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The Effects of Primary Care on Breast Cancer Mortality and Incidence Among Medicare Beneficiaries

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Abstract

BACKGROUND—Primary care physician (PCP) services may have an impact on breast cancer mortality and incidence, possibly through greater use of screening mammography.

METHODS—The authors conducted a retrospective, 1:1 matching case-control study using the Surveillance, Epidemiology, and End Results (SEER)-Medicare-linked database to examine use of PCP services and their association with breast cancer mortality and incidence. SEER cases representing the 3 outcomes of interest (breast cancer mortality, all-cause mortality among women diagnosed with breast cancer, and breast cancer incidence) were matched to unaffected controls from the 5% Medicare random sample. Conditional logistic regression was used to examine associations between physician visits and breast cancer outcomes while controlling for other covariates.

RESULTS—Women who had 2 or more PCP visits during the 24-month assessment interval had lower odds of breast cancer mortality, all-cause mortality, and late-stage breast cancer diagnosis compared with women who had no PCP visits or 1 PCP visit while adjusting for other covariates, including mammography and non-PCP visits. Women who had 5 to 10 PCP visits had 0.69 times the odds of breast cancer mortality (95% confidence interval, 0.63-0.75), 0.83 times the odds of death from any cause having been diagnosed with breast cancer (95% confidence interval, 0.79-0.87), and 0.67 times the odds of a late-stage breast cancer diagnosis (95% confidence interval, 0.61-0.73) compared with those who had no PCP visits or 1 PCP visit.

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CONFLICT OF INTEREST DISCLOSURES

The authors made no disclosures.

CONCLUSIONS—The current findings suggest that PCPs play an important role in reducing breast cancer mortality among the Medicare population. Further research is needed to better understand the impact of primary care on breast cancer and other cancers that are amenable to prevention or early detection.

Keywords

breast neoplasms; SEER; Medicare; primary health care; mammography

INTRODUCTION

Primary care physicians (PCPs) play an important role in reducing breast cancer (BC) mortality by detecting BC at earlier, more favorable stages.¹ There is significant empiric evidence that preventive care in general, and cancer screening in particular, is overwhelmingly delivered in the ambulatory setting.²⁻⁴ The recommendations by PCPs for screening are often one of the strongest predictors of BC screening.^{5,6} PCPs also may reduce BC mortality by preventing diagnostic delays after screening.⁷

Understanding the effects of primary medical care is important because of the looming shortage of PCPs in the United States. Medical student interest in primary care⁸ and the proportion of US physicians engaged in primary care⁹ are both in decline. This problem may be worsened by heightened demand for PCP services expected under health care reform.¹⁰

Previous ecologic studies that linked higher PCP supply with improved cancer outcomes¹¹⁻¹⁴ are subject to an ecologic fallacy: it is not possible to determine whether individuals who had better outcomes in those studies are the same individuals who received care from PCPs. Cohort studies linking PCP visits with improved cancer survival also are subject to lead-time bias, in which longer survival is not associated with true reductions in mortality.^{1,15} Because of these limitations, it is unclear how PCP services impact cancer outcomes at the population level.

The current study overcomes the limitations of previous studies by examining the impact of the number of PCP visits on population-based measures of BC mortality and incidence among Medicare beneficiaries using the linkage of 2 large, population-based data sources. We extend our prior work by examining the association of PCP use with BC mortality and incidence among Medicare beneficiaries.¹ We hypothesize that PCP visits will have a protective effect against mortality, because PCP visits may increase detection at an earlier stage as a result of greater mammography use. Similarly, we hypothesize that PCP visits will decrease the incidence of late-stage cancers but will increase the incidence of early stage cancers (because of greater mammography screening).^{1,16} In addition, we hypothesize that PCP visits will increase the incidence of estrogen receptor (ER)-positive cancers (because long-term hormone replacement therapy [HRT] is associated with ER-positive tumors).^{17,18} Understanding the relation between primary medical care and cancer outcomes is important in preparing for policy changes necessary to improve our nation's health care system.

MATERIALS AND METHODS

Study Design

For this study, we used a retrospective, 1:1 matching case-control study design to examine the relation between PCP visits and 3 outcomes: 1) BC-specific mortality, 2) all-cause mortality once diagnosed with BC, and 3) BC incidence using the 2008 Surveillance, Epidemiology, and End Results (SEER)-Medicare linked data set (available at: <http://healthservices.cancer.gov/seermedicare/>) (accessed April 25, 2012). This study was approved by the institutional review boards of the University of South Florida and Beth Israel Deaconess Medical Center. In our study, we examined PCP visits for cases and controls during a 2-year interval before the case's month of diagnosis. Because physician visit patterns are likely to change during the time that a potential BC is being diagnosed, we excluded the 3-month period immediately before the month of SEER diagnosis in our analysis and assessed physician claims during the preceding 24-month period (ie, the period 4-27 months before diagnosis).¹⁹ Previous studies suggest that the overwhelming majority of patients complete diagnostic evaluations within this 3-month prediagnosis period.^{7,20} Our measures of PCP visits, thus, are intended to reflect routine care rather than care specifically associated with diagnosing BC.

Study Population

Inclusion criteria: Cases—Women newly diagnosed with BC within the SEER Program from April 1994 to December 2005 represented the cohort of interest for identifying cases (n = 309,616). We excluded women without 27 months of continuous Medicare fee-for-service (FFS) insurance before diagnosis and whose diagnosis was not within their first continuous FFS interval from 1992 to 2005 (n = 190,641). Because screening procedures generally are not recommended for women aged <40 years or >85 years, we excluded those who were diagnosed before age 40 years or after age 85 years (n = 13,933), yielding a final number of 105,042 cases for the BC incidence analysis.

For our assessment of PCP visits on BC-specific mortality, we also excluded cases who did not die from BC by December 31, 2005, the last available date for cause-of-death information, yielding 10,369 cases for the BC-specific mortality analysis. For our assessment of PCP visits on all-cause mortality, we excluded incident BC cases who were alive at December 31, 2007, which was the latest available date of death, leaving 38,402 all-cause mortality cases.

Inclusion criteria: Controls—The candidate controls came from the 5% random sample of Medicare beneficiaries residing in the SEER registries and represented those who were at risk but did not develop the outcome of interest. Women whose first continuous FFS interval between 1992 and 2005 was longer than 27 months were considered. Those beneficiaries who did not develop BC through 2007 were eligible controls for the incidence analysis (n = 269,962). Those who did not die of BC by December 31, 2005 were eligible controls for the BC mortality analysis (n = 274,832). Finally, those who were alive at December 31, 2007 were eligible controls for the all-cause mortality analysis (n = 171,053).

Matching Criteria 1:1 for Cases and Controls

Cases were matched to candidate controls using a greedy algorithm,²¹ matching each case to 1 control who had the same original reason for Medicare entitlement (age, disability, end-stage renal disease), who lived in the same SEER registry as the case during the year of the case's diagnosis, whose birth year was within 5 years of the case's, and who had at least 27 months of continuous FFS Medicare enrollment before the case's BC diagnosis month.

For the incidence and all-cause mortality analyses, 425 (0.4%) and 664 (1.7%) cases were not matched, respectively, because no available controls met the matching criteria. Unmatched cases were excluded from the analyses.

Physician Visits

We examined Medicare claims (National Claims History) for the following ambulatory-based evaluation and management services representing routine office visits: codes 99201 through 99205 and codes 99211 through 99215. Similar to prior research,^{22,23} we identified the physician specialty associated with each claim using the Medicare provider specialty field in National Claims History claims. We defined PCPs as providers who had the following specialties: general practice, family medicine, primary care internal medicine, geriatric medicine, and obstetrics-gynecology. We classified obstetrics-gynecology as primary care, because 64.3% of visits to such physicians by older women are for routine follow-up or preventive care. All other specialties were considered nonprimary care providers (non-PCPs). For each case and control, we determined the number of ambulatory claims for PCP and non-PCP office visits during the 4-month to 27-month period before the case's BC diagnosis. The numbers of PCP and non-PCP visits were categorized into 4 groups: 0 to 1 visits, 2 to 4 visits, 5 to 10 visits, and 11 visits (quartiles of PCP visits).

In addition, we determined if either a mammography procedure was done during this 4-month to 27-month period. Because codes for screening and diagnostic mammography often are used interchangeably, codes alone cannot be relied on to determine whether the test was done for screening or diagnosis.¹⁹ We defined these procedures as Healthcare Common Procedure Coding System/Current Procedural Terminology codes G0202 through G0207, 76092, 77055, 77056, and 77052.

Statistical Analysis

Bivariate associations between 2 categorical variables were tested using Pearson chi-square tests. The relations between PCP visits and mammography receipt, BC-specific mortality, all-cause mortality, and BC incidence were examined using conditional logistic regression analysis conditioned on matched pairs.

We considered the following variables as potential confounders in multivariable models: race-ethnicity (reported by Medicare), age at case's diagnosis, census-derived measures of zip-code level median household income and educational attainment (percentage of individuals with less than a high school education) categorized by quintiles within each registry, metropolitan statistical area, Charlson comorbidity index^{24,25} (determined from both inpatient and outpatient claims), prior influenza vaccination in the 4-month to 27-

month interval (as a marker of preventive behaviors),^{15,26} and the number of non-PCP visits. Missing values were not imputed. Because of the large sample size and modeling constraints, patients who were missing any confounders were excluded from the multivariable models.

Stratified analyses were conducted to investigate potential effect modifiers: age at diagnosis (ages 40-64 years, 65-75 years, and 76-85 years), ER status of the tumor (positive, negative), and stage at diagnosis (ductal carcinoma in situ [DCIS], early, late). Early stage disease was defined as stage I or II (models also were refit to include DCIS), and late stage was defined as stage III or IV.

All tests and 95% confidence intervals (CIs) were 2-sided with a significance level of .05. We adjusted for multiple comparisons of the *P* values of the 3 primary outcomes in the overall and stratified multivariable models using the step-down Bonferroni method. All analyses were performed using SAS software (version 9.3; SAS Institute Inc., Cary, NC).

RESULTS

Sample Characteristics

The median age at cancer diagnosis was 74 years (inter-quartile range [IQR], 70-79 years). Most women who died of BC had late-stage incident cancers (stage III, 15.7%; stage IV, 27.1%), whereas fewer had early stage cancers (stage I, 10.3%; stage II, 26.9%) or DCIS (1%). Only 9.2% of incident cancers overall were ER-negative, whereas 20.4% of those who died of BC and 12.6% of those who died of any cause had incident ER-negative cancers.

For the BC mortality analysis, cases and controls visited a PCP within the 2 years before the case's month of diagnosis a median of 5 times (IQR, 1-11 visits). Non-PCP visits were fewer, with a median of 2 visits (IQR, 0-7 visits). The percentage of BC mortality cases with no PCP visits or 1 PCP visit was 36.2% and decreased to 26.4% and 21.7% for the all-cause mortality and incidence analyses, respectively. Conversely, the percentage of controls who had no PCP visits or 1 PCP visit remained relatively stable for all 3 analyses at 23.9%, 22.9%, and 23.5% for BC mortality, all-cause mortality, and incidence, respectively.

Breast Cancer-Specific Mortality

Having fewer than 2 PCP or non-PCP visits, being of African American race, living in a zip code in the most uneducated quintile or in the highest quintile of median household income, not receiving an influenza vaccination, and not receiving a mammogram were associated independently with increased BC-specific mortality (Table 1). When adjusting for potential confounders, all categories of multiple PCP visits decreased BC-specific mortality compared with no visits or 1 visit (2-4 visits: odds ratio [OR], 0.77; 95% CI, 0.70-0.84; 5-10 visits: OR, 0.69; 95% CI, 0.63-0.75; 11 visits: OR, 0.68; 95% CI, 0.62-0.74; all adjusted *P* < .0001).

The effect of PCP visits on BC-specific mortality stratified by potential effect modifiers are illustrated in Figure 1. Most categories of 2 or more PCP visits decreased BC mortality compared with no visits or 1 visit for most stratified analyses, and the most protective effect

was observed with late-stage cancer. However, PCP visits did not affect BC mortality in those who had an early stage diagnosis or a diagnosis before age 65 years.

All-Cause Mortality

All-cause mortality among women with a previous BC diagnosis was independently associated with increased age, being of African American race, having more comorbidities, living in a zip code in the most uneducated quintile, not receiving an influenza vaccine, and not receiving a mammogram (Table 1). In the overall adjusted analysis, the odds of getting diagnosed with BC and dying from any cause, compared with being alive through 2007 with or without BC, were lower for those who had 2 or more PCP visits in a 2-year span compared with those who had no visits or 1 visit (2-4 visits: OR, 0.82; 95% CI, 0.78-0.86; adjusted $P < .0001$; 5-10 visits: OR, 0.83; 95% CI, 0.79-0.87; adjusted $P < .0001$; 11 visits: OR, 0.89; 95% CI, 0.85-0.94; adjusted $P = .0003$).

Figure 2 demonstrates the effect of PCP visits on all-cause mortality for the stratified analyses. PCP visits were most protective against all-cause mortality with late-stage cancer and did not affect all-cause mortality in those with a BC diagnosis before age 65 years, whereas 11 PCP visits were associated with increased mortality among those with early stage BC.

Incidence and Mammography

The unadjusted results provided in Table 1 indicate that incidence was independently associated with having more than 1 PCP visit, having more than 1 non-PCP visit, having no comorbidities, being older, and living in a zip code with higher income. When adjusting for potential confounders, all categories of PCP visits increased the incidence of BC compared with no PCP visits or 1 PCP visit in a 2-year span. The effects of PCP visits on incidence stratified by potential effect modifiers are illustrated in Figure 3. Having 2 or more PCP visits increased the incidence of ER-positive tumors but was not associated with the incidence of ER-negative tumors. Having 2 or more PCP visits increased the incidence of DCIS and early stage BC but decreased the incidence of late stage BC.

Only 39.5% of women in the incidence analysis received a mammogram in a 2 year interval, and there was no statistical difference in the receipt of mammography between cases and controls ($P = .66$). Mammography use dwindled to 15.6% and 24% for cases who died of BC or of any cause, respectively. For mammography to be considered a mediator for PCP visits on incidence, mammography receipt must be associated with PCP visits. Increased PCP visits, compared with no visits or 1 visit, was associated with a greater likelihood of receiving a mammogram (2-4 visits: OR, 2.96; 95% CI 2.83-3.10; 5-10 visits: OR, 3.79; 95% CI, 3.63-3.95; 11 visits: OR, 3.67; 95% CI, 3.52-3.83).

Multivariable models were fit without and then with mammography receipt. The extent to which the ORs for PCP effects were attenuated after including mammography indicates how much this effect can be explained by mammography receipt. The addition of mammography attenuated the effects of PCP visits on incidence of DCIS and late-stage cancer (Table 2), although the effects remained statistically significant. Mammograms were protective against

late-stage cancer (OR, 0.37; 95% CI, 0.35-0.40) but increased the incidence of DCIS (OR, 1.37; 95% CI, 1.30-1.45). Mammography did not attenuate the effect of PCPs on the incidence of early stage disease (stages I and II) or on the other potential effect modifiers (age at diagnosis, ER status).

DISCUSSION

Strengths/Importance

Our study had numerous strengths, including a population-based design and large sample sizes, giving us high power to detect small effects, even when adjusting for multiple comparisons. Conducting stratified analyses allowed us to explore relevant and biologically plausible mechanisms and associations. Overall, PCP visits significantly affected our 3 outcomes (BC-specific mortality, all-cause mortality, and BC incidence), even when adjusting for non-PCP visits and other factors. Our results suggest that ensuring access to PCPs is important in the early detection of BC and reduction of BC mortality among the US Medicare population. However, ensuring a PCP visit may prove challenging, even within this universally insured population, because we observed that 16.6% of cases and controls from the incidence analysis never visited a PCP. In addition, the PCP shortage currently experienced in the United States may worsen with increased demand stemming from the Affordable Care Act.²⁷

Our data also support the important role of mammography in reducing late-stage diagnosis and mortality. We observed that increased PCP visits increased the incidence of DCIS and early stage BC and decreased the incidence of late-stage BC, and mammography explained some of this effect. When DCIS is diagnosed and treated, it may thwart the development of invasive cancer, although some have concerns about overdiagnosis.^{28,29} Despite mammography's importance, our findings revealed a general lack of screening over the entire period. Some physician services that may impact mortality and incidence, such as promoting healthy lifestyles, discussing risk-reducing medications, and addressing HRT, are considerably more complex than ordering a mammogram. For example, our results supported our hypothesis that PCP visits have a greater positive association with ER-positive BC. This finding is consistent with the hypothesis that factors affecting ER-positive tumors (eg, being prescribed HRT) are influenced by PCP visits. We also observed that more than 10 visits to a PCP were associated with increased mortality in the early stage analysis, which may be because patients who were sicker visited a PCP more often.

Limitations

Our results reflect the Medicare population living in SEER registries, and these trends may not apply to other populations or to those with other insurance plans. In addition, the SEER-Medicare records lack certain information on the nature of health care visits (eg, whether they were preventive visits, what recommendations or referrals were made, patient preferences and health beliefs), nor do they provide individual-level information on income or education. Although HRT use was postulated as a potential mediator for the positive effect of PCPs on BC incidence, we lacked information regarding HRT prescriptions and prevention strategies, so these theories could not be directly evaluated. Also, we were unable

to differentiate between screening and diagnostic mammograms. However, we excluded the 3 months before diagnosis to avoid capturing diagnostic mammograms. Although our large sample size enabled us to have power to detect very small differences between groups, statistical significance may not necessarily translate to clinical significance. Nevertheless, small differences still may be important at the population level. Also, we did not estimate the underlying odds of mortality or incidence, but only the ORs, which may impede interpretation. Despite these limitations, our study is one of the first attempts to directly measure the impact of PCP visits on BC outcomes for Medicare beneficiaries. Our findings suggest that PCPs play an important role in reducing BC mortality among this population. Promoting and increasing access to primary care should be an important priority in health policy discussions if we are to decrease the burden of BC in the United States.

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Figure 1.

This chart illustrates the effect of primary care physician (PCP) visits on breast cancer (BC)-specific mortality for stratified analyses using multivariable conditional logistic regression. ER indicates estrogen receptor; DCIS, ductal carcinoma in situ; OR, odds ratio; CI, confidence interval.

Figure 2.

This chart illustrates the effect of primary care physician (PCP) visits on all-cause mortality for stratified analyses using multivariable conditional logistic regression. ER indicates estrogen receptor; DCIS, ductal carcinoma in situ; OR, odds ratio; CI, confidence interval; BC; breast cancer.

Figure 3.

This chart illustrates the effect of primary care physician (PCP) visits on breast cancer (BC) incidence for stratified analyses using multivariable conditional logistic regression. ER indicates estrogen receptor; DCIS, ductal carcinoma in situ; OR, odds ratio; CI, confidence interval.

TABLE 1

Associations With Mortality and Incidence

Variable	OR (95% CI)					
	BC Mortality, N = 20,738		All-Cause Mortality, N = 75,476		Incidence, N = 209,234	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
PCP visits						
0-1	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
2-4	0.62 (0.57-0.67)	0.77 (0.70-0.84)	0.73 (0.69-0.76)	0.82 (0.78-0.86)	1.12 (1.09-1.15)	1.08 (1.05-1.11)
5-10	0.53 (0.50-0.57)	0.69 (0.63-0.75)	0.77 (0.74-0.80)	0.83 (0.79-0.87)	1.13 (1.11-1.16)	1.09 (1.07-1.12)
11	0.51 (0.48-0.56)	0.68 (0.62-0.74)	0.99 (0.95-1.03)	0.89 (0.85-0.94)	1.08 (1.05-1.11)	1.06 (1.03-1.09)
Non-PCP visits						
0-1	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
2-4	0.69 (0.64-0.74)	0.85 (0.78-0.92)	0.93 (0.90-0.97)	0.96 (0.91-1.00)	1.16 (1.14-1.19)	1.15 (1.12-1.18)
5-10	0.65 (0.60-0.70)	0.82 (0.75-0.90)	0.99 (0.95-1.03)	0.96 (0.92-1.00)	1.22 (1.20-1.25)	1.21 (1.18-1.24)
11	0.66 (0.61-0.72)	0.84 (0.77-0.93)	1.30 (1.25-1.36)	1.12 (1.06-1.17)	1.29 (1.25-1.32)	1.27 (1.23-1.30)
Age						
1-Y increase	0.99 (0.93-1.06)	0.99 (0.92-1.06)	1.60 (1.57-1.64)	1.59 (1.55-1.63)	1.06 (1.04-1.08)	1.06 (1.05-1.08)
Race/ethnicity						
White	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Asian	0.50 (0.40-0.62)	0.43 (0.34-0.54)	0.33 (0.29-0.36)	0.26 (0.23-0.29)	0.42 (0.40-0.45)	0.40 (0.38-0.43)
Black	1.32 (1.20-1.46)	1.22 (1.08-1.36)	1.12 (1.06-1.18)	0.97 (0.90-1.03)	0.90 (0.87-0.93)	1.00 (0.97-1.04)
Hispanic	0.61 (0.49-0.76)	0.57 (0.45-0.72)	0.49 (0.43-0.55)	0.38 (0.34-0.44)	0.51 (0.48-0.55)	0.53 (0.49-0.57)
North American Native	0.45 (0.27-0.77)	0.36 (0.20-0.63)	0.66 (0.49-0.88)	0.48 (0.35-0.66)	0.52 (0.44-0.62)	0.59 (0.50-0.71)
Other	0.75 (0.58-0.98)	0.68 (0.51-0.91)	0.51 (0.44-0.59)	0.40 (0.34-0.47)	0.56 (0.52-0.61)	0.56 (0.51-0.60)
Unknown	1.93 (1.00-3.69)	1.63 (0.82-3.26)	0.90 (0.66-1.22)	0.69 (0.49-0.98)	0.86 (0.69-1.07)	0.83 (0.66-1.04)
Charlson Comorbidity Index						
0	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
1	0.91 (0.85-0.97)	1.04 (0.96-1.12)	1.69 (1.63-1.76)	1.78 (1.70-1.85)	0.98 (0.96-1.00)	0.94 (0.92-0.96)
2	1.06 (0.98-1.14)	1.19 (1.09-1.31)	3.31 (3.17-3.47)	3.29 (3.12-3.47)	0.90 (0.87-0.92)	0.85 (0.83-0.87)
Metropolitan statistical area						
Large metropolitan	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Less urban	0.84 (0.73-0.96)	0.92 (0.79-1.08)	0.74 (0.69-0.80)	0.80 (0.73-0.87)	0.75 (0.72-0.78)	0.89 (0.86-0.94)
Metropolitan	0.83 (0.76-0.91)	0.87 (0.79-0.96)	0.86 (0.82-0.90)	0.88 (0.83-0.93)	0.86 (0.84-0.88)	0.91 (0.88-0.93)
Rural	0.81 (0.65-1.02)	0.82 (0.63-1.05)	0.69 (0.61-0.78)	0.73 (0.64-0.84)	0.73 (0.68-0.79)	0.91 (0.85-0.98)
Urban	0.84 (0.74-0.96)	0.89 (0.77-1.03)	0.84 (0.78-0.90)	0.88 (0.81-0.95)	0.84 (0.81-0.88)	0.96 (0.91-1.00)
Education at zip-code level						
Quintile 1	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Quintile 2	0.77 (0.70-0.84)	0.73 (0.66-0.80)	0.83 (0.80-0.87)	0.77 (0.73-0.82)	0.87 (0.85-0.90)	0.79 (0.77-0.82)
Quintile 3	0.72 (0.66-0.78)	0.64 (0.57-0.71)	0.83 (0.80-0.87)	0.72 (0.68-0.76)	0.91 (0.88-0.93)	0.72 (0.70-0.75)
Quintile 4	0.73 (0.67-0.79)	0.59 (0.53-0.66)	0.79 (0.75-0.82)	0.61 (0.58-0.65)	0.94 (0.92-0.97)	0.66 (0.64-0.68)
Quintile 5: Highest	0.68 (0.63-0.75)	0.46 (0.41-0.52)	0.75 (0.72-0.79)	0.52 (0.48-0.55)	1.00 (0.97-1.03)	0.57 (0.55-0.59)
Income at zip-code level						

Variable	OR (95% CI)					
	BC Mortality, N = 20,738		All-Cause Mortality, N = 75,476		Incidence, N = 209,234	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Quintile 1	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Quintile 2	0.97 (0.88-1.06)	1.22 (1.10-1.35)	1.05 (1.00-1.10)	1.23 (1.16-1.30)	1.14 (1.11-1.17)	1.26 (1.22-1.30)
Quintile 3	0.97 (0.88-1.05)	1.35 (1.21-1.51)	1.02 (0.98-1.07)	1.28 (1.21-1.36)	1.20 (1.17-1.23)	1.39 (1.35-1.44)
Quintile 4	0.99 (0.91-1.09)	1.54 (1.37-1.74)	1.05 (1.00-1.10)	1.49 (1.39-1.59)	1.25 (1.21-1.28)	1.56 (1.51-1.62)
Quintile 5: Richest	1.21 (1.11-1.32)	2.15 (1.89-2.45)	1.21 (1.16-1.27)	1.89 (1.76-2.03)	1.59 (1.55-1.64)	2.07 (1.99-2.15)
Influenza vaccination						
No	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Yes	0.66 (0.63-0.70)	0.89 (0.84-0.95)	0.92 (0.89-0.95)	0.96 (0.92-0.99)	1.14 (1.12-1.16)	1.10 (1.08-1.12)
Mammogram						
No	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Yes	0.33 (0.30-0.35)	0.38 (0.35-0.41)	0.49 (0.48-0.51)	0.51 (0.49-0.53)	1.00 (0.98-1.01)	0.91 (0.89-0.93)

Abbreviations: BC, breast cancer; CI, confidence interval; OR, odds ratio; PCP, primary care physician; Ref, referent category.

TABLE 2

Effect of Primary Care Physician Visits and Mammography on the Incidence of Ductal Carcinoma In Situ and Late-Stage Breast Cancer

Variable	OR (95% CI)					
	DCIS, N = 30,206			Late Stage, N = 20,614		
	Unadjusted	Adjusted Without Mammography ^a	Adjusted With Mammography ^a	Unadjusted	Adjusted Without Mammography ^a	Adjusted With Mammography ^a
PCP visits						
0-1	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
2-4	1.55 (1.44-1.67)	1.43 (1.33-1.55)	1.36 (1.25-1.47)	0.56 (0.51-0.60)	0.62 (0.57-0.68)	0.71 (0.65-0.78)
5-10	1.67 (1.56-1.78)	1.50 (1.39-1.61)	1.39 (1.30-1.50)	0.48 (0.44-0.51)	0.56 (0.51-0.61)	0.67 (0.61-0.73)
11	1.63 (1.53-1.75)	1.49 (1.38-1.60)	1.39 (1.29-1.50)	0.47 (0.43-0.50)	0.58 (0.53-0.63)	0.70 (0.64-0.77)
Mammography receipt						
Yes vs no	1.64 (1.56-1.72)	–	1.37 (1.30-1.45)	0.31 (0.29-0.34)	–	0.37 (0.35-0.40)

Abbreviations: CI, confidence interval; DCIS, ductal carcinoma in situ; MSA, metropolitan statistical area; OR, odds ratio; PCP, primary care physician; Ref, referent category.

^aModels were adjusted for non-PCP visits, age, race/ethnicity, comorbidities, MSA of residence, receipt of flu vaccination, and zip code-level education and income.