Published in final edited form as:

Cancer Causes Control. 2014 April ; 25(4): 507–513. doi:10.1007/s10552-014-0353-y.

Bilateral oophorectomy and risk of cancer in African American women

Deborah A. Boggs¹, Julie R. Palmer¹, and Lynn Rosenberg¹

¹Slone Epidemiology Center at Boston University, Boston, MA

Abstract

Purpose—African American women are more likely to undergo hysterectomy, with or without bilateral oophorectomy, at younger ages than white women. It is well established that women who have a bilateral oophorectomy at younger ages are at reduced risk of breast cancer, and there is some evidence of an increased risk for colorectal and lung cancer.

Methods—Using data from 44,514 women in the Black Women's Health Study, we prospectively investigated the relation of hysterectomy and oophorectomy to incidence of breast, colorectal, and lung cancer and to mortality from cancer. Hazard ratios (HRs) and 95% confidence intervals (CIs) were estimated using Cox proportional hazards regression with control for confounding factors.

Results—During 16 years of follow-up, hysterectomy alone, relative to no hysterectomy, was not associated with risk of breast, lung, or colorectal cancer. Bilateral oophorectomy, relative to hysterectomy with ovarian conservation, was inversely associated with risk of estrogen receptor-positive (ER+) breast cancer (HR=0.62; 95% CI 0.45–0.85) but not with ER-negative breast cancer; age at surgery and menopausal hormone use did not modify the associations. HRs for the association of bilateral oophorectomy with incidence of colorectal and lung cancer were nonsignificantly elevated for women who had surgery before age 40 years and had used menopausal hormones for less than 2 years (HR=1.65; 95% CI 0.73–3.73 for colorectal cancer and HR=1.71; 95% CI 0.68–4.31 for lung cancer). Bilateral oophorectomy was not associated with cancer mortality.

Conclusions—Bilateral oophorectomy was associated with reduced risk of ER+ breast cancer regardless of age at surgery and use of menopausal hormones. There were nonsignificant increases in risk of colorectal and lung cancer for women with oophorectomy at younger ages and short duration of menopausal hormone use.

Approximately 600,000 women undergo a hysterectomy in the United States each year, with about half having a concurrent bilateral oophorectomy (1). Elective bilateral oophorectomy at the time of hysterectomy for benign disease is typically recommended to reduce the risk of ovarian cancer. However, the long-term risks and benefits with respect to other health outcomes are less clear. A few previous studies have found bilateral oophorectomy to be

Corresponding author: Deborah A. Boggs, Slone Epidemiology Center, 1010 Commonwealth Avenue, Boston, MA, 02215; Tel: (617) 734-6006; Fax: (617) 738-5119; dboggs@bu.edu.

Conflict of interest: The authors declare no conflicts of interest.

associated with increased mortality rates (2–4), but other studies have not supported this finding (5, 6). Bilateral oophorectomy has been associated with reduced breast cancer risk overall (4, 7–12), but whether the association differs by breast cancer subtype is not established (13, 14). A few studies suggest that bilateral oophorectomy may be associated with increases in risk of colorectal cancer (4, 15) and lung cancer (4, 16–18); although the mechanism is unclear, estrogens are thought to be protective, as evidenced by some epidemiologic studies that have found inverse associations between menopausal hormone use and risk of colorectal cancer (19, 20) and lung cancer (21, 22).

The prevalence of hysterectomy for benign disease is higher in African American women relative to white women (23, 24), and the average age at surgery is lower for African American women (25). There is substantial between-hospital variation in oophorectomy rates that is not explained by patient or physician characteristics (26). African American women are also less likely to use menopausal hormones following a bilateral oophorectomy (27). The disparities in clinical practice highlight the need for evidence to clarify the risk-to-benefit ratio of elective oophorectomy for women not at increased risk for ovarian cancer.

The objective of the present study was to investigate the relation of hysterectomy and oophorectomy to the incidence of common cancers (breast, colorectal, and lung) and to total cancer mortality among African American women. We assessed breast cancer according to estrogen receptor (ER) status. In addition, we sought to examine whether associations were influenced by age at surgery and use of menopausal hormones. This investigation is the first to prospectively assess these associations among African American women.

METHODS

Study population

The Black Women's Health Study, an ongoing follow-up study of African American women, was established in 1995 when 59,000 African American women aged 21–69 years completed a self-administered baseline questionnaire that collected information on demographic characteristics, lifestyle factors, and medical history (28). Biennial follow-up questionnaires ascertain updated information on risk factors and newly diagnosed medical conditions. Follow-up of the baseline cohort through 2011 was 80%. The study was approved by the institutional review board of Boston University Medical Center.

The present analysis was restricted to women aged at least 40 years at baseline or who reached age 40 during follow-up; 3,385 women were excluded because they had a history of cancer prior to baseline, had a family history of ovarian cancer, had a unilateral oophorectomy or oophorectomy without hysterectomy, had reproductive surgery after natural menopause, or had missing data on type of surgical menopause, leaving 44,514 women for the analysis.

Exposure assessment

Questions on menopausal status were included on the baseline and all follow-up questionnaires. Women were asked if they had stopped menstruating at least 12 months earlier; if yes, they were asked for the reason their periods had stopped (natural, surgical,

due to medication or chemotherapy, or unknown), and the age at which they had stopped. Women who reported surgical menopause were also asked whether they had both ovaries removed, only one ovary removed, or only the uterus removed.

We assessed the reliability of self-report of surgical menopause on the 1997 questionnaire using data from 1,148 participants who completed and returned 2 questionnaires during that follow-up cycle; the kappa coefficient was 0.91 for self-reported hysterectomy and bilateral oophorectomy, indicating very high reproducibility in the reporting of these surgeries.

The baseline questionnaire collected information on height, weight, educational attainment, and family history of breast cancer. The 1999 questionnaire ascertained family history of ovarian cancer. Baseline and biennial follow-up questionnaires ascertained information on parity, oral contraceptive use, menopausal hormone use, physical activity, smoking history, and alcohol intake. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Smoking status, number of cigarettes smoked, and duration of smoking were used to calculate total pack-years of smoking.

End points

Incident diagnoses of invasive breast cancer, colorectal cancer, and lung cancer were ascertained by self-report on biennial follow-up questionnaires from 1995–2011. Cases were confirmed by medical record or by linkage with cancer registries from 24 states in which 96% of participants resided at baseline. Deaths through December 31, 2011 were identified through linkage with the National Death Index for all participants who had not completed the 2011 questionnaire. The *International Classification of Diseases*, Tenth Revision (ICD-10) was used to classify underlying cause of death; death from cancer was based on ICD-10 codes C00-C97.

Statistical analysis

Cox proportional hazards models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for risk of incident cancer and cancer mortality. Women contributed person-time from baseline in 1995 until diagnosis of the cancer of interest (for incident cancer analyses), death, or the end of follow-up on December 31, 2011, whichever occurred first. Women under age 40 years in 1995 entered the analysis in the questionnaire cycle in which they reached 40 years. History of reproductive surgery was updated every 2 years as a time-dependent variable. In analyses restricted to women with a hysterectomy, women contributed person-time from cohort entry or the questionnaire cycle in which they first reported a hysterectomy with retention of both ovaries or hysterectomy with removal of both ovaries. Participants were censored during follow-up if they reported a unilateral oophorectomy or reproductive surgery after natural menopause or age 60 years.

Multivariable models, stratified by age in years and 2-year questionnaire cycle, were adjusted for BMI in 1995 (<25, 25–29, 30 kg/m²), menopausal hormone use (never, <2, 2–4, 5 years), smoking history (never, former <20 pack-years, former 20 pack-years, current <20 pack-years, current 20 pack-years), educational attainment (12, 13–15, 16 years), geographic region (northeast, south, midwest, west), and family history of breast cancer.

Parity, oral contraceptive use, vigorous physical activity, and alcohol intake were assessed as potential confounders but inclusion of these covariates in multivariable models did not appreciably affect the results. Covariates that changed over time were updated as time-varying variables in the analysis. We conducted subgroup analyses according to age at hysterectomy (<40, 40 years) and among women with <2 years of menopausal hormone use. All statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

At baseline, 10.3% of participants reported a history of hysterectomy with retention of both ovaries and 10.2% reported a hysterectomy with bilateral oophorectomy (Table 1). The mean age at surgery was 37.8 years for hysterectomy alone and 39.5 years for bilateral oophorectomy. Compared to women with no hysterectomy, women with hysterectomy, with or without bilateral oophorectomy, were older, less educated, and more likely to live in the South, to be obese and to have used menopausal hormones for at least 2 years.

Hysterectomy alone relative to no hysterectomy was not associated with incidence of breast cancer, colorectal cancer, or lung cancer (Table 2). However, compared with no hysterectomy, bilateral oophorectomy was associated with a significant reduction in risk of breast cancer. The inverse association was evident only for ER+ breast cancer (HR=0.65; 95% CI 0.50–0.86). Bilateral oophorectomy was associated with increased colorectal cancer risk (HR=1.42; 95% CI 1.02–2.00); adjustment for menopausal hormone use had the greatest effect on the estimates. Bilateral oophorectomy was not materially associated with lung cancer risk.

Table 3 presents results restricted to women with a hysterectomy, alone or with removal of both ovaries, according to age at surgery and use of menopausal hormones. Relative to hysterectomy with ovarian conservation, bilateral oophorectomy was associated with lower risk of ER+ breast cancer (HR=0.62; 95% CI 0.45–0.85), with similar associations for surgery that occurred before and after age 40 years. Estimates were not appreciably different when analyses were restricted to women with little or no menopausal hormone use. Bilateral oophorectomy was not significantly associated with risks of colorectal cancer and lung cancer, but the HRs were greatest among women with surgery before age 40 and <2 years of menopausal hormone use (HR=1.65; 95% CI 0.73–3.73 for colorectal cancer and HR=1.71; 95% CI 0.68–4.31 for lung cancer).

There was no association for bilateral oophorectomy, relative to hysterectomy with ovarian conservation, with total cancer mortality overall based on 301 deaths (HR=0.96; 95% CI 0.75–1.23) or among women with surgery <40 years who had used menopausal hormones for <2 years based on 70 deaths (HR=0.97; 95% CI 0.57–1.64). We had limited power to examine death from specific cancers separately, and no significant associations were observed for mortality from breast, colorectal, or lung cancer (data not shown).

DISCUSSION

In this prospective study of African American women, bilateral oophorectomy, relative to no surgery or to hysterectomy alone, was associated with a decreased risk of ER+ breast cancer but was not associated with ER– cancer. Our findings are consistent with previous studies that have found bilateral oophorectomy relative to no reproductive surgery to be associated with reduced breast cancer risk overall (7–12). Only two studies have specifically examined bilateral oophorectomy compared with ovarian conservation at the time of hysterectomy in relation to breast cancer risk (4, 5). Similar to our findings, bilateral oophorectomy was significantly associated with reduced breast cancer risk in the Nurses' Health Study (4). In contrast, no association was observed in the Women's Health Initiative, a study in which all participants were 50 years or older at the start of follow-up (5).

Two studies have examined bilateral oophorectomy and breast cancer risk according to breast cancer subtype (13, 14): in one study, bilateral oophorectomy relative to no reproductive surgery was associated with a strong reduction in ER+ but not ER– breast cancer risk among both white and black women (13), and in the other, a study that included mostly white women, bilateral oophorectomy relative to natural menopause was inversely associated only with luminal breast cancer (14).

In the present study, hysterectomy with ovarian conservation was not associated with breast cancer risk overall or by ER status. Previous studies of hysterectomy alone in relation to breast cancer risk have been inconsistent (9–13); of the few that assessed risk by breast cancer subtype, one found hysterectomy alone to be inversely associated only with ER+ breast cancer (13), and another reported no association overall or by ER status (29).

For colorectal and lung cancer, we observed nonsignificant increases in risk associated with bilateral oophorectomy that appeared stronger among women with younger ages at surgery and short duration of menopausal hormone use. Some previous studies support a positive association of bilateral oophorectomy with risk of colorectal cancer (4, 15) and lung cancer (4, 16–18). In a comparison of bilateral oophorectomy to hysterectomy with ovarian conservation in the Nurses' Health Study, there was a significant increase in lung cancer risk that was greatest among women who had never used menopausal hormones and a marginally significant increase in colorectal cancer risk (4); in an updated analysis of mortality with additional follow-up, bilateral oophorectomy was significantly associated with increased risk of death from colorectal cancer and lung cancer (30). In contrast, the Women's Health Initiative, an older cohort at study enrollment, found no significant associations for bilateral oophorectomy relative to ovarian conservation with risk of colorectal or lung cancer, though statistical power was limited among women with no menopausal hormone use, as in the present study (5). Findings between studies may differ if bilateral oophorectomy has a greater effect on cancer risk closer to the age at surgery.

A protective effect of endogenous estrogens on colorectal and lung cancer risk is supported by studies showing that earlier age at natural menopause is associated with increased risk of colorectal cancer (31) and lung cancer (17, 18, 32, 33). If exogenous estrogens are protective, as suggested by studies that have observed inverse associations between

menopausal hormone use and risk of colorectal cancer (19, 20) and lung cancer (21, 22), this might explain why an association of bilateral oophorectomy with colorectal and lung cancer risk was more apparent in women who had little or no menopausal hormone use.

The present study has several strengths. The prospective design obviated reporting bias on reproductive surgery. Information on surgical menopause and important covariates was obtained at baseline and updated every 2 years by follow-up questionnaire. We controlled for numerous lifestyle factors, although residual confounding cannot be discounted. We excluded women with a family history of ovarian cancer, unilateral oophorectomy, or oophorectomy without hysterectomy in order to reduce confounding by indication for surgery. Few studies that have examined the effect of oophorectomy on various health outcomes have specifically compared bilateral oophorectomy at the time of hysterectomy with ovarian conservation, which is an important clinical decision for women undergoing hysterectomy for benign disease. The mean age at reproductive surgery in the Black Women's Health Study was lower than in other studies, which allowed us to assess the effects of early surgical menopause.

A limitation was lack of validation of self-report of reproductive surgery. It has been shown that history of hysterectomy is reported with great accuracy, whereas reporting of oophorectomy history is less accurate (34). Although we did not have validation data, we found that there was high reliability in the reporting of bilateral oophorectomy and hysterectomy alone. The misclassification of women with a prior oophorectomy as having had a hysterectomy alone would tend to attenuate the associations. Another limitation was that the number of cancer deaths was relatively small. It will be informative to reevaluate associations with mortality after longer follow-up. In the Nurses' Health Study, with an older cohort and longer follow-up, bilateral oophorectomy was associated with increased rates of total cancer mortality, and the magnitude of association was highest for oophorectomy before age 50 years in women who never used menopausal hormones (4, 30).

In summary, bilateral oophorectomy was associated with decreased risk of ER+ breast cancer, regardless of age at surgery and use of menopausal hormones, in this cohort of African American women. There were suggestive increases in risk of colorectal and lung cancer among women who underwent oophorectomy before age 40 years and used menopausal hormones for less than 2 years. Further evidence is needed to weigh the risks and benefits of elective oophorectomy for women not at high risk of ovarian cancer.

ACKNOWLEDGMENTS

We gratefully acknowledge the continuing dedication of the Black Women's Health Study participants and staff. This work was supported by the National Cancer Institute (R03CA162103 and R01CA058420). The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health. Data on breast cancer pathology were obtained from several state cancer registries (AZ, CA, CO, CT, DE, DC, FL, GA, IL, IN, KY, LA, MD, MA, MI, NJ, NY, NC, OK, PA, SC, TN, TX, VA), and results reported do not necessarily represent their views.

REFERENCES

1. Whiteman MK, Hillis SD, Jamieson DJ, Morrow B, Podgornik MN, Brett KM, et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. *Am J Obstet Gynecol.* 2008; 198:34, e1–7. [PubMed: 17981254]
2. Parker WH, Broder MS, Liu Z, Shoupe D, Farquhar C, Berek JS. Ovarian conservation at the time of hysterectomy for benign disease. *Obstet Gynecol.* 2005; 106:219–26. [PubMed: 16055568]
3. Rocca WA, Grossardt BR, de Andrade M, Malkasian GD, Melton LJ 3rd. Survival patterns after oophorectomy in premenopausal women: a population-based cohort study. *Lancet Oncol.* 2006; 7:821–8. [PubMed: 17012044]
4. Parker WH, Broder MS, Chang E, Feskanich D, Farquhar C, Liu Z, et al. Ovarian conservation at the time of hysterectomy and long-term health outcomes in the nurses' health study. *Obstet Gynecol.* 2009; 113:1027–37. [PubMed: 19384117]
5. Jacoby VL, Grady D, Wactawski-Wende J, Manson JE, Allison MA, Kuppermann M, et al. Oophorectomy vs ovarian conservation with hysterectomy: cardiovascular disease, hip fracture, and cancer in the Women's Health Initiative Observational Study. *Arch Intern Med.* 2011; 171:760–8. [PubMed: 21518944]
6. Duan L, Xu X, Koebnick C, Lacey JV Jr. Sullivan-Halley J, Templeman C, et al. Bilateral oophorectomy is not associated with increased mortality: the California Teachers Study. *Fertil Steril.* 2012; 97:111–7. [PubMed: 22088205]
7. Nichols HB, Trentham-Dietz A, Newcomb PA, Titus LJ, Egan KM, Hampton JM, et al. Postoophorectomy estrogen use and breast cancer risk. *Obstet Gynecol.* 2012; 120:27–36. [PubMed: 22914389]
8. Trichopoulos D, MacMahon B, Cole P. Menopause and breast cancer risk. *J Natl Cancer Inst.* 1972; 48:605–13. [PubMed: 5058966]
9. Irwin KL, Lee NC, Peterson HB, Rubin GL, Wingo PA, Mandel MG. Hysterectomy, tubal sterilization, and the risk of breast cancer. *Am J Epidemiol.* 1988; 127:1192–201. [PubMed: 3369418]
10. Parazzini F, Braga C, La Vecchia C, Negri E, Acerboni S, Franceschi S. Hysterectomy, oophorectomy in premenopause, and risk of breast cancer. *Obstet Gynecol.* 1997; 90:453–6. [PubMed: 9277661]
11. Schairer C, Persson I, Falkeborn M, Naessen T, Troisi R, Brinton LA. Breast cancer risk associated with gynecologic surgery and indications for such surgery. *Int J Cancer.* 1997; 70:150–4. [PubMed: 9009152]
12. Kreiger N, Sloan M, Cotterchio M, Kirsh V. The risk of breast cancer following reproductive surgery. *Eur J Cancer.* 1999; 35:97–101. [PubMed: 10211095]
13. Press DJ, Sullivan-Halley J, Ursin G, Deapen D, McDonald JA, Strom BL, et al. Breast cancer risk and ovariectomy, hysterectomy, and tubal sterilization in the women's contraceptive and reproductive experiences study. *Am J Epidemiol.* 2011; 173:38–47. [PubMed: 21109566]
14. Phipps AI, Malone KE, Porter PL, Daling JR, Li CI. Reproductive and hormonal risk factors for postmenopausal luminal, HER-2-overexpressing, and triple-negative breast cancer. *Cancer.* 2008; 113:1521–6. [PubMed: 18726992]
15. Jacobs EJ, White E, Weiss NS. Exogenous hormones, reproductive history, and colon cancer (Seattle, Washington, USA). *Cancer Causes Control.* 1994; 5:359–66. [PubMed: 8080948]
16. Gallagher LG, Rosenblatt KA, Ray RM, Li W, Gao DL, Applebaum KM, et al. Reproductive factors and risk of lung cancer in female textile workers in Shanghai, China. *Cancer Causes Control.* 2013; 24:1305–14. [PubMed: 23584535]
17. Brinton LA, Gierach GL, Andaya A, Park Y, Schatzkin A, Hollenbeck AR, et al. Reproductive and hormonal factors and lung cancer risk in the NIH-AARP Diet and Health Study cohort. *Cancer Epidemiol Biomarkers Prev.* 2011; 20:900–11. [PubMed: 21467241]
18. Koushik A, Parent ME, Siemiatycki J. Characteristics of menstruation and pregnancy and the risk of lung cancer in women. *Int J Cancer.* 2009; 125:2428–33. [PubMed: 19585503]

19. Johnson JR, Lacey JV Jr, Lazovich D, Geller MA, Schairer C, Schatzkin A, et al. Menopausal hormone therapy and risk of colorectal cancer. *Cancer Epidemiol Biomarkers Prev.* 2009; 18:196–203. [PubMed: 19124498]
20. Delellis Henderson K, Duan L, Sullivan-Halley J, Ma H, Clarke CA, Neuhausen SL, et al. Menopausal hormone therapy use and risk of invasive colon cancer: the California Teachers Study. *Am J Epidemiol.* 2010; 171:415–25. [PubMed: 20067917]
21. Rodriguez C, Spencer Feigelson H, Deka A, Patel AV, Jacobs EJ, Thun MJ, et al. Postmenopausal hormone therapy and lung cancer risk in the cancer prevention study II nutrition cohort. *Cancer Epidemiol Biomarkers Prev.* 2008; 17:655–60. [PubMed: 18349283]
22. Schwartz AG, Wenzlaff AS, Prysak GM, Murphy V, Cote ML, Brooks SC, et al. Reproductive factors, hormone use, estrogen receptor expression and risk of non small-cell lung cancer in women. *J Clin Oncol.* 2007; 25:5785–92. [PubMed: 18089876]
23. Powell LH, Meyer P, Weiss G, Matthews KA, Santoro N, Randolph JF Jr, et al. Ethnic differences in past hysterectomy for benign conditions. *Womens Health Issues.* 2005; 15:179–86. [PubMed: 16051109]
24. Bower JK, Schreiner PJ, Sternfeld B, Lewis CE. Black-White differences in hysterectomy prevalence: the CARDIA study. *Am J Public Health.* 2009; 99:300–7. [PubMed: 19059854]
25. Kjerulff KH, Guzinski GM, Langenberg PW, Stolley PD, Moye NE, Kazandjian VA. Hysterectomy and race. *Obstet Gynecol.* 1993; 82:757–64. [PubMed: 8414322]
26. Perera HK, Ananth CV, Richards CA, Neugut AI, Lewin SN, Lu YS, et al. Variation in ovarian conservation in women undergoing hysterectomy for benign indications. *Obstet Gynecol.* 2013; 121:717–26. [PubMed: 23635670]
27. Moorman PG, Kuwabara H, Millikan RC, Newman B. Menopausal hormones and breast cancer in a biracial population. *Am J Public Health.* 2000; 90:966–71. [PubMed: 10846517]
28. Palmer JR, Wise LA, Horton NJ, Adams-Campbell LL, Rosenberg L. Dual effect of parity on breast cancer risk in African-American women. *J Natl Cancer Inst.* 2003; 95:478–83. [PubMed: 12644541]
29. Woolcott CG, Maskarinec G, Pike MC, Henderson BE, Wilkens LR, Kolonel LN. Breast cancer risk and hysterectomy status: the Multiethnic Cohort study. *Cancer Causes Control.* 2009; 20:539–47. [PubMed: 19009364]
30. Parker WH, Feskanich D, Broder MS, Chang E, Shoupe D, Farquhar CM, et al. Long-term mortality associated with oophorectomy compared with ovarian conservation in the Nurses' Health Study. *Obstet Gynecol.* 2013; 121:709–16. [PubMed: 23635669]
31. Peters RK, Pike MC, Chang WW, Mack TM. Reproductive factors and colon cancers. *Br J Cancer.* 1990; 61:741–8. [PubMed: 2337511]
32. Weiss JM, Lacey JV Jr, Shu XO, Ji BT, Hou L, Yang G, et al. Menstrual and reproductive factors in association with lung cancer in female lifetime nonsmokers. *Am J Epidemiol.* 2008; 168:1319–25. [PubMed: 18849300]
33. Baik CS, Strauss GM, Speizer FE, Feskanich D. Reproductive factors, hormone use, and risk for lung cancer in postmenopausal women, the Nurses' Health Study. *Cancer Epidemiol Biomarkers Prev.* 2010; 19:2525–33. [PubMed: 20739629]
34. Phipps AI, Buist DS. Validation of self-reported history of hysterectomy and oophorectomy among women in an integrated group practice setting. *Menopause.* 2009; 16:576–81. [PubMed: 19169161]

Age-standardized baseline characteristics according to history of reproductive surgery among participants aged 40–69 years in the Black Women's Health Study

Table 1

Characteristic	No hysterectomy	Hysterectomy alone	With bilateral oophorectomy
N (%)	35,382 (79.5)	4,576 (10.3)	4,556 (10.2)
Age, y (mean ± SD)	43.5 ± 5.7	47.5 ± 7.3	50.3 ± 7.9
Age at surgery, y (mean ± SD)	NA	37.8 ± 5.1	39.5 ± 6.8
Region (%)			
Northeast	27.9	16.6	17.1
South	30.7	37.9	39.9
Midwest	22.7	26.5	25.8
West	18.7	19.0	17.2
Education 16 y (%)	50.8	40.9	37.3
Parity 3 births (%)	24.4	25.9	23.1
Oral contraceptive use 5 y (%)	36.3	31.3	28.5
Menopausal hormone use 2 y (%)	3.3	10.5	51.7
Body mass index 30 kg/m ² (%)	29.2	33.7	39.2
Vigorous activity 5 h/wk (%)	9.8	9.4	8.2
Current smoker (%)	16.5	17.4	22.0
Alcohol intake 7 drinks/wk (%)	5.7	5.9	5.4
Family history of breast cancer (%)	9.8	10.4	10.9

Table 2

Reproductive surgery and risk of incident cancer in the Black Women's Health Study, 1995–2011

	No hysterectomy	Hysterectomy alone	With bilateral oophorectomy
Breast cancer			
Cases/person-years	808/326,182	180/56,178	183/69,841
Age-adjusted HR	1.00 (Ref.)	1.08 (0.92–1.28)	0.80 (0.67–0.94)
Multivariable HR	1.00 (Ref.)	1.11 (0.93–1.31)	0.82 (0.67–0.99)
ER+ breast cancer			
Cases/person-years	428/325,753	96/56,079	88/69,740
Age-adjusted HR	1.00 (Ref.)	1.06 (0.84–1.33)	0.69 (0.54–0.87)
Multivariable HR	1.00 (Ref.)	1.04 (0.82–1.31)	0.65 (0.50–0.86)
ER– breast cancer			
Cases/person-years	236/325,575	48/56,037	60/69,705
Age-adjusted HR	1.00 (Ref.)	1.03 (0.75–1.41)	0.96 (0.71–1.29)
Multivariable HR	1.00 (Ref.)	1.06 (0.76–1.46)	1.03 (0.72–1.46)
Colorectal cancer			
Cases/person-years	175/330,969	44/57,622	62/71,330
Age-adjusted HR	1.00 (Ref.)	1.02 (0.73–1.42)	0.96 (0.71–1.29)
Multivariable HR	1.00 (Ref.)	1.18 (0.84–1.67)	1.42 (1.02–2.00)
Lung cancer			
Cases/person-years	158/331,726	43/57,693	76/71,526
Age-adjusted HR	1.00 (Ref.)	0.99 (0.71–1.39)	1.09 (0.82–1.45)
Multivariable HR	1.00 (Ref.)	1.19 (0.84–1.68)	1.10 (0.80–1.51)

Multivariable model adjusted for age, BMI in 1995, menopausal hormone use, smoking status, educational attainment, geographic region, and family history of breast cancer.

Table 3

Bilateral oophorectomy relative to hysterectomy alone and risk of incident cancer in the Black Women's Health Study, 1995–2011

	All ages at surgery		Age at surgery <40 years		Age at surgery ≥40 years	
	Hysterectomy alone	With bilateral oophorectomy	Hysterectomy alone	With bilateral oophorectomy	Hysterectomy alone	With bilateral oophorectomy
ER+ breast cancer						
Cases/person-years	96/56,079	88/69,740	42/33,051	27/29,595	54/23,027	61/40,146
Age-adjusted HR	1.00 (Ref.)	0.64 (0.48–0.87)	1.00 (Ref.)	0.70 (0.43–1.14)	1.00 (Ref.)	0.56 (0.38–0.81)
Multivariable HR	1.00 (Ref.)	0.62 (0.45–0.85)	1.00 (Ref.)	0.67 (0.39–1.15)	1.00 (Ref.)	0.51 (0.34–0.77)
ER– breast cancer						
Cases/person-years	48/56,037	60/69,705	27/33,039	23/29,583	21/22,998	37/40,122
Age-adjusted HR	1.00 (Ref.)	0.93 (0.63–1.37)	1.00 (Ref.)	0.87 (0.49–1.53)	1.00 (Ref.)	0.89 (0.51–1.55)
Multivariable HR	1.00 (Ref.)	1.03 (0.67–1.59)	1.00 (Ref.)	1.00 (0.53–1.90)	1.00 (Ref.)	0.95 (0.51–1.76)
Colorectal cancer						
Cases/person-years	44/57,622	62/71,330	19/33,748	23/30,152	25/23,875	39/41,178
Age-adjusted HR	1.00 (Ref.)	0.96 (0.65–1.42)	1.00 (Ref.)	1.19 (0.64–2.22)	1.00 (Ref.)	0.77 (0.46–1.28)
Multivariable HR	1.00 (Ref.)	1.31 (0.85–2.00)	1.00 (Ref.)	1.63 (0.82–3.24)	1.00 (Ref.)	1.07 (0.61–1.88)
Lung cancer						
Cases/person-years	43/57,693	76/71,526	19/33,790	27/30,225	24/23,903	49/23,903
Age-adjusted HR	1.00 (Ref.)	1.10 (0.76–1.61)	1.00 (Ref.)	1.35 (0.75–2.46)	1.00 (Ref.)	0.94 (0.57–1.55)
Multivariable HR	1.00 (Ref.)	0.97 (0.65–1.45)	1.00 (Ref.)	1.22 (0.63–2.36)	1.00 (Ref.)	0.79 (0.47–1.33)
Women with 0–<2 years of menopausal hormone use						
ER+ breast cancer						
Cases/person-years	60/40,303	19/22,306	27/23,697	5/9,474	33/16,606	14/12,832
Age-adjusted HR	1.00 (Ref.)	0.50 (0.30–0.86)	1.00 (Ref.)	0.42 (0.16–1.12)	1.00 (Ref.)	0.49 (0.25–0.94)
Multivariable HR	1.00 (Ref.)	0.52 (0.30–0.90)	1.00 (Ref.)	0.43 (0.16–1.18)	1.00 (Ref.)	0.50 (0.26–0.99)
ER– breast cancer						
Cases/person-years	30/40,277	22/22,304	17/23,687	8/9,474	13/16,590	14/12,829
Age-adjusted HR	1.00 (Ref.)	1.26 (0.71–2.24)	1.00 (Ref.)	1.22 (0.51–2.94)	1.00 (Ref.)	1.24 (0.57–2.74)
Multivariable HR	1.00 (Ref.)	1.25 (0.70–2.23)	1.00 (Ref.)	1.19 (0.49–2.88)	1.00 (Ref.)	1.11 (0.48–2.53)
Colorectal cancer						
Cases/person-years	35/41,332	33/22,886	15/24,121	13/9,633	20/17,212	20/13,252

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

	All ages at surgery		Age at surgery <40 years		Age at surgery ≥40 years	
	Hysterectomy alone	With bilateral oophorectomy	Hysterectomy alone	With bilateral oophorectomy	Hysterectomy alone	With bilateral oophorectomy
Age-adjusted HR	1.00 (Ref.)	1.26 (0.77–2.08)	1.00 (Ref.)	1.57 (0.71–3.46)	1.00 (Ref.)	0.96 (0.50–1.85)
Multivariable HR	1.00 (Ref.)	1.28 (0.77–2.14)	1.00 (Ref.)	1.65 (0.73–3.73)	1.00 (Ref.)	0.98 (0.49–1.93)
Lung cancer						
Cases/person-years	25/41,350	33/22,994	11/24,151	11/9,668	14/17,198	22/13,325
Age-adjusted HR	1.00 (Ref.)	1.50 (0.88–2.57)	1.00 (Ref.)	1.61 (0.68–3.80)	1.00 (Ref.)	1.37 (0.68–2.77)
Multivariable HR	1.00 (Ref.)	1.26 (0.72–2.20)	1.00 (Ref.)	1.71 (0.68–4.31)	1.00 (Ref.)	1.10 (0.52–2.32)
Multivariable model adjusted for age, BMI in 1995, menopausal hormone use, smoking status, educational attainment, geographic region, and family history of breast cancer.						