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Original article

Travel distance to screening facilities and completion of abnormal mammographic follow-up among disadvantaged women

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ABSTRACT

Purpose: Although many studies have examined factors in predicting incomplete and delay in abnormal mammogram follow-up, few have used geospatial methods to examine these factors. Consequently, the purpose of this study was to examine the relationship between travel distance to health facilities and completion of abnormal mammogram follow-up among disadvantaged women in South Carolina.
Methods: Women participating in South Carolina's Best Chance Network between 1996 and 2009 with abnormal mammogram were included in the study. Kaplan–Meier survival was used to describe the probability of work-up completion after abnormal mammogram among different distance categories, and Cox proportional hazards model was used to further assess the relationship between work-up completion and travel distance to the screening provider and mammography facility.
Results: Among 1,073 women, there was significant difference in time to completion of abnormal mammogram work-up by race; African American women had longer time to completion compared to European American women. Accounting for race, age, previous mammograms, income, and insurance status, women who lived closest to their diagnosing mammography facility were more likely to complete their work-up compared to those who lived the farthest (HR = 1.41; 95% CI = 1.00–1.80).
Conclusions: Distance to the diagnosing mammography facility may play a role on the completion of abnormal mammogram work-up.

Breast cancer is the most commonly diagnosed cancer and is the second cause of cancer-related mortality among women in the United States [1]. Mammography is considered the single-most effective method of early detection of breast cancer; it can identify the cancer at an early stage, when treatment is more effective [2]. At the time these data were collected, the American Cancer Society screening guidelines recommended that average-risk women aged 40 years and older receive mammography screening on an annual basis [1]. Annual mammography with adequate follow-up is estimated to result in reductions in mortality ranging from 25% to 44% [3–7]. Despite the benefit of mammography, many women are not up-to-date on screening [8–10], and about 38%–54% do not maintain annual adherence to screening mammograms [8,9]. Inadequate screening and follow-up are associated with late-stage breast cancer at diagnosis [10–14], which lead to poor survival.

About 9%–15% of women who receive mammography screening have an abnormal finding that require further testing [15,16], and approximately 30%–50% will delay follow-up testing [17,18]. Women who delay follow-up testing increase the risk of having larger tumor size, late-stage breast cancer at diagnosis, and poorer prognosis. Tumor volume doubling times ranging from 46 to 825 days (mean 193 days, depending on molecular breast cancer sub-type) are documented for breast cancer in studies of delayed postmammography biopsy [19]. Factors contributing to inadequate or incomplete abnormal mammogram follow-up include fear [20], language barrier [21], race/ethnicity [22–26], lack of provider [26], low income level [25,27], and less education [28].

South Carolina is a relatively rural state with approximately 30% African American representation [29]. The poverty rate in South Carolina from 2008 to 2009 is about 20%, with African Americans

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having a higher rate compared to European Americans (35% vs. 13%, respectively) [29]. At close to 18% [30], South Carolina has one of the highest proportions of uninsured women in the nation. Breast cancer is the third-most common cancer diagnosed and is the second leading cause of cancer deaths among women in South Carolina [31].

To reduce the disproportionate burden of breast cancer and ensure adequate follow-up from abnormal mammograms among disadvantaged women in South Carolina, the Best Chance Network (BCN), which is the state program of the National Breast and Cervical Cancer Early Detection Program, was established in 1991. The program has established service delivery and ensures timely and complete diagnostic follow-up and treatment initiation for underserved women screened through the program. Although many studies have examined factors in predicting incomplete and delay in abnormal mammogram follow-up [20–28], few have used geospatial methods to examine factors related to distance to screening facilities [32–34], and none have examined this among women of low socioeconomic status in the southeastern United States. We hypothesize that longer distance to screening facilities may be related to incomplete or delay in abnormal mammogram follow-up. The purpose of this study was to examine the relationship between travel distance to the screening provider (where screening referral is being made), diagnosing mammography facility (actual facility that patient was diagnosed), closest mammography facility (facility closest to the patient), and completion of abnormal mammogram follow-up among women participating in the Best Chance Network.

Methods

Study setting/participants

Study participants were women from the Best Chance Network of South Carolina. The program provides free mammograms, clinical breast examinations, Pap tests, pelvic examinations, diagnostic procedures, case management, community education on breast/cervical cancer, and early detection for underserved women aged 47–64 years, who are at or below 200% of the Federal trade poverty level, and those who lack insurance or have insurance that only covers hospital care. BCN is a network that consists of public and private partnerships between federally funded primary care centers, private physicians, laboratories, university sponsored clinics, free clinics, regional medical centers, and radiology facilities. Between January 2007 to December 2011, the BCN performed 24,917 mammograms to eligible women in the state [35].

Mammogram results are interpreted by radiologists using the American College of Radiologist Breast Imaging Reporting and Data System (BIRADS) categories: 0—"incomplete"; 1—"Negative"; 2—"Probably benign"; 3—"Suspicious"; 4—"Suspicious abnormality"; 5—"Highly suspicious of malignancy"; and 6—"Known biopsy proven malignancy" [36]. A category of 4 and 5 requires additional diagnostic procedures to determine the presence or absence of the disease. All participants with abnormal mammography are provided with case management services, which work with the participant to help her receive follow-up diagnostic services within 60 days.

Subjects were included in the analyses if they were enrolled in BCN between 1996 and 2009 and had an abnormal mammogram BIRADS reading (BIRADS category of 4 or 5). Only women with race/ethnicity categorized as African American (AA) and European American (EA) were included in the sample because other individual racial or ethnic groups ($n = 31$) did not have sufficient numbers to make meaningful contributions to the analysis. AA and EA women were not separated by Hispanic and non-Hispanic because ethnicity-by-race data were not collected at the time. A total of 1388 BCN participants were obtained from BCN.

The study was approved by the South Carolina's Department of Health and Environmental Control (SC-DHEC) and was exempted from approval from the Institutional Review Board of the University of South Carolina Office of Research.

Measures

The outcome of interest was time-to-resolution or completion of abnormal mammogram follow-up. The measure of time was the number of days between the first mammogram and the date that the follow-up status was finalized (work-up completed, refused, or lost to follow-up). A completed work-up is designated when the diagnostic testing is complete at the diagnostic facility, and a final diagnosis has been made (benign or malignant breast cancer). Refused work-up indicates a woman had her diagnostic work-up performed by another provider. A loss-to-follow-up status indicates that the woman died, moved before her work-up started, or BCN could not make contact with the patient. Women whose final status was recorded as refused or loss-to-follow-up were considered censored observations.

There were three main exposure variables of interest: travel distance from the patient's residence to the screening provider (where screening referral is being made), travel distance to the diagnosing mammogram facility (actual facility that patient was diagnosed), and travel distance to the nearest mammography facility (facility closest to the patient). The travel distances were calculated in miles and along the road network based on point location of residence to the facilities using ArcGIS 9.3 (Redland, CA) Network Analyst and an updated street road network file (as of 2011) from the SC-DHEC. Distances were calculated using the shortest path through the network. Geocoding of residence and facilities were done using the Method and Tiers method [37] developed by the SC-DHEC. Geocoded addresses were given a tier and match score value, which determines the spatial horizontal accuracy of the geocoded point. Approximately 98% of the geocoded addresses were within 482-foot horizontal accuracy (75% were within 7 foot). Patients' addresses, screening providers' addresses, and diagnosing mammography facilities' addresses were obtained from BCN. The closest mammography facilities were identified from a regularly updated list of Food and Drug Administration (FDA) accredited facilities [38]. We excluded all patients and screening providers with missing addresses, addresses that were PO Boxes and those that were matched to the five-digit zip code only. Of the 1,388 subjects, there were 1,073 matchable patient addresses. There were 218 screening providers; however, we were able to geocode only 137 facilities due to missing addresses and PO boxes. There were 500 patients with a diagnosing mammography facility designated. Owing to change in data collection, a portion of the records only captured the provider where the initial referral or screening mammography was performed. Thus, we were unable to perform geospatial analyses using diagnosing facility for these individuals. There were a total of 111 certified mammography facilities, identified from the FDA list, in South Carolina that were used as the closest mammography facilities. All distances to the screening provider, diagnosing mammography facilities, and closest mammography facilities were broken into <5 miles, 5–10 miles, 10–15 miles, and 15+ miles. Demographic characteristics obtained from BCN for analyses included age, race, previous mammogram, yearly family income, and insurance status at time of visit with the BCN.

Statistical analysis

Descriptive statistics were calculated for all characteristic variables. χ^2 test and t test were used to examine the bivariate associations between demographic and race variables. The median days from the abnormal mammogram to diagnostic resolution for each