TNBC in 53.2% of Ghanaians and 29.8% of African Americans; the frequency of TNBC was similarly low among white Americans and Ethiopians, at 15.5% and 15.0% respectively ($P < .0001$). Population migration patterns may explain these findings (**Figure 1**). The European-controlled trans-Atlantic slave trade transported West Africans to North America. In contrast, the slave trade from east Africa was largely controlled by Arab traders, with forced migration to the Mideast and Asia.[45] African American women therefore are more likely to have shared ancestry with west Africans than east Africans, and this is confirmed by ancestry informative marker genotyping.[46] **Figure 2** summarizes results from studies evaluating TNBC in African vs non-African ancestry populations, revealing that increased TNBC frequencies are generally seen when west African countries comprise the comparison populations.[4,47-52] **Table 2** reveals TNBC frequencies by country as well as region, also demonstrating that western sub-Saharan Africa is the site of increased TNBC prevalence. Regions of Africa with stronger ancestral ties to east Africa (eg, central and south Africa) tend to have relatively lower TNBC frequencies.

The increased frequency of TNBC among women with western sub-Saharan African ancestry becomes particularly relevant as advances are made in the gene expression technology of precision medicine and the heterogeneity of TNBC becomes apparent. Gene expression profiling indicates that several distinct TNBC

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subtypes exist, characterized by different prognostic and treatment-predictive profiles.[76,77] For example, the luminal androgen receptor subtype is less likely to respond to neoadjuvant chemotherapy but may be a candidate for targeted therapy with antiandrogenic agents, such as bicaludamide.[12] Unfortunately, however, few patients with African ancestry contributed to the landmark studies defining TNBC subtypes. We therefore do not know whether the TNBC subtypes of women with European and Asian heritage represent the same TNBC patterns of women with African ancestry.

A recent analysis of The Cancer Genome Atlas compared the genomic landscape of breast tumors from 159 African American and 711 white American women, finding significantly more intratumoral genetic heterogeneity and basal gene expression among African American cases. Subtyping of TNBC furthermore identified no luminal androgen receptor tumors among the African American women, but African American women were more likely to have basal-like 1 and mesenchymal stem cell-like tumors.[78] An earlier and smaller gene expression study also demonstrated an increased frequency of the basal subtype in African American patients with TNBC.[79] International collaborative partnerships, such as the Henry Ford Health System International Center for the Study of Breast Cancer Subtypes, have promising research under way to characterize germline as well as somatic tumors among women with African ancestry throughout the United States and Africa.[4,80]

Conclusions

Understanding cancer variations associated with racial/ethnic identity requires a transdisciplinary approach that we describe as oncologic anthropology, and this effort is integral to the overarching goals of precision medicine. Many questions remain unanswered regarding the epidemiology of breast cancer in individuals who self-identify as African American or white American; explanations for these differences involve disparities in our health care delivery system as well as race- and ethnicity-related variation in breast tumor biology and genetics. The definitions of race and ethnicity are in transition as patterns of genetic admixture and social groupings evolve and the genotyping technologies that allow us to quantify ancestral heritage advance. It is clear that international collaborations between social scientists, population geneticists, translational oncologists, clinicians, and community-based health care advocates are essential as we strive to eliminate breast cancer outcome disparities and maximize the benefits of personalized therapy. Oncologic anthropology represents a unified, global research effort that will be vital in 21st century medicine.

ARTICLE INFORMATION

Accepted for Publication: November 17, 2016.

Published Online: March 29, 2017. doi:10.1001/jamasurg.2017.0005

Author Contributions: Drs Newman and Kaljee had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Newman.
Acquisition, analysis, or interpretation of data: Both authors.
Drafting of the manuscript: Both authors.
Critical revision of the manuscript for important intellectual content: Both authors.
Statistical analysis: Newman.
Obtained funding: Newman.
Administrative, technical, or material support: Both authors.
Study supervision: Newman.

Conflict of Interest Disclosures: None reported.

Funding/Support: Funding was provided from Susan G. Komen for the Cure through Komen Scholars Leadership Grant HFHS F11047.

Role of the Funder/Sponsor: The funding organization had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: Jack Butler (Department of Surgery, Henry Ford Hospital) assisted with adapting and creating Figure 1 depicting the African Diaspora. There was no financial compensation other than salary.

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