Published in final edited form as:

Gynecol Oncol. 2014 November ; 135(2): 285–291. doi:10.1016/j.ygyno.2014.08.029.

The effect of neighborhood-level socioeconomic status on racial differences in ovarian cancer treatment in a population-based analysis in Chicago

Charlotte E. Joslin^{1,2,3}, Katherine C. Brewer², Faith G. Davis³, Kent Hoskins^{3,5}, Caryn E. Peterson², and Heather A. Pauls⁶

¹Department of Ophthalmology and Visual Sciences, University of Illinois at Chicago

²Division of Epidemiology and Biostatistics, School of Public Health, University of Illinois at Chicago

³University of Illinois at Chicago Cancer Center, Cancer Control and Population Science Research Program

⁴School of Public Health, University of Alberta

⁵Department of Hematology/Oncology, University of Illinois at Chicago

⁶Institute for Health Research and Policy (IHRP), University of Illinois at Chicago

Abstract

BACKGROUND—Less than half of women with ovarian cancer and blacks specifically receive therapy adherent to National Comprehensive Cancer Network (NCCN) guidelines. The purpose is to assess the effect of neighborhood-level socioeconomic status (SES) on black-white treatment differences in a population-based analysis in a highly-segregated community.

METHODS—Illinois State Cancer Registry data for invasive epithelial ovarian cancer cases diagnosed in Cook County, IL in non-Hispanic white (NHW) or black (NHB) women from 1998 – 2009 was analyzed. As few women receive NCCN-adherent care, variables were constructed to assess extent of treatment, including receipt of: 1) debulking surgery; 2) any surgery; 3) multi-agent chemotherapy; and 4) any chemotherapy. Two measures (concentrated affluence and disadvantage) were used to estimate neighborhood-level SES. Multivariable logistic regression was used to compute odds ratios (OR) and 95% confidence intervals (95% CI), with generalized linear mixed models to account for hierarchical data.

RESULTS—2766 (81.0%) NHW and 647 (19.0%) NHB women were diagnosed. Adjusting for covariates, NHB were less likely to receive debulking surgery (OR: 0.39; 95% CI: 0.30–0.50), any

© 2014 Elsevier Inc. All rights reserved.

Corresponding Author: Charlotte E. Joslin, 1855 W. Taylor St, Ste. 3.154, Chicago, IL 60612, 312-996-5410 phone, 312-996-4255 fax, charjosl@uic.edu.

The authors have no potential conflicts of interest to disclose.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

surgery (OR: 0.38; 95% CI: 0.29–0.49), multi-agent chemotherapy (OR: 0.56; 95% CI: 0.45–0.71) and any chemotherapy (OR: 0.58; 95% CI: 0.45–0.74). Concentrated affluence but not disadvantage was significant in final models for multi-agent and any chemotherapy, but not debulking or any surgery.

CONCLUSIONS—Results identify black-white differences consistent across treatments that persist despite adjustment for neighborhood-level SES.

IMPACT—Results advance inequality awareness beyond “ideal” NCCN-adherent care, indicating inequality exists in delivery of even the most basic oncologic care.

Keywords

ovarian cancer; treatment; racial disparities; neighborhood socioeconomic status; comorbidities

INTRODUCTION

Ovarian cancer is the leading cause of gynecologic cancer deaths, with an estimated 21,980 new cases and 14,270 deaths in 2014 in the United States (1). An absence of effective screening contributes to late stage diagnoses and poor survival, and considerable evidence supports black-white survival disparities (2–5), including stage-specific survival disparities (6–9). Survival rates that are worsening in blacks while improving in whites contribute to escalating disparities (1, 3, 7, 8).

Black-white differences in stage at diagnosis exist, despite heterogeneity across studies (2, 3, 10–12). Lower neighborhood socioeconomic status (SES) has been associated with tumor characteristics indicative of more advanced and aggressive disease (13). Although significant treatment differences contribute to survival disparities with analysis of national data (3–5, 14), poorer black survival persists despite uniform stage, treatment, and follow-up in analysis of data pooled from Phase III randomized clinical trials (trials conducted from 1974 – 2001) (15). More recent analyses at a tertiary referral center setting identified that black-white survival differences are largely mitigated with equal access to highly specialized care (9).

Primary therapy for advanced ovarian carcinoma according to National Comprehensive Cancer Network (NCCN) guidelines should include radical cytoreductive surgery followed by a chemotherapy doublet with a platinum agent (i.e., cisplatin or carboplatin) and a taxane (i.e., paclitaxel or docetaxel) delivered through intravenous or intraperitoneal routes for women with FIGO stage III/IV disease (NCCN v 2010). More recent recommendations include the “dose dense” approach, with paclitaxel given in a lower dose weekly for 3 weeks per cycle (NCCN v 3.2012). Analysis of National Cancer Data Base (NCDB) data indicated less than half of women with ovarian cancer receive care adherent to NCCN guidelines (5). In addition, analysis of California Cancer Registry data in women with late-stage disease indicated less than 5% received treatment at high-volume hospitals with high-volume physicians, which together was an independent predictor of survival (16).

Increasing survival disparities with ovarian cancer mirror the progressively widening differences in black-white mortality with breast cancer, which is better studied as it is not a

rare cancer. In Chicago, breast cancer black-white mortality disparities increased from 1990 – 2005 after being non-existent in 1980 (17, 18), and analysis in 2005 demonstrated considerably larger mortality disparities in Chicago versus New York City and elsewhere (19). A comparative analysis of the 25 most populous US cities identified median household income and Index of Dissimilarity (an index of segregation) (20) as significantly related to black-white disparities (21), and analysis over time (between 1990 and 2009) demonstrated large and growing black-white disparities with considerable heterogeneity by city (22). Further, research with other health outcomes [e.g., mortality secondary to coronary heart disease (23) and diabetes mellitus (24)] has similarly identified significant US geographical heterogeneity in black-white differences, even though cities ranked differently by disease-specific disparity (21, 22, 24), emphasizing the importance of local contextual factors that may operate differently in chronic and acute disease (24).

The purpose of this analysis is to assess the effect of neighborhood-level SES on black-white difference in ovarian cancer treatment administration in a population-based analysis in highly-segregated Cook County, IL (25). Value exists in assessing treatment in Cook County as: a) treatment is one of few modifiable prognostic factors (26); b) treatments over the past few decades have significantly increased survival (27–32); c) women infrequently receive care adherent with NCCN guidelines, particularly blacks (5, 16, 33); and, d) geographic heterogeneity suggests population-based analyses may be informative in a county segregated and large enough for sufficiently powered analysis.

MATERIALS AND METHODS

Study Population

The Institutional Review Board (IRB) at the University of Illinois at Chicago and the Illinois Public Health Department, Illinois State Cancer Registry both reviewed and approved this research. Cancer registry data for ovarian cancer cases diagnosed from June 1, 1995 – December 31, 2009 in Cook County, Illinois was obtained from the Illinois State Cancer Registry, the only source of population-based cancer incidence data for the state (34). Illinois State Cancer Registry records included standardized data on age, race, Hispanic ethnicity, and Surveillance Epidemiology and End Results (SEER) general summary stage at diagnosis (35), with data for diagnosis years 1995 – 2009 estimated as 98 – 100% (36) complete based on North American Association of Central Cancer Registry (NAACCR) certification, meeting the NAACCR gold certification criteria for all years analyzed. First course treatment data, based on Facility Oncology Registry Data Standards (FORDS) standards, was available for cases diagnosed 1998 or later (excluding 2003), so analyses were restricted to non-Hispanic women who were black or white diagnosed from 1998 – 2009.

Cook County, which is highly segregated (25, 37) and the second most populous county in the US (38), includes 1,350 census tracts (850 in Chicago, 500 in suburban Cook County) with the majority of predominantly black census tracts located on the south side. More than one-third of Cook County census tracts (n= 495) are designated by the US Department of Health and Human Services as being Medically Underserved Areas/Populations (39). In 2000, the black-white Index of Dissimilarity (20) for Cook County was 82.5% (37), which

exceeded other US metropolitan areas with the exception of Milwaukee and Detroit (25). The Index of Dissimilarity (an index of segregation) quantifies the degree to which the minority group is distributed differently than whites across census tracts (20, 25).

Case Ascertainment and Variable Definition

Analysis included all cases of invasive epithelial ovarian cancer in non-Hispanic white (NHW) or non-Hispanic black (NHB) women aged 20 years or older (40) at diagnosis (ICD-03 epithelial histology codes included (41, 42): 8010–8046, 8441–8442, 8460–8462, 8470–8472, 8480–8482, 8380–8382, 8140–8260, 8050–8074, 8562, 8120, 8130, 9014, 8313, 9015, 8800, 8801, 9000, 8310, 8323, 8440, 8450, 8490, 8570, 8574). Tumor grade was dichotomized for analysis: 1) well or moderately differentiated tumors; and, 2) poorly differentiated, undifferentiated, or anaplastic tumors (5). To minimize data missingness, stage was constructed by using the pathologic stage group, or clinical stage group if pathologic stage was not reported (5, 43). Age was evaluated as continuous and categorical (40, 44, 45), but analyzed as categorical (<50 years, 50 – 64 years, 60 – 74 years, and 75+ years) (40) since it was significantly associated with each treatment outcome. Year of diagnosis was dichotomized on the median year to allow comparison of treatment effects over time (1998 – 2003; 2004 – 2009).

Neighborhood SES Variables

Similar to previous work (13), two well-established measures of neighborhood SES were constructed: concentrated disadvantage (disadvantage) and concentrated affluence (affluence) (46, 47). Residential address at diagnosis was geocoded using ArcGIS US Street Locator (ESRI, 12.0; Redlands, CA) to obtain patient census tract and matched to 2000 US Census data to obtain census tract-level demographic variables. Census variables were standardized and summed with equal weighting to create the final neighborhood-level disadvantage and advantage scores (13, 46, 47). Census 2000 variables used to create final neighborhood-level disadvantage and advantage scores include the following: 1) neighborhood-level disadvantage: percent below poverty, percent unemployed, percent receiving public assistance, percent in female-headed households, percent under age 18, and percent black (46); 2) neighborhood-level affluence: percent of families with incomes above \$75,000, percent of adults with college educations; and the percent of the civilian labor force employed in professional/managerial occupations (47).

Outcome Treatment Variables

As previous research identified that women and blacks specifically are unlikely to receive ideal NCCN-adherent therapy (5, 14), additional less stringent treatment variables were constructed to assess receipt of varying extent of treatment. Four outcome variables were constructed: 1) receipt of debulking surgery; 2) receipt of any surgery; 3) receipt of multi-agent chemotherapy; and 4) receipt of any chemotherapy. Receipt of debulking surgery included women classified as receiving either debulking cytoreductive surgery or pelvic exenteration; any surgery included women with resection of the ovary, oophorectomy with or without omentectomy, debulking cytoreductive surgery, surgery (unspecified) or pelvic exenteration. Receipt of multi-agent chemotherapy was restricted to cases listed as having

received multi-agent chemotherapy, while any chemotherapy included all cases in which chemotherapy was administered, regardless of type or number of agents.

Statistical Analysis

Race-stratified descriptive statistics were compared for demographic and clinical variables using the Chi-Square test and t-tests. Stage-stratified (Stage I/II vs. Stage III/IV) descriptive statistics were similarly computed given the strong association with race and the impact of stage on treatment. Binomial logistic regression (PROC LOGISTIC) was used to assess the independent effects of race, neighborhood-level SES indicators, and tumor characteristics on treatment outcomes. Multivariable logistic regression (48) models were constructed using factors significant ($p < 0.05$) in univariate models to compute odds ratios (OR) and 95% confidence intervals (95% CI). Five nested models were compared using log likelihood ratio methods, including 1) unadjusted; 2) adjusted for age, stage at diagnosis, and tumor grade; 3) previous covariates plus early/late year of diagnosis; 4) previous covariates plus concentrated affluence; and, 5) previous covariates plus concentrated disadvantage. Potential interactions between race and stage were assessed in final logistic regression models. Multi-level models were similarly constructed using generalized linear mixed models (GLMM; PROC GLIMMIX) to compute the adjusted odds ratio, accounting for the clustering or hierarchical nature of data (e.g., cases within census tracts). Since data on insurance status was not available, a sensitivity analysis was performed restricting analyses to Medicare eligible-women aged 65 years and older (14) to assess potential biases created without an insurance covariate. Statistical significance was set to $P < 0.05$, and all analyses were performed using SAS version 9.4 (SAS Institute, Inc, Cary, NC). All statistical tests were two-sided.

RESULTS

A total of 2766 (81.0%) NHW and 647 (19.0%) NHB women in Cook County were diagnosed with invasive epithelial ovarian cancer between 1998 and 2009. Demographic and clinical characteristics were significantly different between NHW and NHB for all variables analyzed. Notably, the mean NHW age at diagnosis was older (62.8 vs 61.1 years; $p = 0.007$), NHW were significantly more likely to have their disease staged and be diagnosed at earlier stages, and NHW were significantly more likely to have contextual scores of higher affluence and lower disadvantage (Table 1). In terms of treatment, NHW were more likely to have any surgery (82.6% vs. 66.2%, $p < 0.0001$) or debulking surgery (25.8% vs. 12.8%, $p < 0.0001$), and they were also more likely to receive any chemotherapy (70.0 vs. 60.9, $p < 0.0001$) or multi-agent chemotherapy (60.3% vs. 48.5%, $p < 0.0001$). Comparison of early and late stage diagnosis (Stage I/II vs. III/IV) identified significant differences for all variables except concentrated disadvantage, highlighting the strong relationship between stage and treatment. Notably, women diagnosed at Stage I/II were younger (57.1 vs. 64.4 years, $p < 0.0001$) and more likely to receive any surgery (96.5% vs. 74.6%; $p < 0.0001$), but were less likely to receive debulking surgery (7.8% vs. 31.9%, $p < 0.0001$), any chemotherapy (50.1% vs. 78.7%, $p < 0.0001$) or multi-agent chemotherapy (42.5% vs. 67.8%, $p < 0.0001$).

Multivariable analysis demonstrated remarkable consistency amongst nested models with each of the four treatment outcome variables (e.g., debulking surgery, any surgery, multi-agent chemotherapy, any chemotherapy), with NHB being significantly less likely to receive administration of each treatment outcome. Multi-level models accounting for the hierarchical structure of the data yielded similar results to the various nested models that ignored data clustering. In final models (Table 2), NHB were significantly less likely than NHW to receive debulking surgery (OR: 0.39; 95% CI: 0.30 – 0.50), any surgery (OR: 0.38; 95% CI: 0.29 – 0.49), multi-agent chemotherapy (OR: 0.56; 95% CI: 0.45 – 0.71) and any chemotherapy (OR: 0.58; 95% CI: 0.45 – 0.74). Analysis of final models restricted to Medicare-eligible women (aged 65 years and older) demonstrated similar results: NHB were significantly less likely than NHW to receive debulking surgery (OR: 0.34; 95% CI: 0.22 – 0.52), any surgery (OR: 0.50; 95% CI: 0.35 – 0.70), multi-agent chemotherapy (OR: 0.63; 95% CI: 0.45 – 0.89) and any chemotherapy (OR: 0.54; 95% CI: 0.38 – 0.78).

Three covariates were significant in the final models for each treatment outcome, including age, stage, and tumor grade (Table 2). Year of diagnosis (1998 – 2003 vs. 2004 – 2009) was a significant covariate in the final model for all treatment outcomes except any surgery. Concentrated affluence but not disadvantage was a significant covariate in final non-hierarchical models for both multi-agent chemotherapy and any chemotherapy, but not in final models for debulking surgery or any surgery. Interaction between race and stage was not significant in final models for any treatment outcome. Hierarchical analysis for each treatment outcome incorporating covariates identical to the treatment-specific final model (which ignored clustering) was nearly identical to final models that ignored clustering (Table 2, Model 7).

DISCUSSION

Notably, results demonstrate in highly-segregated Cook County that NHB women diagnosed between 1998 – 2009 with invasive epithelial ovarian cancer are significantly less likely to receive: 1) debulking surgery; 2) any surgery; 3) multi-agent chemotherapy; or, 4) any chemotherapy. NHB are less than 40% as likely to receive surgery (debulking or any), and less than 60% as likely to receive chemotherapy (multi-agent or any). Results are consistent with previous research (3–5, 14, 49), and are important as they advance awareness of black-white treatment differences beyond more “ideal” treatments such as NCCN guidelines, the historical National Institutes of Health Consensus recommendations (50), or even more recently-approved therapies (51). Our analysis indicates that in this highly segregated county, there is an inequality in delivery of even the most basic level of oncologic care for women with ovarian cancer. These results are more appropriately generalized to real-world circumstances as only a minority of women in general and blacks specifically receive NCCN-concordant therapy (5) or recently-approved therapies (51–53). In addition, population-based results include analysis of data from all hospitals in Cook County, as opposed to results from SEER analyses (3, 4, 14) which represent sampled areas of the US (e.g., Chicago is omitted from SEER) (54), or NCDB results (5, 49), which include higher-tier, Commission on Cancer (CoC)-approved hospitals reflecting approximately 70% of US cases annually (55).

Interestingly, neighborhood-level SES (concentrated affluence, disadvantage) were not significant covariates in final models for treatment outcomes of debulking or any surgery. In contrast, concentrated affluence was significant in the final model for both multi-agent and any chemotherapy. Concentrated disadvantage was not significant in final models; moreover, hierarchical models yielded results almost identical to models ignoring clustering (e.g., cases within census tracts). Among reports assessing black-white treatment differences (3–5, 14, 49), measures of SES and/or contextual-level variables were assessed in a limited number of analyses (4, 5, 49), and were statistically significantly associated with treatment in some (4, 5), but not all populations studied (49). In this analysis, concentrated advantage and disadvantage contextual factors represent a mixture of individual- and neighborhood-level resources, in that neighborhood SES reflects not only the structural characteristics of the person's neighborhood (46, 47, 56), but also their individual circumstance (57). As the demands required for a patient to undergo administration of surgical versus chemotherapeutic treatments likely vary, it could be hypothesized that the effect of contextual factors may differ by treatment type, similar to suggestions that contextual factors operate differently between chronic and acute disease (24). Further research is necessary to confirm the importance of contextual factors in chemotherapeutic treatment as opposed surgical interventions.

A possible explanation for black-white differences with ovarian cancer treatment is comorbidity, which may encompasses treatment decisions (e.g., sicker women are less likely treated with aggressive therapy), and to a lesser extent, shared risk factors (e.g., poor health care access prior to diagnosis). Suboptimal treatment in patients with comorbidity was common across tumor sites in a review of >2500 articles published between 2002–2012 on the association between comorbidity and survival in patients with colon, breast, and lung cancer (58). Specifically, surgical management declined (59–63) and the risk of complications increased (64–67) with increasing comorbidities; further, patients with increased comorbidities were less likely to receive any adjuvant chemotherapy (68–75), more likely to receive reduced doses (76, 77), and fail to complete chemotherapy treatment (76, 78). Comorbidity has been associated with suboptimal ovarian cancer treatment (79, 80), yet population-based analyses show mixed results between comorbidity and ovarian cancer mortality (79, 81–83). Notably, a recent analysis identified cardiovascular comorbidities at diagnosis as independently related to decreased ovarian cancer survival (84). One limitation of studies using tumor registry data is that information on comorbidities is generally lacking.

Several additional limitations on this effort exist and results should be interpreted in context. First, similar to other state cancer registries, quality control on treatment data is not performed and the issue of missing data must be addressed. Missing data was present with three variables: stage, chemotherapy and surgery. Stage was unknown or missing in 288 women (8.4%) and more likely in NHB (7.7% NHW vs. 11.6% NHB, $p = 0.001$), likely a reflection that nearly twice as many NHB women did not undergo surgical procedures (NHW: 17.4 vs. 33.4; $p < 0.0001$). Stage was significantly more likely missing among older women, women diagnosed in 1998 – 2003, and women with lower quartiles of concentrated affluence. To minimize potential biases, stage was analyzed as a categorical variable that included unknown/missing. Chemotherapy data was missing in 383 women (11.2%), and

data on chemotherapeutic agent, dose, and number of cycles delivered is not available for any patients. There was no significant difference in missingness for all final covariates except stage (more likely with stage unknown/missing) and year of diagnosis (earlier). Finally, data on surgery data was missing in 21 women (0.6% overall; 0.5% NHW vs. 1.2% NHB); missingness was generally similar across categories of final covariates, with the exception of stage and grade (more likely with stage unknown/missing or grade missing).

Second, data on insurance was not available, which is not insignificant as it has been associated with treatment receipt in NCDB analyses (5, 49, 85) and SEER analyses (33). However, sensitivity analysis restricted to Medicare eligible-women aged 65 years and older (14) yielded statistically significant results nearly identical to original analyses, with only slight variability in the point estimates and widened confidence intervals. Finally, case-level data on hospital or provider characteristics are not included as the IRB for Illinois Public Health Department and Illinois State Cancer Registry determined their inclusion would violate hospital and/or provider confidentiality based on the limited geographic area and identifiable characteristics.

Strengths include the fact that results reflect the relatively smaller county-level scale, minimizing confounding due to geographic heterogeneity. In addition, Cook County has a large enough population and sufficient cases to adequately power analyses for comparison of black-white treatment differences. Moreover, the contrasting nature of sociodemographic and clinical factors for women of Cook County provides the variation necessary in analyses. In addition, results are from analysis of population-based Illinois State Cancer Registry data that includes all Cook County cases, as compared to analyses of case from single institutions (12) or based on nationally-sampled data sets (3–5, 14, 49). Finally, results provide informative data on what is happening in Chicago and Cook County, which is not available through SEER data (54).

In summary, results identify important black-white treatment differences with invasive epithelial ovarian cancer consistent across all treatment outcomes analyzed, and advance awareness of black-white treatment differences beyond the more “ideal” standard of NCCN-adherent care. Neighborhood-level SES factors were significant in predicting black-white treatment differences related to chemotherapy but not to surgery, which if confirmed may help identify mechanisms to reduce treatment differences. Significant inequality in treatment is particularly important with invasive epithelial ovarian cancer, as ineffective screening shifts responsibility in minimizing disease burden to treatment, yet most women fail to receive NCCN-adherent care. Analysis of suboptimal treatments further supports treatment differences identified with NCCN-adherent care, indicating that systematic treatment differences exist that may contribute to black-white survival disparities. Results identify modifiable treatment differences that may help reduce black-white disparities and improve ovarian cancer survival.

Acknowledgments

Financial support, including the source and number of grants, for each author

C.E. Joslin: NIH/NCMHD P60 MD003424, American Cancer Society Research Scholar Grant RSG-13-380-01-CPHPS

K.C. Brewer: NIH/NCMHD P60 MD003424, American Cancer Society Research Scholar Grant RSG-13-380-01-CPHPS

F.G. Davis: NIH/NCMHD P60 MD003424, American Cancer Society Research Scholar Grant RSG-13-380-01-CPHPS

K. Hoskins: NIH/NCI 2P50CA106743-06, American Cancer Society Research Scholar Grant RSG-13-380-01-CPHPS

C.E. Peterson: American Cancer Society Research Scholar Grant RSG-13-380-01-CPHPS

H.A. Pauls: NIH/NCMHD P60 MD003424, NIH/NCI 2P50CA106743-06

NIH/NCMHD P60 MD003424: (CEJ, KCB, FGD, KH, HP)

American Cancer Society Research Scholar Grant RSG-13-380-01-CPHPS: (CEJ, KCB, FGD, KH, CEP)

Abbreviations

NHB	Non-Hispanic Black
NHW	Non-Hispanic White
OVCA	Ovarian cancer

References

1. Siegel R, Ma J, Zou Z, Jemal A. Cancer statistics, 2014. *CA: a cancer journal for clinicians*. 2014; 64:9–29. [PubMed: 24399786]
2. Parham G, Phillips JL, Hicks ML, Andrews N, Jones WB, Shingleton HM, et al. The National Cancer Data Base report on malignant epithelial ovarian carcinoma in African-American women. *Cancer*. 1997; 80:816–26. [PubMed: 9264366]
3. Chan JK, Zhang M, Hu JM, Shin JY, Osann K, Kapp DS. Racial disparities in surgical treatment and survival of epithelial ovarian cancer in United States. *Journal of surgical oncology*. 2008; 97:103–7. [PubMed: 17979133]
4. Du XL, Sun CC, Milam MR, Bodurka DC, Fang S. Ethnic differences in socioeconomic status, diagnosis, treatment, and survival among older women with epithelial ovarian cancer. *International journal of gynecological cancer: official journal of the International Gynecological Cancer Society*. 2008; 18:660–9. [PubMed: 17892451]
5. Bristow RE, Powell MA, Al-Hammadi N, Chen L, Miller JP, Roland PY, et al. Disparities in Ovarian Cancer Care Quality and Survival According to Race and Socioeconomic Status. *Journal of the National Cancer Institute*. 2013
6. Kim S, Dolecek TA, Davis FG. Racial differences in stage at diagnosis and survival from epithelial ovarian cancer: a fundamental cause of disease approach. *Soc Sci Med*. 2010; 71:274–81. [PubMed: 20483517]
7. McGuire V, Herrinton L, Whittemore AS. Race, epithelial ovarian cancer survival, and membership in a large health maintenance organization. *Epidemiology (Cambridge, Mass)*. 2002; 13:231–4.
8. McGuire V, Jessor CA, Whittemore AS. Survival among U.S. women with invasive epithelial ovarian cancer. *Gynecol Oncol*. 2002; 84:399–403. [PubMed: 11855877]
9. Bristow RE, Ueda S, Gerardi MA, Ajiboye OB, Ibeanu OA. Analysis of racial disparities in stage IIIC epithelial ovarian cancer care and outcomes in a tertiary gynecologic oncology referral center. *Gynecol Oncol*. 2011; 122:319–23. [PubMed: 21632099]

10. Goodman MT, Shvetsov YB. Incidence of ovarian, peritoneal, and fallopian tube carcinomas in the United States, 1995–2004. *Cancer Epidemiol Biomarkers Prev.* 2009; 18:132–9. [PubMed: 19124490]
11. Barnholtz-Sloan JS, Tainsky MA, Abrams J, Severson RK, Qureshi F, Jacques SM, et al. Ethnic differences in survival among women with ovarian carcinoma. *Cancer.* 2002; 94:1886–93. [PubMed: 11920552]
12. Terplan M, Temkin S, Tergas A, Lengyel E. Does equal treatment yield equal outcomes? The impact of race on survival in epithelial ovarian cancer. *Gynecol Oncol.* 2008; 111:173–8. [PubMed: 18823649]
13. Peterson CE, Rauscher GH, Johnson TP, Kirschner CV, Barrett RE, Kim S, et al. The association between neighborhood socioeconomic status and ovarian cancer tumor characteristics. *Cancer causes & control: CCC.* 2014
14. Howell EA, Egorova N, Hayes MP, Wisnivesky J, Franco R, Bickell N. Racial disparities in the treatment of advanced epithelial ovarian cancer. *Obstetrics and gynecology.* 2013; 122:1025–32. [PubMed: 24104782]
15. Albain KS, Unger JM, Crowley JJ, Coltman CA Jr, Hershman DL. Racial disparities in cancer survival among randomized clinical trials patients of the Southwest Oncology Group. *Journal of the National Cancer Institute.* 2009; 101:984–92. [PubMed: 19584328]
16. Bristow RE, Chang J, Ziogas A, Randall LM, Anton-Culver H. High-volume ovarian cancer care: Survival impact and disparities in access for advanced-stage disease. *Gynecol Oncol.* 2014; 132:403–10. [PubMed: 24361578]
17. Orsi JM, Margellos-Anast H, Whitman S. Black-White health disparities in the United States and Chicago: a 15-year progress analysis. *American journal of public health.* 2010; 100:349–56. [PubMed: 20019299]
18. Ansell D, Grabler P, Whitman S, Ferrans C, Burgess-Bishop J, Murray LR, et al. A community effort to reduce the black/white breast cancer mortality disparity in Chicago. *Cancer causes & control: CCC.* 2009; 20:1681–8. [PubMed: 19688184]
19. Whitman S, Ansell D, Orsi J, Francois T. The racial disparity in breast cancer mortality. *Journal of community health.* 2011; 36:588–96. [PubMed: 21190070]
20. Jahn JA, Schmid CF, Schrag C. The measurement of ecological segregation. *American Sociological Review.* 1947; 12:293–303.
21. Whitman S, Orsi J, Hurlbert M. The racial disparity in breast cancer mortality in the 25 largest cities in the United States. *Cancer epidemiology.* 2012; 36:e147–51. [PubMed: 22443886]
22. Hunt BR, Whitman S, Hurlbert MS. Increasing Black:White disparities in breast cancer mortality in the 50 largest cities in the United States. *Cancer epidemiology.* 2014
23. Gebreab SY, Diez Roux AV. Exploring racial disparities in CHD mortality between blacks and whites across the United States: A geographically weighted regression approach. *Health Place.* 2012; 18:1006–14. [PubMed: 22835483]
24. Rosenstock S, Whitman S, West JF, Balkin M. Racial Disparities in Diabetes Mortality in the 50 Most Populous US Cities. *Journal of urban health: bulletin of the New York Academy of Medicine.* 2014
25. Frey, WH. New Racial Segregation Measures for States and Large Metropolitan Areas: Analysis of the 2005–2009. American Community Survey and 2000 US Census. Available from: <http://census.gov/ACS/Segregation.html>
26. Benedet JL, Bender H, Jones H 3rd, Ngan HY, Pecorelli S. FIGO staging classifications and clinical practice guidelines in the management of gynecologic cancers. FIGO Committee on Gynecologic Oncology. *Int J Gynaecol Obstet.* 2000; 70:209–62. [PubMed: 11041682]
27. Venesmaa P. Epithelial ovarian cancer: impact of surgery and chemotherapy on survival during 1977–1990. *Obstet Gynecol.* 1994; 84:8–11. [PubMed: 8008329]
28. Ries LA. Ovarian cancer. Survival and treatment differences by age. *Cancer.* 1993; 71:524–9. [PubMed: 8420672]
29. Einhorn N, Nilsson B, Sjøvall K. Factors influencing survival in carcinoma of the ovary. Study from a well-defined Swedish population. *Cancer.* 1985; 55:2019–25. [PubMed: 3978582]

30. Balvert-Locht HR, Coebergh JW, Hop WC, Brolmann HA, Crommelin M, van Wijck DJ, et al. Improved prognosis of ovarian cancer in The Netherlands during the period 1975–1985: a registry-based study. *Gynecol Oncol.* 1991; 42:3–8. [PubMed: 1916506]
31. Hogberg T, Glimelius B, Nygren P. A systematic overview of chemotherapy effects in ovarian cancer. *Acta Oncol.* 2001; 40:340–60. [PubMed: 11441940]
32. Bjorge T, Engeland A, Sundfor K, Trope CG. Prognosis of 2,800 patients with epithelial ovarian cancer diagnosed during 1975–94 and treated at the Norwegian Radium Hospital. *Acta Obstet Gynecol Scand.* 1998; 77:777–81. [PubMed: 9740528]
33. Harlan LC, Clegg LX, Trimble EL. Trends in surgery and chemotherapy for women diagnosed with ovarian cancer in the United States. *J Clin Oncol.* 2003; 21:3488–94. [PubMed: 12972525]
34. Illinois County Cancer Statistics Review, 2006–2010. Springfield, IL: Illinois Department of Public Health; 2013.
35. Young, J.L.J.; Roffers, S.D.; Ries, L.A.; Fritz, A.G.; Hurlbert, A.A. SEER Summary Staging Manual - 2000: Codes and Coding Instructions. Bethesda, MD: National Cancer Institute; 2001.
36. Illinois Department of Public Health Division of Epidemiologic Studies Illinois State Cancer Registry. User Manual. 2013. Available from: <http://www.idph.state.il.us/cancer/13/READMEv20.txt>
37. Farley, R. Racial Residential Segregation, Census 2000 Findings. Mar 25. 2014]; Available from: <http://enceladus.isr.umich.edu/race/racestart.asp>
38. U.S. Census Bureau. County Population Estimates, 100 Largest Counties 2008. Sep 25. 2009 Available from: <http://www.census.gov/popest/counties/CO-EST2008-07.html>
39. Health Resources and Services Administration. Find Shortage Areas: MUA/P by State and County. US Department of Health and Human Services; Mar 25. 2014]; Available from: <http://muafind.hrsa.gov/index.aspx>
40. Baldwin LA, Huang B, Miller RW, Tucker T, Goodrich ST, Podzielinski I, et al. Ten-year relative survival for epithelial ovarian cancer. *Obstetrics and gynecology.* 2012; 120:612–8. [PubMed: 22914471]
41. Fritz, A.G.; Percy, C.; Jack, A.; Shanmugaratnam, K.; Sobin, L.H.; Parkin, D.M., et al. International Classification of Disease for Oncology. 3. Geneva: World Health Organization; 2000.
42. Bureau of Health Information S. Research, and Evaluation;. Data Report: Ovarian Cancer in Massachusetts. Massachusetts Department of Public Health; 2010.
43. American College of Surgeons Commission on Cancer. National Cancer Data Base PUF. 2012. [cited 2014 March 25]; Available from: <http://ncdbpuf.facs.org/>
44. Grann AF, Norgaard M, Blaakaer J, Sogaard-Andersen E, Jacobsen JB. Survival of patients with ovarian cancer in central and northern Denmark, 1998–2009. *Clinical epidemiology.* 2011; 3 (Suppl 1):59–64. [PubMed: 21814472]
45. O'Malley CD, Cress RD, Campleman SL, Leiserowitz GS. Survival of Californian women with epithelial ovarian cancer, 1994–1996: a population-based study. *Gynecol Oncol.* 2003; 91:608–15. [PubMed: 14675685]
46. Browning CR, Cagney KA. Neighborhood structural disadvantage, collective efficacy, and self-rated physical health in an urban setting. *Journal of health and social behavior.* 2002; 43:383–99. [PubMed: 12664672]
47. Sampson RJ, Morenoff JD, Earls F. Beyond social capital: spatial dynamics of collective efficacy for children. *Am Soc Rev.* 1999; 64:633–60.
48. Hidalgo B, Goodman M. Multivariate or multivariable regression? *American journal of public health.* 2013; 103:39–40. [PubMed: 23153131]
49. Chase DM, Fedewa S, Chou TS, Chen A, Ward E, Brewster WR. Disparities in the allocation of treatment in advanced ovarian cancer: are there certain patient characteristics associated with nonstandard therapy? *Obstetrics and gynecology.* 2012; 119:68–77. [PubMed: 22183213]
50. National Institutes of Health Consensus Development Conference Statement. Ovarian cancer: screening, treatment, and follow-up. *Gynecol Oncol.* 1994; 55:S4–14. [PubMed: 7835809]
51. Armstrong DK, Bundy B, Wenzel L, Huang HQ, Baergen R, Lele S, et al. Intraperitoneal cisplatin and paclitaxel in ovarian cancer. *N Engl J Med.* 2006; 354:34–43. [PubMed: 16394300]

52. Aletti GD, Nordquist D, Hartmann L, Gallenberg M, Long HJ, Cliby WA. From randomized trial to practice: single institution experience using the GOG 172 i.p. chemotherapy regimen for ovarian cancer. *Ann Oncol.* 2010; 21:1772–8. [PubMed: 20139154]
53. Naumann RW, Sukumvanich P, Edwards RP. Practice patterns of intraperitoneal chemotherapy in women with ovarian cancer. *Gynecol Oncol.* 2009; 114:37–41. [PubMed: 19410281]
54. Yu JB, Gross CP, Wilson LD, Smith BD. NCI SEER public-use data: applications and limitations in oncology research. *Oncology (Williston Park, NY).* 2009; 23:288–95.
55. Winchester DP, Stewart AK, Phillips JL, Ward EE. The national cancer data base: past, present, and future. *Ann Surg Oncol.* 2010; 17:4–7. [PubMed: 19847564]
56. Warnecke RB, Oh A, Breen N, Gehlert S, Paskett E, Tucker KL, et al. Approaching health disparities from a population perspective: the National Institutes of Health Centers for Population Health and Health Disparities. *American journal of public health.* 2008; 98:1608–15. [PubMed: 18633099]
57. Islami F, Kahn AR, Bickell NA, Schymura MJ, Boffetta P. Disentangling the effects of race/ethnicity and socioeconomic status of neighborhood in cancer stage distribution in New York City. *Cancer causes & control: CCC.* 2013; 24:1069–78. [PubMed: 23504151]
58. Sogaard M, Thomsen RW, Bossen KS, Sorensen HT, Norgaard M. The impact of comorbidity on cancer survival: a review. *Clinical epidemiology.* 2013; 5:3–29. [PubMed: 24227920]
59. Berglund A, Wigertz A, Adolfsson J, Ahlgren J, Fornander T, Warnberg F, et al. Impact of comorbidity on management and mortality in women diagnosed with breast cancer. *Breast cancer research and treatment.* 2012; 135:281–9. [PubMed: 22829398]
60. Iversen LH, Norgaard M, Jacobsen J, Laurberg S, Sorensen HT. The impact of comorbidity on survival of Danish colorectal cancer patients from 1995 to 2006--a population-based cohort study. *Diseases of the colon and rectum.* 2009; 52:71–8. [PubMed: 19273959]
61. Luchtenborg M, Jakobsen E, Krasnik M, Linklater KM, Mellemegaard A, Moller H. The effect of comorbidity on stage-specific survival in resected non-small cell lung cancer patients. *Eur J Cancer.* 2012; 48:3386–95. [PubMed: 22795582]
62. Rich AL, Tata LJ, Free CM, Stanley RA, Peake MD, Baldwin DR, et al. How do patient and hospital features influence outcomes in small-cell lung cancer in England? *British journal of cancer.* 2011; 105:746–52. [PubMed: 21829191]
63. Cykert S, Dilworth-Anderson P, Monroe MH, Walker P, McGuire FR, Corbie-Smith G, et al. Factors associated with decisions to undergo surgery among patients with newly diagnosed early-stage lung cancer. *JAMA: the journal of the American Medical Association.* 2010; 303:2368–76.
64. Kennedy GD, Rajamanickam V, O'Connor ES, Loconte NK, Foley EF, Levenson G, et al. Optimizing surgical care of colon cancer in the older adult population. *Annals of surgery.* 2011; 253:508–14. [PubMed: 21169811]
65. Houterman S, Janssen-Heijnen ML, Verheij CD, Louwman WJ, Vreugdenhil G, van der Sangen MJ, et al. Comorbidity has negligible impact on treatment and complications but influences survival in breast cancer patients. *British journal of cancer.* 2004; 90:2332–7. [PubMed: 15162155]
66. Rueth NM, Parsons HM, Habermann EB, Groth SS, Virnig BA, Tuttle TM, et al. Surgical treatment of lung cancer: predicting postoperative morbidity in the elderly population. *The Journal of thoracic and cardiovascular surgery.* 2012; 143:1314–23. [PubMed: 22341420]
67. Morris EJ, Taylor EF, Thomas JD, Quirke P, Finan PJ, Coleman MP, et al. Thirty-day postoperative mortality after colorectal cancer surgery in England. *Gut.* 2011; 60:806–13. [PubMed: 21486939]
68. Van Leeuwen BL, Rosenkranz KM, Feng LL, Bedrosian I, Hartmann K, Hunt KK, et al. The effect of under-treatment of breast cancer in women 80 years of age and older. *Critical reviews in oncology/hematology.* 2011; 79:315–20. [PubMed: 20655242]
69. van Steenberghe LN, Rutten HJ, Creemers GJ, Pruijt JF, Coebergh JW, Lemmens VE. Large age and hospital-dependent variation in administration of adjuvant chemotherapy for stage III colon cancer in southern Netherlands. *Ann Oncol.* 2010; 21:1273–8. [PubMed: 19880434]

70. Bradley CJ, Given CW, Dahman B, Fitzgerald TL. Adjuvant chemotherapy after resection in elderly Medicare and Medicaid patients with colon cancer. *Archives of internal medicine*. 2008; 168:521–9. [PubMed: 18332299]
71. Luo R, Giordano SH, Freeman JL, Zhang D, Goodwin JS. Referral to medical oncology: a crucial step in the treatment of older patients with stage III colon cancer. *The oncologist*. 2006; 11:1025–33. [PubMed: 17030645]
72. Gross CP, Guo Z, McAvay GJ, Allore HG, Young M, Tinetti ME. Multimorbidity and survival in older persons with colorectal cancer. *Journal of the American Geriatrics Society*. 2006; 54:1898–904. [PubMed: 17198496]
73. Gray SW, Landrum MB, Lamont EB, McNeil BJ, Jaklitsch MT, Keating NL. Improved outcomes associated with higher surgery rates for older patients with early stage nonsmall cell lung cancer. *Cancer*. 2012; 118:1404–11. [PubMed: 21800285]
74. Pasetto LM, Falci C, Basso U, Gasparini G, D'Andrea M, Bonginelli P, et al. Adjuvant treatment for elderly patients with colon cancer. An observational study. *Anticancer research*. 2008; 28:2513–8. [PubMed: 18751443]
75. Dy SM, Sharkey P, Herbert R, Haddad K, Wu AW. Comorbid illnesses and health care utilization among Medicare beneficiaries with lung cancer. *Critical reviews in oncology/hematology*. 2006; 59:218–25. [PubMed: 16829124]
76. Booth CM, Shepherd FA, Peng Y, Darling G, Li G, Kong W, et al. Adjuvant chemotherapy for non-small cell lung cancer: practice patterns and outcomes in the general population of Ontario, Canada. *Journal of thoracic oncology: official publication of the International Association for the Study of Lung Cancer*. 2012; 7:559–66.
77. Gronberg BH, Sundstrom S, Kaasa S, Bremnes RM, Flotten O, Amundsen T, et al. Influence of comorbidity on survival, toxicity and health-related quality of life in patients with advanced non-small-cell lung cancer receiving platinum-doublet chemotherapy. *Eur J Cancer*. 2010; 46:2225–34. [PubMed: 20471248]
78. Hu CY, Delclos GL, Chan W, Du XL. Assessing the initiation and completion of adjuvant chemotherapy in a large nationwide and population-based cohort of elderly patients with stage-III colon cancer. *Med Oncol*. 2011; 28:1062–74. [PubMed: 20714945]
79. Maas HA, Kruitwagen RF, Lemmens VE, Goey SH, Janssen-Heijnen ML. The influence of age and co-morbidity on treatment and prognosis of ovarian cancer: a population-based study. *Gynecol Oncol*. 2005; 97:104–9. [PubMed: 15790445]
80. Jorgensen TL, Teiblum S, Paludan M, Poulsen LO, Jorgensen AY, Bruun KH, et al. Significance of age and comorbidity on treatment modality, treatment adherence, and prognosis in elderly ovarian cancer patients. *Gynecol Oncol*. 2012; 127:367–74. [PubMed: 22800653]
81. Tetsche MS, Dethlefsen C, Pedersen L, Sorensen HT, Norgaard M. The impact of comorbidity and stage on ovarian cancer mortality: a nationwide Danish cohort study. *BMC cancer*. 2008; 8:31. [PubMed: 18230177]
82. Tingulstad S, Skjeldestad FE, Halvorsen TB, Hagen B. Survival and prognostic factors in patients with ovarian cancer. *Obstetrics and gynecology*. 2003; 101:885–91. [PubMed: 12738145]
83. DiSilvestro P, Peipert JF, Hogan JW, Granai CO. Prognostic value of clinical variables in ovarian cancer. *Journal of clinical epidemiology*. 1997; 50:501–5. [PubMed: 9180642]
84. Shinn EH, Lenihan DJ, Urbauer DL, Basen-Engquist KM, Valentine A, Palmero L, et al. Impact of cardiovascular comorbidity on ovarian cancer mortality. *Cancer epidemiology, biomarkers & prevention: a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology*. 2013; 22:2102–9.
85. Bristow RE, Palis BE, Chi DS, Cliby WA. The National Cancer Database report on advanced-stage epithelial ovarian cancer: impact of hospital surgical case volume on overall survival and surgical treatment paradigm. *Gynecol Oncol*. 2010; 118:262–7. [PubMed: 20573392]

Highlights

The research findings include the following:

- Racial inequality exists in receipt of even the most basic level of oncologic care for OVCA in Cook County, Illinois
- Neighborhood-level concentrated advantage appears to play a role in receipt of chemotherapy, but not in receipt of surgery
- Inequality in treatment for OVCA persisted despite adjustment for both individual-level clinical factors and neighborhood-level SES (concentrated affluence and disadvantage)

Table 1
Demographics and clinical variables by non-Hispanic White and non-Hispanic Black (NHW, NHB).

	NHW		NHB		Total	Chi-Square
	n	%	n	%	3413	p-value
Age at diagnosis						
<50 yrs	537	19.4	142	22.0	679	0.003
50 – 64 years	954	34.5	228	35.2	1182	
60 – 74 years	594	21.5	160	24.7	754	
75+ years	681	24.6	117	18.1	798	
Concentrated Disadvantage^{*,†}						
1st quartile (lowest)	815	29.5	34	5.3	849	<.0001
2nd quartile	833	30.1	19	3.0	852	
3rd quartile	675	24.4	174	27.2	849	
4th quartile (highest)	441	16.0	414	64.6	855	
Concentrated Affluence[‡]						
1st quartile (lowest)	465	17.6	342	57.5	807	<.0001
2nd quartile	649	24.6	160	26.9	809	
3rd quartile	734	27.8	61	10.3	795	
4th quartile (highest)	795	30.1	32	5.34	827	
Period of diagnosis						
2004 – 2009	1254	45.3	327	50.5	1581	0.02
1998 – 2003	1512	54.7	320	49.5	1832	
Stage						
Stage I	632	22.9	85	13.1	717	<.0001
Stage II	200	7.2	49	7.6	249	
Stage III	1036	37.5	198	30.6	1234	
Stage IV	685	24.8	240	37.1	925	
NA, Unknown or Missing	213	7.7	75	11.6	288	
Grade						
Well/moderately differentiated	704	25.5	152.0	23.5	856	0.0002

	NHWS		NHB		Total	Chi-Square
	n	%	n	%		p-value
Poorly differentiated/undifferentiated/anaplastic	1282	46.4	260.0	40.2	1542	
Cell type not determined, not stated or not applicable	780	28.2	235.0	36.3	1015	
Vital Status						
Alive	1188	43.0	193	29.8	1381	<.0001
Dead	1578	57.1	454	70.2	2032	
Surgery Performed						
No surgery	480	17.4	216	33.4	696	<.0001
Resection of the ovary	35	1.3	13	2.0	48	
Oophorectomy	593	21.4	148	22.9	741	
Oophorectomy with omentectomy	915	33.1	168	26.0	1083	
Debulking cytoreductive surgery	686	24.8	77	11.9	763	
Pelvic extenteration	25	0.9	5	0.8	30	
Surgery, unspecified	19	0.7	12	1.9	31	
Missing	13	0.5	8	1.2	21	
Administration of Any Surgery						
Yes	2273	82.6	423	66.2	2696	<.0001
No	480	17.4	216	33.8	696	
Administration of Debulking Surgery						
Yes	711	25.8	82	12.8	793	<.0001
No	2042	74.2	557	87.2	2599	
Chemotherapy						
None	736	28.9	224	37.2	960	<.0001
Chemotherapy administered, type and number of agents not documented	166	6.5	57	9.5	223	
Single-agent chemotherapy	73	2.9	14	2.3	87	
Multi-agent chemotherapy	1482	58.2	278	46.2	1760	
Unknown	90	3.5	29	4.8	119	
Missing	219		46		265	
Administration of Any Chemotherapy						
Yes	1721	70.0	349	60.9	2070	<.0001

	NHW		NHB		Total	Chi-Square <i>p</i> -value
	n	%	n	%		
No	736	30.0	224	39.1	960	
Administration of Multi-Agent Chemotherapy						
Yes	1482	60.3	278	48.5	1760	<.0001
No	975	39.7	295	51.5	1270	

* Concentrated affluence and disadvantage divided into quartiles based on the sample distribution.

[†] Concentrated disadvantage: index variable constructed using the sum of standardized 2000 Census tract variables, including percent below poverty, percent unemployed, percent receiving public assistance, percent in female-headed households, percent under age 18, and percent Black.

[‡] Concentrated affluence: index variable constructed using the sum of standardized 2000 Census tract variables, including percent of families with incomes above \$75,000, percent of adults with college education, and percent of civilian labor force employed in professional/managerial occupations.

Table 2

Multivariable logistic regression odds ratio (OR) results for the association between non-Hispanic Black (NHB) and administration of various ovarian cancer treatments: 1) Debulking Surgery; 2) Any Surgery; 3) Multi-Agent Chemotherapy; and, 4) Any Chemotherapy. Results demonstrate NHB were significantly less likely than NHW to receive treatment in unadjusted (Model 1) and adjusted models (Models 2–7). Models 1–5 ignore the hierarchical structure of the data (e.g., cases clustered within Census tracts), while Models 6 and 7 account for clustering through use of a multi-level logistic regression model. Statistically significant models for each treatment outcome (identified by comparison –2Log Likelihood among Models 1–5) are highlighted in bold (Debulking Surgery: Model 3; Any Surgery: Model 2; Multi-Agent Chemotherapy: Model 4; Any Chemotherapy: Model 4).

Logistic Regression	Debulking Surgery			Any Surgery			Multi-Agent Chemotherapy			Any Chemotherapy		
	OR	95% CI	P Value	OR	95% CI	P Value	OR	95% CI	P Value	OR	95% CI	P Value
Model 1 *	0.42	0.33	0.54	<.0001	0.41	0.34	0.50	<.0001	0.62	0.52	0.74	<.0001
Model 2 †	0.38	0.29	0.49	<.0001	0.38	0.29	0.49	<.0001	0.50	0.41	0.61	<.0001
Model 3 ‡	0.39	0.30	0.50	<.0001	0.37	0.29	0.49	<.0001	0.48	0.39	0.59	<.0001
Model 4 §	0.44	0.33	0.58	<.0001	0.39	0.29	0.53	<.0001	0.56	0.45	0.71	<.0001
Model 5 **	0.43	0.32	0.59	<.0001	0.43	0.30	0.60	<.0001	0.53	0.41	0.68	<.0001
Model 6, ML Model ††	0.47	0.34	0.65	<.0001	0.42	0.30	0.61	<.0001	0.51	0.39	0.67	<.0001
Model 7, Final ML Model †††	0.39	0.30	0.51	<.0001	0.38	0.29	0.50	<.0001	0.56	0.44	0.70	<.0001

* Unadjusted.

† Adjusted for age, stage at diagnosis, tumor grade.

‡ Adjusted for age, stage at diagnosis, tumor grade, and year of diagnosis.

§ Adjusted for age, stage at diagnosis, tumor grade, year of diagnosis, and concentrated affluence.

** Adjusted for age, stage at diagnosis, tumor grade, year of diagnosis, concentrated disadvantage and affluence.

†† Multi-level model (nested by Census tract) adjusted for age, stage at diagnosis, tumor grade, year of diagnosis, concentrated disadvantage and affluence..

††† Multi-level model (nested by Census tract) for each treatment outcome adjusted by outcome-specific covariates significant in each final multivariable logical regression model.

Concentrated affluence: index variable constructed using the sum of standardized 2000 Census tract variables, including percent of families with incomes above \$75,000, percent of adults with college education, and percent of civilian labor force employed in professional/managerial occupations.

Concentrated disadvantage: index variable constructed using the sum of standardized 2000 Census tract variables, including percent below poverty, percent unemployed, percent receiving public assistance, percent in female-headed households, percent under age 18, and percent Black.