



Using mammograms to predict preventive health services behavior and mortality in women

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ABSTRACT

This study examined whether mammography receipt was associated with mortality due to causes other than breast cancer, hypothesizing that mammography screening was a proxy for the predisposition to seek preventive health behaviors. Using data on 89,574 women from the 2000 National Health Interview Survey and National Death Index, a discrete-time hazard model estimated the mortality from any cause except breast cancer as a function of screening status. Receiving a mammogram was associated with a 24% reduction in the likelihood of death all causes except breast cancer. These odds were reduced to 21.1% when demographic and socioeconomic variables are added and reduced further to 20.9% when health resource variables were added. The final adjusted model shows that women who received a mammogram had reduced their probability of death by 20%. These results suggest women who undergo mammograms may be more likely to seek other preventive health services or engage in healthy behaviors that affect mortality. While the use of mammograms to predict breast cancer mortality merits further consideration, if a proxy for a woman's predisposition for additional preventive screenings, encouraging mammography may be a pivotal pathway for preventing mortality due to other causes for women.

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1. Introduction

Preventive health services significantly reduce premature morbidity and mortality (Sox, 1994; Hayward et al., 1991). Preventive health behavior has been defined as “any activity under taken by a person who believes himself to be healthy for the purpose of preventing disease or detecting disease in an asymptomatic stage.” (Kasl and Cobb, 1966). Health researchers often measure the use of preventive health services by asking questions about receipt of influenza vaccination (Diab and Johnston, 2004), participation in routine checkups (Musa et al., 2009), a prostate-specific antigen (PSA) test for men (Trivedi and Ayanian, 2006), and mammograms for women (Diamant et al., 2000), all of which being performed within the recommended time frames. These health services and preventive health behaviors can be viewed as social constructs, changing over time according to social norms at given times (Nathanson, 1977).

Receiving a mammogram is not part of a standard physical as pap smear is; rather, routine checkups have to be followed up with a specialist appointment. Hence, women who receive a mammogram may be thought of as *active preventive health service seekers*. In other words, these women may be more likely to seek routine preventive care and

also participate in other healthy behaviors that could reduce mortality compared to women who did not receive a mammogram. For instance people who smoke tend to exhibit other unhealthy behaviors related to exercise, diet, alcohol, and preventive screening (Fredman et al., 1999; Rakowski et al., 1999).

In the U.S., nearly 40,000 women die each year due to breast cancer (DeSantis et al., 2013). Breast cancer screening by mammography has been shown to detect breast cancer before any signs or symptoms occur (Egan, 1962). The United States Prevention Services Task Force (USPSTF) recommends that women who are 50–74 years old and have average risk for breast cancer should receive a mammogram every two years (US Preventive Services Task Force, 2009). Other cancer organizations, such as the American Cancer Society (ACS), have changed previous screening recommendations to annual mammogram for women who are 45–55 years old and of average risk and every other year for women 55 and older (Oeffinger et al., 2015; Keating and Pace, 2015). Screening recommendations for high-risk women include annual mammograms beginning at age 30 (National Comprehensive Cancer Network, 2013). Furthermore, women at moderate risk are advised to discuss with their physician the timing for beginning routine mammograms and the frequency of receiving mammograms (National Comprehensive Cancer Network, 2013; National Cancer Institute, 2012).

Given the current mortality risk for breast cancer among women and the awareness and attention on breast cancer screening, we hypothesize that mammography screening to be a proxy for a woman's

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predisposition to preventive health behaviors. The use of mammogram is an ideal proxy for health behavior since most screening is done when a woman does not exhibit any breast cancer symptoms. The routine use of mammography for women, particularly those who may be at increased risk of breast cancer, is important to reduce the number of lives lost to breast cancer (Berry et al., 2005; Kalager et al., 2010), but the act of obtaining a mammogram itself could be related to other causes of mortality. The effect of mammography on all-cause mortality and causes of death other than breast cancer have not been investigated.

Demographic characteristics, such as socioeconomic status, age and marital status, as well as access to a usual source of care, have been identified as factors associated with receiving preventive services (Weissman et al., 1991). For an accurate estimate of the effect of mammography on mortality rates, the influence of these factors, as well as measures of health status, must be controlled. This study examines whether mammography is associated with mortality due to causes other than breast cancer. In addition, this study examines how the probability of death changes with additional resources known to be associated with screening. The overall goal is to examine if ever having obtained a mammogram affects the mortality rate in U.S. females.

2. Methods

2.1. Data

This study uses data from the 2000 National Health Interview Survey (NHIS) Cancer Control Supplement (CSS) and linked mortality file. The NHIS is a cross-sectional, nationally representative survey of the civilian, non-institutionalized U.S. population (CDC/National Center for Health Statistics, 2012). The cancer screening section of the 2000 Cancer Control supplement collected information about several cancer screening tests received by sample adults, including mammograms. The linked mortality file used probabilistic matching to connect NHIS participants to death records from the National Death Index (NDI). This 2000 sample was followed through December 31, 2006, resulting in six-year follow-up from the initial survey. Data for this study was downloaded from the Integrated Health Interview Series (Minnesota Population Center and State Health Access Data Assistance Center, 2012).

2.2. Sample

The sampling technique and the sampling frame used by NHIS are described elsewhere (CDC/National Center for Health Statistics, 2012). The final sample was restricted to women who answered the cancer control supplement, had known vital status in the NDI and who were 30 and older at the time of the survey since NHIS only asked women in this age group about mammography use ($n = 89,574$). The incidence of breast cancer before 30 is small (American Cancer Society, 2013) and sensitivity analysis (not shown) used a sample of women 40 and older and did not yield significant differences in results. For this analysis, the person-level data file was reshaped into person-year records, which included one record for each year of survival following the survey until death or censorship.

2.3. Measures

The outcome of interest is the probability of death of each respondent. For each year of follow-up, this variable is categorized as death from any cause except breast cancer (from here referred to as 'deaths'), and no death (reference). The specific cause of death is not available in the public access data file for survey participants in later NHIS samples or for participants who died after December 2006 (Minnesota Population Center and State Health Access Data Assistance Center, 2012). The NHIS asked women the main reason they had their most recent mammogram. The independent variable, "received mammogram" in this study included women who had never had a mammogram, those

who had had a mammogram as part of a routine physical exam or screening test and those who had their first mammogram. It excluded women who had gotten a mammogram due to prior breast cancer diagnosis, a family history of breast cancer or a previously identified breast issue. The reliability of self-reported mammogram rates has been shown in different populations (Caplan et al., 2003). Current age was categorized into five-year intervals, starting with 30–34 (reference) to 80+ to calculate five-year mortality specific rates. Demographic variables included race, categorized as non-Hispanic White (reference), non-Hispanic Black, non-Hispanic Asian, Hispanic and other consisting of women who identified as American Indian/Alaska native, multiple or other race. Other variables included in the analyses were: education was categorized as <12 years (reference), 12 years, and >12 years; married was categorized as single (reference) and married; and poverty categorized as below the poverty line (reference) and at/above the poverty line. Finally a wealth variable was added that captures home ownership (yes or no). Health resource variables were also added. Access to care was measured with two variables: health insurance status and usual source of care. Insurance status was coded to insured and uninsured (reference). Usual source of care was coded as yes if women had one or more usual sources of care and no if women did not have a usual source of care (reference).

To capture a women's predisposition toward a healthy lifestyle or use of other preventive services, we included several measures of health behaviors. Alcohol use was categorized as never (reference), former drinker, and current drinker. Smoking status was categorized as never smoked (reference), current smoker, and former smoker. BMI was categorized as underweight (reference), normal, overweight, and obese. Self-rated health was categorized as not good (reference) if women said their health was poor or fair and good if their response was good, very good, or excellent. Finally, ever received a pap smear was coded as yes or no (reference).

2.4. Analysis

Data from NDI was used to determine who died among the NHIS participants and if death occurred within the five years following the survey. Descriptive statistics were used to summarize characteristics of the sample by survival and death. For a better understanding of the relationship between mammography and death, discrete time survival analysis was used to estimate the probability that each woman died as a function of whether she was screened or not in four models. This method is more appropriate than standard regression models because it accounts both for whether the respondent died during the follow-up period and her age of death (Allison, 2014). Model 1 was unadjusted; model 2 controlled for race, education, marital status, wealth and poverty; model 3 added additional health resources to model 2; and model 4 added health behaviors to model 3. Estimates from these models take the form of hazard ratios (Singer and Willett, 2003). Variance and standard error of the estimates were adjusted with individual, strata, and probability sampling unit (PSU) weights provided by NHIS. All analyses were carried out in Stata 13 (College Station, TX).

3. Results

Table 1 shows the descriptive statistics and survival status of the sample by mammogram receipt. Of the total sample of women analyzed, 61,114 had received a mammogram while 28,460 had never had a mammogram. Of the women who had never had a mammogram 1.1% of them had died during the interval period analyzed compared to 2.2% of women who had received a mammogram died during the same time period. In total, 1.8% of the sample or 1872 women died in the 5 year period following the survey. Table 2 shows hazard-odds ratios (HR) associated with the risk of mortality after receiving a mammogram across various models. Model 1 shows that receiving a mammogram, compared to not receiving a mammogram, was associated with a 24%

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