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Racial disparities in treatment and survival from ovarian cancer

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ABSTRACT

Background: Black women with ovarian cancer in the U.S. have lower survival than whites. We aimed to identify factors associated with racial differences in ovarian cancer treatment and overall survival (OS).
Methods: We examined data from 365 white and 95 black ovarian cancer patients from the Hollings Cancer Center Cancer Registry in Charleston, S.C. between 2000 and 2015. We used unconditional logistic regression to estimate odds ratios (ORs) and 95% confidence intervals (CIs) between race and receipt of surgery and chemotherapy, and Cox proportional hazards regression to estimate hazard ratios (HRs) and 95% CIs between race and OS. Model variables included diagnosis center, stage, histology, insurance status, smoking, age-adjusted Charlson comorbidity index (AACI) and residual disease. Interactions between race and AACI were assessed using −2 log likelihood tests.
Results: Blacks vs. whites were over two-fold less likely to receive a surgery-chemotherapy sequence (multivariable-adjusted OR 2.46, 95% CI 1.43–4.21), particularly if they had a higher AACI (interaction p = 0.008). In multivariable-adjusted Cox models, black women were at higher risk of death (HR 1.81, 95% CI 1.35–2.43) than whites, even when restricted to patients who received a surgery-chemotherapy sequence (HR 1.79, 95% CI 1.10–2.89) and particularly for those with higher AACI (HR 4.70, 95% CI 2.00 − 11.02, interaction p = 0.01).
Conclusions: Among blacks, higher comorbidity associates with less chance of receiving guideline-based treatment and also modifies OS. Differences in receipt of guideline-based care do not completely explain survival differences between blacks and whites with ovarian cancer. These results highlight opportunities for further research.

1. Introduction

Black women are at lower risk of incident ovarian cancer compared to white women in the U.S. (9.4 vs. 12.0 cases per 100,000, respectively) [1], but their cancers are more likely to be fatal [1,2]. Five-year survival after diagnosis is 31% among blacks versus 42% among whites [3], and the disparity is seen in every age group [4] and tumor stage distribution [3]. Explanatory factors for the lower survival consistently observed among black ovarian cancer patients include later stage of tumor at diagnosis [5,6], unequal access to care due to socioeconomic disadvantage [7,8], receipt of non-guideline based care regimens [7,9–12], and greater comorbidity at presentation [13], but the contributions of some of these factors to the racial disparities that exist are not consistently reported.

The National Comprehensive Cancer Network (NCCN) guidelines for treatment of epithelial ovarian cancer has established primary cytoreductive or debulking surgery followed by platinum and taxane-based chemotherapy as the standard of care for most patients, depending upon stage of disease and ability to tolerate treatment [14]. Patients who are treated in accordance with these guidelines have better chances of survival than those who are not [11,15–17], yet less than half of all ovarian cancer patients receive the standard of care [13]. For example, in the National Cancer Institute's (NCI) Patterns of Care studies data, only 30% of blacks and 35% of whites received stage appropriate surgery and multi-agent chemotherapy, and only 39% of blacks and 48% of whites received stage appropriate surgery [12]. Results from population-based [7,17] and clinical [18] studies, as well as a meta-analysis [11], suggest that racial differences in the initiation of guideline-based care may account for a major fraction of the observed disparities in survival. However, some studies have found that survival differences often persist whether or not guideline-adherent treatment is administered [9,19–21]. Reasons for the variation in study findings are unclear, but it is possible that other factors influence associations between race and survival. In particular, comorbidities could

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impact results if their distributions differ by race [22].

Clarification of associations between race, treatment, and survival are essential to understanding the reasons for racial disparities in ovarian cancer outcomes. We utilized data from a single cancer registry, taking into account tumor characteristics, insurance status, comorbidities, and smoking history, to identify factors associated with racial differences in the receipt of guideline-based care for ovarian cancer and with overall survival.

2. Materials and methods

2.1. Study population

De-identified data were obtained on 467 ovarian cancer cases diagnosed between 2000 and 2015 at the Hollings Cancer Center (HCC), a NCI-designated cancer center located in Charleston, SC. Certified Tumor Registrars abstracted medical charts for clinical, pathological, treatment-related, demographic, and lifestyle factors. Vital status and cancer status were updated annually by the Registrar based upon the most recent patient contact through the treatment facility, the treating medical oncologist or by direct patient contact. Five-year follow-up of ovarian cancer patients by the HCC Cancer Registry exceeds 96%. Human investigations were performed in accordance with the principles outlined in the Declaration of Helsinki.

This study was restricted to women of non-Hispanic white or black race with invasive cancer of the ovary, fallopian tube, or peritoneum (International Classification of Diseases for Oncology, 3rd edition [ICD-O-3], topographical codes C56.9, C57.0, and C48.0-C48.2, respectively). After excluding women of other race (N = 6) and one case with borderline tumor, 460 cases including 365 white and 95 black women were eligible for analysis. Tumor histology was classified as serous (ICD-O-3 morphology codes 8441, 8460, 8461), mucinous (8470, 8480), endometrioid (8380), mixed cell (8255, 8323), other papillary not otherwise specified (NOS) (8050, 8260, 8450), or other epithelial NOS (8000, 8010, 8012, 8020, 8070, 8140, 8144, 8244, 8246, 8263, 8440, 8503, 8570).

2.2. Study variables

We evaluated all relevant variables available from the registry that are known or potential confounders or effect modifiers of the association between race and our outcomes. Demographic and lifestyle variables included age at diagnosis in years, diagnosis center (diagnosed at HCC but treatment or decision not to treat made elsewhere, diagnosed at HCC and part or all of treatment at HCC, diagnosed elsewhere and part or all of treatment at HCC), health insurance status (uninsured/self-pay, private insurance, Medicare/Medicaid/Tricare or military, or unknown), and smoking status (lifelong nonsmoker, current smoker, former smoker, or unknown). The HCC registry records a maximum of 10 concurrent medical diagnoses using the ICD, 9th or 10th Revision, Clinical Modification (ICD-9-CM, ICD-10-CM). We used the Age-Adjusted Charlson Comorbidity Index (AACI) [23] to assess severity of comorbidity, which was categorized as none, mild, moderate, moderate-to-severe, or severe. The AACI is a validated algorithm that incorporates ICD-CM codes to calculate a summary measure of disease burden associated with survival among hospital populations [23,24]. Briefly, seventeen medical conditions are individually scored on a qualitative scale of 1–4 for severity (Supplemental Table 1). A severity score is then calculated as the sum of scores for all medical conditions. For age-adjustment, one point is added for each decade after 40 years to derive the overall AACI score. In addition to modeling the AACI, we assessed the component conditions hypertension, diabetes mellitus, and chronic obstructive pulmonary disease (COPD), but these were not independently associated with our outcomes of interest and were excluded from further analysis in favor of the AACI score for overall severity. Pathology variables known to be important predictors of survival were included. Tumor stage (summarized as localized [FIGO stage IA, IB or I(NOS)], regional [FIGO stage IC, IIA, IIB, IIC or II (NOS)], advanced [FIGO stage IIIA, IIIB, IIIC, III(NOS) or IV], or unknown) [25] was ascertained through tumor diagnosis or from fine needle biopsy or cytology in patients who did not have surgery. Residual disease remaining after surgery was categorized as no visible macroscopic disease, macroscopic disease, disease of unknown size, or unknown residual disease.

2.3. Treatment assessment and outcome

Three treatment modalities were defined: surgery (none, any); chemotherapy (none, any [including neoadjuvant chemotherapy, adjuvant chemotherapy, chemotherapy with no surgery, chemotherapy of unknown timing]); and a surgery-chemotherapy sequence, defined as surgery and adjuvant chemotherapy, with or without neoadjuvant chemotherapy. Overall survival (OS) was calculated as months from date of diagnosis to death from any cause or last follow-up contact.

2.4. Statistical analysis

We evaluated differences in the distribution of cohort characteristics by race with the Chi-square or Fisher's exact test for sparse data. We used unconditional logistic regression to estimate odds ratios (ORs) with 95% confidence intervals (CIs) comparing black to white patients for the treatment being evaluated. These models included adjustment for diagnosis center, stage, histology, AACI, smoking status, and insurance status. Because the AACI score derives from comorbidities and age, it is highly correlated with age alone (Spearman r = 0.90); therefore, age was not included in the model. We stratified the models on AACI (collapsed to none, mild-moderate, and moderate-severe to severe comorbidities) and assessed statistical interaction by comparing multivariable-adjusted models with and without a product term for race and comorbidities using -2 log likelihood tests. Because surgery and/or chemotherapy may not always be recommended for some non-serous cancers diagnosed at stage I, we performed a sensitivity analysis excluding all stage I patients (N = 46). We also modeled the joint associations of race and diagnosis center with treatment outcomes.

We compared unadjusted Kaplan-Meier survival curves between blacks and whites with the **log-**rank test. We evaluated OS using Cox proportional hazards (PH) regression to estimate the death hazard ratio (HR) and 95% CI in relation to race, adjusted for diagnosis center, stage, histology, AACI, smoking status, insurance status, surgery-chemotherapy sequence, and residual disease. We evaluated interactions between comorbidities and race as described above. The PH assumption, assessed using a -2 **log** likelihood test for interaction between race and time to death, was met. We also conducted a sensitivity analysis with survival outcome restricted to patients who received a surgery-chemotherapy sequence.

To assess if change in treatment over time could explain racial differences, we assessed the proportion of cases receiving surgical care across three 5-year intervals (2000–2004, 2005–2009, and 2010–2015) by race for all tumor stages combined and for advanced tumor stage only. To provide additional insight into tumor characteristics among surgical patients, we also compared the proportion of black and white women with macroscopic residual disease according to tumor stage at diagnosis. All statistical tests were two-sided with a threshold of $p < 0.05$ for significance, and all analyses were conducted using SAS version 9.4.

3. Results

Nearly all patients (98%) were treated at HCC (Supplemental Table 2) and significantly more black than white women were also diagnosed at HCC (72%% vs. 55%, respectively). Substantial differences were observed between black and white women in the care that

Table 1
Associations between clinical, pathologic and demographic variables and not receiving treatment for ovarian cancer.

Model Variables[a]	No surgery		No chemotherapy		No surgery-chemotherapy sequence[b]	
	N	OR (95% CI)	N	OR (95% CI)	N	OR (95% CI)
Race						
White	36 / 329	1.00	49 / 316	1.00	113 / 252	1.00
Black	32 / 63	4.02 (2.00-8.08)	33 / 62	3.37 (1.81-6.28)	53 / 42	2.46 (1.43-4.21)
Diagnosed at Hollings Cancer Center						
Yes	49 / 221	1.00	62 / 208	1.00	100 /170	1.00
No	19 / 171	0.59 (0.29-1.19)	20 / 170	0.53 (0.29-0.99)	66 / 124	1.24 (0.78-1.95)
Stage						
Local / Regional	5 / 86	1.00	30 / 61	1.00	33 / 58	1.00
Distant	47 / 288	3.05 (1.05-8.91)	39 / 296	0.28 (0.14-0.54)	111 / 224	1.01 (0.57-1.80)
Histology						
Serous	16 / 258	1.00	23 / 251	1.00	62 / 212	1.00
Non-serous	3 / 69	0.82 (0.20-3.41)	19 / 53	2.28 (1.01-5.14)	27 / 45	2.01 (1.05-3.83)
Other papillary / epithelial NOS	49 / 65	8.24 (4.12-16.49)	40 / 74	3.46 (1.81-6.60)	77 / 37	5.19 (3.07-8.77)
Age-adjusted Charlson Comorbidity Index						
None	6 / 72	1.00	20 / 58	1.00	30 / 48	1.00
Mild / moderate	24 / 213	1.60 (0.51-5.02)	23 / 214	0.49 (0.23-1.05)	68 / 169	0.74 (0.39-1.37)
Moderately − severe / severe	38 / 107	4.34 (1.23-15.35)	39 / 106	2.43 (0.95-6.20)	68 / 77	1.46 (0.69-3.11)
Smoking Status						
Never	35 / 219	1.00	41 / 213	1.00	80 / 174	1.00
Current or former smoker	27 / 164	1.47 (0.73-2.93)	34 / 157	1.34 (0.70-2.43)	72 / 119	1.61 (1.02-2.54)
Insurance Status						
Private insurance	14 / 149	1.00	29 / 134	1.00	48 / 115	1.00
Medicaid / Medicare / Military	47 / 211	0.97 (0.40-2.36)	45 / 213	0.37 (0.17-0.79)	100 / 158	0.86 (0.49-1.50)
Uninsured / self − pay / unknown	7 / 32	1.70 (0.49-5.88)	8 / 31	0.80 (0.28-2.27)	18 / 21	1.54 (0.69-3.45)

N, Number of patients who did not receive procedure / number who received procedure.
[a] Each independent variable is mutually adjusted for all others including unknown categories (not shown) for stage (n = 34) and smoking (n = 15).
[b] With or without neoadjuvant.

they received: significantly ($p < 0.001$) more white women than black women received surgery (90% vs. 66%, respectively), chemotherapy (87% vs. 65%, respectively) or a surgery-chemotherapy sequence (69% vs. 44%, respectively). Twice as many black than white women had tumors classified as “other epithelial NOS”. The most common co-morbid conditions were hypertension, diabetes, and COPD with the former two significantly more prevalent in black women than whites, although the AACI scores for overall severity of comorbidities were not significantly different by race. Age at diagnosis, tumor stage, smoking status, and health insurance status were not statistically different by race.

In multivariable logistic regression, patients who did not receive surgery as part of their treatment were four times more likely to be black (OR 4.02, 95% CI 2.00–8.08) (Table 1). The main reasons for not receiving surgery were contraindication due to patient risk factors (19% whites vs. 25% blacks), patient death (0% whites vs. 9% blacks), patient-declined treatment (3% whites vs. 9% blacks) and not planned/recommended (72% whites vs. 53% blacks). Black race was also associated with not receiving chemotherapy (OR 3.37, 95% CI 1.81–6.28) and not receiving a surgery-chemotherapy sequence (OR 2.46, 95% CI 1.43–4.21). These disparities persisted independent of diagnosis center (Supplemental Table 3). Results did not change when stage I tumors were excluded from analyses: black women were still at significantly higher risk of not receiving surgery (RR 3.79, 95% CI 1.88-7.66), chemotherapy (RR 4.21, 95% CI 2.04–8.70), or a surgery-chemotherapy sequence (RR 2.76, 95% CI 1.52–5.00) (data not shown). The main reasons for not receiving chemotherapy were contraindication due to patient risk factors (0% whites vs. 9% blacks), patient death (6% whites vs. 12% blacks), patient/guardian-declined treatment (10% whites vs. 21% blacks) and not planned/recommended (69% whites vs. 48% blacks). When associations were stratified by comorbidity, the disparity in treatment disappeared among women who had no comorbid conditions. In contrast, among women with mild or more severe comorbidity, black race was associated with over three-fold likelihood of not receiving a surgery-chemotherapy sequence ($p = 0.008$ for interaction between race and level of comorbidity) (Table 2). The significant interaction remained when stage I tumors were excluded (data not shown). Median overall survival was 49.2 months among white women and 29.3 months among blacks (log rank $p < 0.001$) (Fig. 1). In multivariable-adjusted Cox models, blacks had over 80% higher risk of dying compared to whites (HR 1.81, 95% CI 1.35–2.43) (Table 3). The survival disadvantage for black women was seen at all levels of co-morbidity, and no statistical interaction was detected ($p = 0.12$). The association was also unchanged when restricted to women who had undergone a surgery-chemotherapy sequence (multivariable-adjusted HR 1.79, 95% CI 1.10–2.89) (Table 4). When stratified by level of co-morbidity, blacks compared to whites had an increased risk of death at the lowest and highest strata of comorbidity level, but not at the middle strata of mild/moderate comorbidity level (interaction between race and AACI score $p = 0.01$). The number of women in each stratum was relatively low.

Although the proportion of black patients who received surgery increased over the study period, the proportion remained lower than that of whites for all tumor stages and when restricted to advanced stage disease (Fig. 2A-B). This suggests that changes in surgical treatment over the study period do not account for the survival differences observed by race. Black patients were as likely as whites to have no macroscopic residual tumor following surgery when diagnosed at local/regional stage (77% vs. 75%, respectively) or distant stage (39% vs 36%, respectively) (data not shown), suggesting that differences in amount of residual tumor at surgery do not explain racial differences in survival.

4. Discussion

At a single NCI-designated cancer center, black women, particularly those with comorbidities, were 2.5 to four times more likely than whites not to receive surgery, chemotherapy, or a surgery-chemotherapy sequence for treatment of primary ovarian cancer. A combination of treatment contraindication and patient-declined treatment among blacks might explain these findings. However, even when treated with guideline based care regimens, black patients were at

Table 2
Multivariable-adjusted[a] associations between race and not receiving treatment for ovarian cancer stratified by level of comorbidities.

Age-adjusted Charlson Comorbidity Index	No surgery		No chemotherapy		No surgery-chemotherapy sequence[b]	
	N	OR (95% CI)	N	OR (95% CI)	N	OR (95% CI)
No comorbidities						
White	5 / 56	1.00	17 / 44	1.00	26 / 35	1.00
Black	1 / 16	0.48 (0.04 − 5.65)	3 / 14	0.61 (0.13-2.87)	4 / 13	0.41 (0.11-1.55)
Mild / moderate comorbidities						
White	13 / 181	1.00	12 / 182	1.00	45 / 149	1.00
Black	11 / 32	3.05 (1.05 − 8.87)	11 / 32	7.15 (2.56-19.93)	23 / 20	3.65 (1.67-7.99)
Moderately − severe / severe comorbidities						
White	18 / 92	1.00	20 / 90	1.00	42 / 68	1.00
Black	20 / 15	8.31 (2.84 − 24.34)	19 / 16	3.73 (1.48-9.41)	26 / 9	3.76 (1.45-9.78)
Interaction p-value[c]		*p = 0.07*		*p = 0.02*		*p = 0.008*

N, Number of patients who did not receive procedure / number who received procedure.
[a] Adjusted for diagnosis center, stage, histology, smoking, and insurance status.
[b] With or without neoadjuvant.
[c] p-values between race and levels of comorbidity estimated using the −2 log likelihood test for interaction.

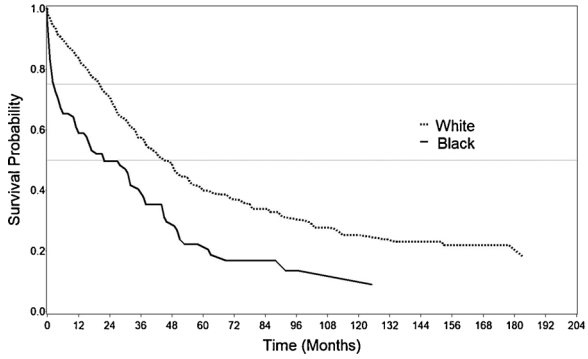

Fig. 1. Comparison of overall survival after ovarian cancer diagnosis according to race (log-rank p < 0.001).

Table 3
Associations between race and overall survival after ovarian cancer diagnosis, all women combined and stratified by level of comorbidities.

Race	Deaths from all causes/ Person-time (months)	HR (95% CI)
All women		
White	229 / 17,943	1.00
Black	72 / 2,787	1.81 (1.35-2.43)
No comorbidities		
White	25 / 3,718	1.00
Black	9 / 879	1.98 (1.90−4.35)
Mild/moderate comorbidities		
White	117 / 9,906	1.00
Black	32 / 1,460	1.35 (0.88−2.06)
Moderately-severe/severe comorbidities		
White	87 / 4,319	1.00
Black	31 / 448	2.57 (1.62−4.06)
Interaction p-value [b]		0.12

[a]Adjusted for diagnosis center, stage, histology, age-adjusted Charlson comorbidity index, smoking status, insurance status, surgery-chemotherapy sequence and residual disease.
[b]p-value estimated using the −2 log likelihood test for interaction.

higher risk of death compared to whites, and the risk was greater among black women with moderate to severe comorbidities.

Several studies have identified race as an independent predictor of standard of care between black and white women [10,11,13,26] that cannot be explained fully by stage [7,12,20], histology [7,20], comorbidities [7,27], household income [10], insurance status [20,27] or provider [10]. Our results add to the existing evidence that black race is associated with suboptimal treatment for ovarian cancer even after controlling for these factors, and contribute additional evidence by showing that severity of comorbidities reduces the likelihood of receiving standard of care therapy specifically among black women. Comorbidities are common among older patients [28] and older patients with higher comorbidity are less likely to receive surgery or chemotherapy for ovarian cancer [29]. Our results support this because the AACI takes into account the correlation between diagnosis age and severity of comorbidity. The severity of comorbidities is also correlated with tumor stage [22], but differences in tumor stage also did not explain our findings because the stage distributions were similar between races. We also found no material changes in surgical management over the last 15 years, particularly among blacks with advanced stage ovarian cancer, to account for the survival differences.

The decision not to treat due to patient risk factors and from patient-centric factors was higher among blacks than whites in our study, which might partially explain our observations. Treatment was contraindicated in more black than white women due to patient risk factors. For example, diabetes and hypertension were significantly more

Table 4
Multivariable-adjusted associations[a] between race and overall survival after ovarian cancer diagnosis restricted to women who had a surgery-chemotherapy sequence and stratified by level of comorbidities.

Race	Deaths from all causes/ Person-time (months)	HR (95% CI)
All women		
White	152 / 13,748	1.00
Black	27 / 1,804	1.79 (1.10-2.89)
No comorbidities		
White	13 / 2,355	1.00
Black	8 / 685	2.90 (1.12 − 7.49)
Mild / moderate comorbidities		
White	91 / 7,913	1.00
Black	12 / 930	1.03 (0.53 − 1.99)
Moderately-severe / severe comorbidities		
White	48 / 3,480	1.00
Black	7 / 189	4.70 (2.00 − 11.02)
Interaction p-value [b]		*0.01*

For stratified analyses, models exclude adjustment for the age-adjusted Charlson comorbidity index.
[a] For all women, the model is adjusted for diagnosis center, stage, histology, age-adjusted Charlson comorbidity index, smoking status, insurance status, and residual disease.
[b] P-value estimated using the −2 log likelihood test for interaction.

Fig. 2. Changes in percent of patients receiving surgery according to race and time period. A. All stages. B. Distant stage.

prevalent in blacks than whites in our study; however, their prevalence alone did not independently predict treatment outcomes. Rather, the overall severity of comorbidity predicted a patient's likelihood of receiving treatment for ovarian cancer. We did not have information on patients' medical management of comorbidities but, compared to white women, fewer black women are reported to achieve therapeutic control for diabetes and hypertension, and more blacks than whites experience a higher burden of morbidity and mortality from these illnesses [30–32]. It is also possible that patient-centric factors unique to minority patients, including using cultural treatments to manage illness [33], low health literacy [34], distrust of physicians and hospitals [35,36] or low autonomous decision-making style [37] could explain our findings. A better understanding of patient perspectives on cancer treatment seems critical to improving utilization of guideline-based cancer care.

Survival from ovarian cancer is known to be worse among blacks than whites [3,38]. A recent study utilizing SEER data from 44,562 white and 3190 African American women diagnosed with ovarian cancer between 1973 and 2008 found that survival disparities increased over that time period, and differences in treatment accounted for part of that disparity [21]. A 2009 meta-analysis also concluded that equal treatment mitigates survival disparities [11]. Our results differed from these conclusions and agree with the findings of others [9,19–21] because, despite receiving the same surgery-chemotherapy sequence of care in our study, blacks remained at significantly higher risk of death from ovarian cancer. This appeared to be due, in part, to the presence of comorbidities. We interpret these findings cautiously, however, because the number of women in each stratum was relatively low. Our results might also point to other explanatory factors including a potentially more aggressive tumor phenotype [19,20,39]. For example, blacks experienced a significant 61% higher risk of death despite uniform stage, histology, treatment, and follow-up [19] and, despite a similar surgical approach to care, black patients were less likely to have optimal tumor debulking and more likely to have platinum-resistant disease than whites [39]. We found no difference between blacks and whites with macroscopic residual disease following surgery, but we did not have information on treatment response. In the current study, more black than white women died prior to receiving surgery or chemotherapy and higher fatality among newly diagnosed black compared to white women with ovarian cancer has been reported previously [2]. Also, a higher proportion of blacks had tumors classified as "other epithelial NOS," possibly indicating more undifferentiated molecular features. These results highlight the need for molecular biomarker studies among racially diverse populations to better characterize ovarian cancer biology.

The strengths of this study include the high quality of data maintained by the HCC cancer registry. In addition, 98% of our sample was treated at HCC, thereby reducing treatment variation based on facility or provider. There are also limitations. We utilized existing de-identified data and information on some variables were either unavailable (e.g., income, education, body mass index) or may have been abstracted imperfectly for others (e.g., comorbid conditions). Thus, the AACI, as a measure of medical comorbidity, may not have fully elucidated the state of health of the individual. Our definition of a surgery-chemotherapy sequence was a surrogate variable for NCCN guideline-adherent care based on whether or not these procedures were administered and, therefore, does not consider whether a patient completed their planned cycles or dose. Also, some strata of AACI had small numbers of patients and caution in interpretation of our results might be needed. Although we were able to control for insurance status, we did not have information on education or income, which may have limited our ability to control for socio-economic status. However, others found that unequal access to care due to inadequate insurance or socioeconomic disadvantage [7,8] does not completely explain the survival disparity following ovarian cancer diagnosis, which has also been observed among women receiving Medicare [7]. More likely, the strong correlation between socioeconomic status and successful treatment indicators (hospital size/volume and consultation with a gynecologic oncologist) explains the observed survival disparity with socioeconomic disadvantage [12], suggesting our findings may not have been confounded appreciably. We also did not have information on marital or family status, caregiver support, or any other behavioral/psychosocial factors that might influence patient treatment decision-making including the decision not to treat. Our findings reflect the survival experience of women in the state of South Carolina, but are consistent with evidence from studies using national databases [7,12] and thus generalizable to other populations with similar characteristics.

5. Conclusions

These findings demonstrate the striking racial disparities that exist in ovarian cancer. Black compared to white women experience a significant disadvantage in their treatment and prognosis that is not fully explained by differences in age, stage at diagnosis, histology, extent of comorbidity, smoking, insurance status, or treatment provider. Moreover, differences in treatment do not satisfactorily account for survival disparities. Future research is needed to understand the impact of the severity of comorbidities and their management at time of diagnosis and during treatment for ovarian cancer, and the decision-making process by patients and their providers to adhere to standard of care treatment guidelines.

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Conflict of interest

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Authorship contribution

JSH and LEK conceived and designed the study, and acquired the data. JSH performed the analysis and drafted the manuscript. KW, WSG and LEK revised the draft. All authors read and approved the final version.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.canep.2018.11.010.

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