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The Synergistic Impact of Income and Rurality on Timely Mammograms in a National Sample of Women in the United States

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THE SYNERGISTIC IMPACT OF INCOME AND RURALITY ON TIMELY MAMMOGRAMS IN A NATIONAL SAMPLE OF WOMEN IN THE UNITED STATES

CAPSTONE PROJECT PAPER

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Abstract

Introduction. Breast cancer is the cancer of highest incidence among women in the U.S., making it a significant public health problem. Currently, the U.S. Preventive Services recommends biennial screening mammography for women ages 50-74. This study examined the associations between socioeconomic status and rurality on breast cancer screening behavior. **Methods.** Data for this study come from the Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System Survey (BRFSS). Breast cancer screening behavior was dichotomized into those who did not meet screening mammogram recommendations (2 years or more) and those who met screening mammogram recommendations (within the past 2 years). Chi-square tests of independence and a Gamma statistic and Phi statistic were used to analyze the relationship between income and rurality on breast cancer screening behavior, respectively. Logistic regression with adjusted odds ratios was used to examine the impact of combined rurality and income on breast cancer screening behavior. **Results.** Of the 113,395 women ages 50-74 with no history of cancer, the mean age was 61.9 years (SD = 6.9) and most participants were non-Hispanic White (78.3%). Bivariate analysis revealed a significant association between income level and breast cancer screening behavior ($X^2 = 2782.3$, $p<0.001$, Gamma = 0.267) and a significant association between rural/urban status and breast cancer screening behavior ($X^2 = 437.6$, $p<0.001$, Phi = 0.067). Logistic regression results controlled for race demonstrated that in comparison to rural, low-income women, rural middle- and high-income women and urban woman of all incomes had higher odds of meeting breast cancer screening recommendations. High-income urban women had 1.824 times the odds of receiving a mammogram within the past two years (95% CI 1.774-1.877) than low-income rural women. **Discussion.** The findings of this study support for further research and prevention efforts of aimed at breast cancer in low-income, rural women. Continued efforts that focus on the confluence of these factors could help the nation reduce its overall breast cancer burden.

Introduction

Breast cancer is the most commonly diagnosed cancer among women in the United States (U.S.) with an estimated 231,840 new cases and 40,290 deaths in the U.S. in 2015,[1] making it a significant public health problem. Mammogram screening can reduce the number of breast cancer-related deaths in women.[2] Mammograms are the most effective means to find breast malignances before a woman shows symptoms of the disease.[3] Screening mammograms help detect breast cancers early so that treatment can be started earlier in the course of the disease.[2] In order to encourage this behavior among women and reduce mortality nationally, the U.S. Preventive Services Task Force recommends biennial screening mammography for women ages 50-74 years.[4]

Some women may face obstacles to receiving recommended breast cancer screening. For example, women of lower socioeconomic status (SES) have lower rates of breast cancer screening than their wealthier counterparts, potentially influencing shorter survival and higher case-fatality from breast cancer.[5] Specifically, women of lower SES may not be able to afford the cost of a healthcare visit,[6] may face transportation difficulties, may not have health insurance, may not be aware of free or low-cost screening programs, and may not be able to take time off from work. Women of low SES may also experience psychosocial barriers such as fear,[7] embarrassment,[8] or perception of susceptibility and barriers. [9] Even with insurance and the availability of free or low cost mammograms, low SES women may still underutilize breast cancer screening, perhaps due to limited knowledge about breast cancer and mammography, distrust of the health care system, or other reasons that have not been adequately studied.[9-12]

Similar to SES status, evidence supports the argument that rurality may also negatively affect breast cancer screening behaviors. Rural residents are less likely to obtain cancer screenings than their urban counterparts.[13, 14] Rural women may be more likely than urban women to be diagnosed with later-stage breast cancers.[15, 16] As mammography screening has improved nationally, mammography screening in rural populations has remained lower than urban populations and low SES is associated with a lack of screening.[17] Women living in rural areas may face barriers to obtaining breast cancer screening, including access to screening facilities, distance from services, fear of cancer diagnosis, and lack of providers.[18-21] A study large Medicare claims study found that women on average traveled ≤ 20 minutes to the nearest mammography services and rural women had to travel times 4-8 times longer than urban women.[22] Odds of advanced diagnosis were significantly greater for women residing farther from a facility.[23] Even when distance to a facility was not associated with recent mammogram, rural residents still had lower screening rates than urban residents.[24] Cultural factors such as fatalism have also been documented as barriers to cancer screenings in rural populations.[25]

Women who are of low SES and also live in a rural area may face a dual disadvantage. Rural women generally are more likely to be low income.[26] For example, among Appalachian women, household income was found to be a strong predictor of having had a mammogram.[27] Though numerous studies have examined SES and breast cancer, fewer have looked at rurality and breast cancer, and even fewer on the confluence of the two. Furthermore, many existing studies have focused on treatment and survival instead of prevention and public health efforts.[28, 29] Currently, there is a paucity of research exploring the concurrent impact of income and rurality on breast cancer

screening behavior, particularly a direct comparison between rural and urban residing women. It is important to address this gap in knowledge because breast cancer is the most common cancer among women[3] and rural, low-income women may face significant barriers to breast cancer screening. In order to tailor appropriate cancer prevention interventions for this unique population, we must deepen our understanding of the concurrent impact of rurality and income on cancer screening behavior.

The goal of this study is to examine the association between socioeconomic status and breast cancer screening behavior, the association between rurality and breast cancer screening behavior, and the effects of both socioeconomic status and rurality on breast cancer screening behavior. We hypothesize that women who are low income and are also from rural areas will have the lowest rates of mammography screening.

Methods

Data Collection

Data for this study come from the Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System Survey (BRFSS), an annual cross-sectional telephone survey of health and risk behaviors of non-institutionalized adult participants >18 years in the U.S. and territories.[30] The 2012 BRFSS interviewed 475,687 individuals recruited through random-digit dialing with a median 45.2% response rate calculated by the number of respondents who completed the survey as a proportion of all eligible and likely eligible persons. A total of 113,395 women completed the survey met qualifications for biennial mammograms, i.e. ages 50-74 without a history of cancer. This

study uses existing, publicly available data and is therefore exempt from review by the University of Kentucky Institutional Review Board.

Measures

The dependent variable was breast cancer screening behavior, measured by self-reported receipt of mammograms. All BRFSS participants were asked, "A mammogram is an x-ray of each breast to look for breast cancer. Have you ever had a mammogram?" The response options were yes, no, and don't know/not sure. Participants who answered "yes" were then asked, "How long has it been since you had your last mammogram?" The response options were: within the past year (anytime less than 12 months ago), within the past 2 years (1 year but less than 2 years ago), within the past 3 years (2 years but less than 3 years ago), within the past 5 years (3 years but less than 5 years ago), 5 or more years ago, and don't know/not sure. The mammogram response was dichotomized into those who did not meet screening mammogram recommendations (2 years or more) and those who met screening mammogram recommendations (within the past 2 years).

Socioeconomic status, measured using income, was an independent variable of this study. To measure income, BRFSS asks, "Is your annual household income from all sources: less than $10,000; $10,000 to less than $15,000; $15,000 to less than $20,000; $20,000 to less than $25,000; $25,000 to less than $35,000; $35,000 to less than $50,000; $50,000 to less than $75,000; and $75,000 or more." These original income intervals were maintained in initial study analyzes assessing the association between income and breast cancer screening behavior. In further analyses, the income responses were recoded into low income, middle income, and high income based on tertiles for clarity of analysis.[31, 32] In this study, low income corresponded with any income up to $25,000,

middle income included $25,000 to less than $50,000, and high income was $50,000 or more.

Metropolitan Status Code was used as a measure of rurality. Metropolitan statistical area (MSA) is defined as a group of counties that contain at least one urbanized area of 50,000 or more inhabitants. Responses are classified as: in the center city of a MSA, outside the center city of a MSA but inside the county containing the center city, inside a suburban county of the MSA, or not in a MSA. MSA code responses were dichotomized as urban and rural in accordance with the Federal Office of Rural Health Policy definitions;[33] those located outside of a MSA were coded as rural and those located inside a MSA were coded as urban. One specification of the MSA data is that since 2006, the BRFSS does not include respondents in counties with 10,000 or fewer residents.[34] BRFSS administrators documented Metropolitan Status Code.

To study the dual impact of rural and SES, responses to both the income and rurality items were combined and recoded into the categories low income rural, low income urban, middle income rural, middle income urban, high income rural, and high income urban. The general conceptual model of the above analyses is illustrated in Figure 1. Sociodemographic variables of age, race/ethnicity, education, employment, marital status, and health care coverage were also investigated.

Analytic Plan

Descriptive statistics were used to characterize the sample. Frequencies and percentages were used to describe race, ethnicity, employment status, and insurance status. Mean and standard deviation was used to represent age.

The first objective was to examine the relationship between income and breast cancer screening behavior. Chi-square tests of independence and a Gamma statistic were used to analyze the relationship between the ordinal variable of income and the dichotomous variable of breast cancer screening behavior. Next, this study examined the relationship between rurality and breast cancer screening behavior using a chi-square test of independence and a Phi statistic. Finally, binary logistic regression was used to examine the relative impact of combined rurality and income on breast cancer screening behaviors, controlling for race. All analyses were conducted in 2015 using IBM SPSS Statistics for Macintosh, Version 22.[35]

Results

Of the 113,395 women ages 50-74 with no history of cancer, the mean age was 61.9 years (SD = 6.9). Most participants were non-Hispanic White (78.3%), and most graduated high school (91.5%). Over half had an annual household income of over $35,000 (56.2%) and over one-third were employed for wages (38.3%). About half of the women were married (53.1%). Over one-third of the women in this sample (34.8%) lived outside of a MSA (in a rural area), which is higher than most reported rates of U.S. individuals residing in rural areas (~15%).[26] Regarding overall breast cancer screening behaviors, most women had ever had a mammogram in their lifetime (95.2%), and many had a mammogram within the last 2 years (81.7%, Table 1).

Bivariate analysis revealed a significant association between income level and breast cancer screening behavior ($X^2 = 2782.3$, $p<0.001$, Gamma = 0.267). As income increased, the proportion of women who received a mammogram within the last two years significantly increased as well, though the effect size was not strong (Table 2). A

Chi-square test for independence also indicated a significant association between rural/urban status and breast cancer screening behavior with a weak effect size (X^2 = 437.6, $p<0.001$, Phi = 0.067). Urban residence was associated with higher proportion of meeting mammogram recommendations. A smaller proportion of rural women met screening mammogram recommendations (Table 3).

Logistic regression results (controlling for race) demonstrated that in comparison to rural, low-income women, rural middle- and high-income women and urban woman of all incomes had higher odds of meeting breast cancer screening recommendations. As income increased, odds of meeting screening recommendations increased, and at each level of income, urban women had higher odds of meeting recommendations than their rural counterparts. High-income urban women had 1.824 times the odds of receiving a mammogram within the past two years (95% CI 1.774-1.877) than low-income rural women (Table 4).

Discussion

The main finding of this study was that rural, low-income women had the lowest odds of being up-to-date on their recommended mammograms than all other women. Additional findings of this study were that income and rurality each significantly played a role in breast cancer screening behavior. As income increased, odds of having a timely mammogram did as well, yet at each level of income, urban women had higher odds of having a timely mammogram than rural women. This finding contributes to the existing body of evidence indicating that rural women and women of low SES are less likely to have obtained a mammogram in the past two years.[5, 13, 14] Past studies indicate that

structural and cultural barriers may play a role, such as poor public infrastructure to address health services.[7]

The main implication of this research is the importance of both SES and rurality as disparities in health. Several solutions have been proposed to address barriers to mammography which include taking a socioecological examination of potential interventions to initiate, improve, or continue at the policy, community, organizational, interpersonal, and individual levels.

At the policy level, potential ways to increase mammography for low-income rural women include better-informed resource allocation and more flexible work policies. For example, the Black Belt of Alabama, like many rural communities, is medically underserved and would benefit from efforts to increase services.[19] High physician turnover in rural areas may lead to little to no discussion about breast cancer screening and poor follow-up among low-income, rural patients.[14] Further research regarding access could also help inform policies and address personal barriers, such as distance to mammograms.

Potential solutions also exist at the community level, such as building coalitions to promote collaboration among organizations and community members. One example of a successful coalition is the Northern Appalachia Leadership Initiative on Cancer, involving universities, the American Cancer Society, and local organizations to better assess and address cervical and breast cancer disparities in Appalachia.[36] Another example of a successful community-level solution is in New Mexico where federal, state, and tribal organizations are atypically well-coordinated; here, American Indians have high preventive service utilization, including women's cancer screenings.[37] One

potentially cost-effective intervention is to recruit and train community volunteers or community health workers to promote mammography.[38] A combination of individual counseling and community activities led by local volunteers could help rural women increase mammography use, especially in communities without female physicians and among women with no health insurance.[39]

At the organizational-level, potential solutions include working with faith-based organizations, training staff in health, and providing mobile mammography. In rural Louisiana, patients who received educational materials and follow-up nurse support were more likely to complete screening mammograms than patients who only received education materials.[40] Teaching healthcare providers in the Delta region with standardized patients, poster and pocket reminder prompts, and easy-to-read newspapers about mammography was a successful intervention.[41] Physician recommendation has been found to be one of the strongest predictors of mammography initiation and maintenance in a rural sample.[21] Tapping into faith-based organizations can help greatly with rural interventions, such as the example of a church-based screening program in rural Hawaii.[42] Mobile mammography units have also shown to help with rural populations.[43]

Interpersonal-level solutions can use families and friends to help increase breast cancer screening behavior. Group education has been recommended to increase breast cancer screening by The Community Guide.[44] This is an effort that could be tailored specifically to low-income rural women to improve screening outcomes.

Individual-level solutions include one-on-one education and small media to address barriers such as knowledge and self-efficacy. Even patients who had high self-

efficacy regarding mammograms, confusion over screening recommendations remained.[14] Interventions should be mindful of the population, including culture and education level.

The strengths of this study included the fact that the sample was large and generally nationally representative of the U.S. Because of the large sample, though, a limitation of this study was that these numbers can contribute to statistical significance with weak effect sizes (i.e., Type 1 error). Another limitation of this survey was the potential for bias due to self-reported data, such as social desirability regarding income. Our results had high mammography proportions, so social desirability and recall bias likely play a role in the mammogram items.

Another limitation of using recent BRFSS data to research rurality was the exclusion of residents of counties with fewer than 10,000 residents. In 2005-2009, these data were available in a restricted use basis; studies comparing restricted and publically available data showed that remote rural populations are generally underrepresented and that mammography estimates tend to be higher in the restricted data.[34] If these conclusions extend to the version of BRFSS used in this study, it is possible that our data on rural breast cancer screening behavior was underestimated.

Beyond the items of the BRFSS, the coding of the responses may be a limitation to this study. Socioeconomic status and rurality may be defined in many ways other than the low, middle, and high income and the dichotomous rural/urban categories used here. A study of rural-urban disparities in late-stage cancer risk in Illinois used a fine-grained classification of rurality that found cancer risk was highest in the most highly urbanized area, decreased as rurality increased, then had a small upturn in risk in the most isolated rural areas. [46]

An additional limitation was the fact that the outcomes were dependent on cancer screening recommendations. Though mammography is currently the best method to detect breast cancer early, some problems are that most women who show abnormal mammograms do not have cancer (95%).[1] This leads to overdiagnosis. Furthermore, if screening recommendations change, the findings of this study may no longer be relevant. Another limitation is that we only looked at the general recommended population and were not able to identify high-risk subsamples such as women with history of breast cancer.

Another limitation of this study was that the categories were broad and did not examine nuances and diversity within the groups. Though it is important to consider the broad barriers that are characteristic of having a low income or living in a rural area,[29, 47, 48] researchers and practitioners should also consider the diversity within these broad categories. Indeed, research that examines rurality (or urbanicity) on a continuum or within specific rural regions may glean additional insights compared to a dichotomous rural/urban categorization. For example, in Appalachia, lower screening rates were associated with later stage breast cancer. In a subregion of Appalachia, screening had a particularly high impact, attributed to this region having more health resources in general.[49] Formative, qualitative research in specific rural communities may address this limitation in future research.

Additionally, missing, "don't know" and refused responses were omitted from this analysis. One study has shown that women who respond "don't know" to breast cancer knowledge questions were more likely to be of lower income and almost one-third

of women from a rural mobile mammography program in Appalachia responded “don’t know.” [50]

Despite the limitations, the findings of this study provide additional support for further research and prevention efforts aimed at breast cancer in low-income, rural women. Continued efforts that focus on the confluence of these factors could help the nation reduce its overall breast cancer burden.

Figure 1. Conceptual Model

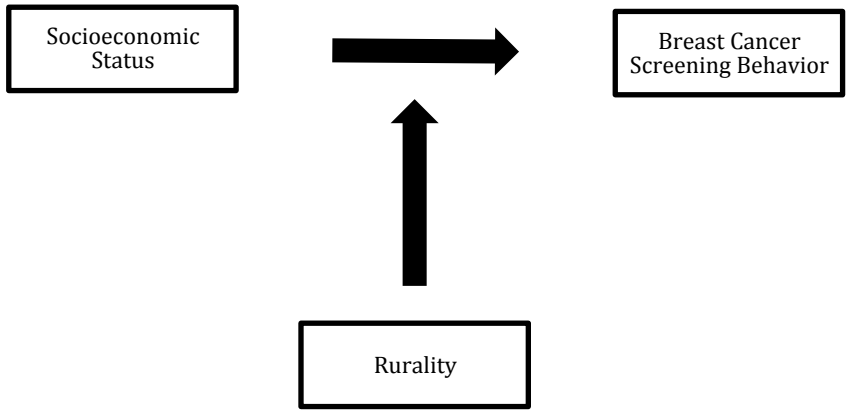

Table 1. Demographic characteristics of study participants, N=113,395

Demographics	n (%)
Female	113,395 (100.0)
Age (mean, SD)	61.9, 6.9
Race/Ethnicity (n=112,266)	
White	87,861 (78.3)
Black/African American	11,927 (10.6)
Hispanic	6,908 (6.2)
Multiracial	1764 (1.6)
American Indian/Alaskan Native	1,565 (1.4)
Asian	1,470 (1.3)
Other	543 (0.5)
Native Hawaiian/Pacific Islander	228 (0.2)
Education (n=113,028)	
Graduated from College or Technical School	36,636 (32.4)
Attended College or Technical School	31,980 (28.3)
Graduated High School	34,832 (30.8)
Did not graduate High School	9,580 (8.5)
Annual Household Income (n=96,482)	
Less than $10,000	6,462 (6.7)
$10,000 to less than $15,000	6,720 (7.0)
$15,000 to less than $20,000	8,001 (8.3)
$20,000 to less than $25,000	9,564 (9.9)
$25,000 to less than $35,000	11,499 (11.9)
$35,000 to less than $50,000	14,566 (15.1)
$50,000 to less than $75,000	15,838 (16.4)
$75,000 or more	23,832 (24.7)
Employment (n=112,902)	
Employed for wages	43,255 (38.3)
Retired	34,457 (30.5)
Unable to work	11,872 (10.5)
Homemaker	9,390 (8.3)
Self-Employed	7,962 (7.1)
Out of work > 1 year	3,527 (3.1)
Out of work < 1 year	2,148 (1.9)
Student	291 (0.3)
Marital status (n=113,329)	
Married	60,246 (53.4)
Divorced	21,964 (19.5)
Widowed	17,600 (15.6)
Never Married	8,775 (7.8)
Separated	2,594 (2.3)
Member of unmarried couple	1,588 (1.4)
Health Care Coverage (n=113,148)	
Yes	102,580 (90.7)
No	10,568 (9.3)
Metropolitan Status Code (n=100,533)	
In the center city of an MSA*§	30,388 (30.2)
Outside the center city of an MSA* but inside the county containing the center city §	20,525 (20.4)
Inside a suburban county of the MSA*§	14,025 (14.0)
In an MSA* that has no center city§	574 (0.6)

Not in an MSA* °	35,021	(34.8)
Breast Cancer Screening Behaviors		
Have you ever had a mammogram? (n=109,862)		
Yes	104,640	(95.2)
No	5,222	(4.8)
How long has it been since you had your last mammogram? (n=103,889)		
Within the past year +	67,615	(65.1)
More than 1 year but less than 2 years ago+	17,210	(16.6)
More than 2 years but less than 3 years ago	6,712	(6.5)
More than 3 years but less than 5 years ago	4,717	(4.5)
5 or more years ago	7,635	(7.3)

*Metropolitan statistical Area (MSA)

§Urban

° Rural

Table 2. Income on breast cancer screening behavior (N=94,125)

Income level	Breast Cancer Screening Behavior: Did not meet mammogram recommendations: Over 2 years (n=21,433)	Breast Cancer Screening Behavior: Met mammogram recommendations: Within 2 years (n=72,692)	Test statistic	p value
Less than $10,000	34.0%	66.0%	$X^2 = 2782.3$	<0.001
$10,000 to less than $15,000	34.4%	65.6%		
$15,000 to less than $20,000	32.1%	67.9%		
$20,000 to less than $25,000	29.0%	71.0%		
$25,000 to less than $35,000	25.2%	74.8%	Gamma = 0.267	<0.001
$35,000 to less than $50,000	21.1%	78.9%		
$50,000 to less than $75,000	17.6%	82.4%		
$75,000 or more	14.3%	82.4%		

Table 3. Rural/urban status on breast cancer screening behavior (N=97,483)

Rurality	Breast Cancer Screening Behavior: Did not meet mammogram recommendations: Over 2 years (n=21,582)	Breast Cancer Screening Behavior: Met mammogram recommendations: Within 2 years (n=75,901)	Test statistic	p value
Rural	25.9%	74.1%	$X^2 = 437.6$	<0.001
Urban	20.1%	79.9%	Phi = 0.067	<0.001

Table 4. Logistic regression of income/rurality on breast cancer screening behavior controlled for race (N=82,660)

Demographics	Odds Ratio	95% C.I.	
		Lower	Upper
Low Income Rural	REF		
Low Income Urban	1.297	1.281	1.313
Middle Income Rural	1.373	1.355	1.393
Middle Income Urban	1.500	1.471	1.532
High Income Rural	1.646	1.611	1.682
High Income Urban	1.824	1.774	1.877

Works Cited

1. American Cancer Society. Cancer Facts & Figures 2015. 2015.
2. National Institutes of Health, National Cancer Institute. Mammograms Fact Sheet. In; 2014.
3. Centers for Disease Control and Prevention. Breast Cancer. In; 2014.
4. United States Preventive Services Task Force. Final Recommendation Statement: Breast Cancer: Screening. 2014.
5. DeSantis C, Siegel R, Bandi P, Jemal A. Breast cancer statistics, 2011. CA Cancer J Clin 2011;61(6):409-18.
6. Kiefe CI, McKay SV, Halevy A, Brody BA. Is cost a barrier to screening mammography for low-income women receiving Medicare benefits? A randomized trial. Arch Intern Med 1994;154(11):1217-24.
7. Bowen SA, Williams EM, Stoneberg-Cooper CM, Glover SH, Williams MS, Byrd MD. Effects of social injustice on breast health-seeking behaviors of low-income women. Am J Health Promot 2013;27(4):222-30.
8. Crump SR, Mayberry RM, Taylor BD, Barefield KP, Thomas PE. Factors related to noncompliance with screening mammogram appointments among low-income African-American women. J Natl Med Assoc 2000;92(5):237-46.
9. Garza MA, Luan J, Blinka M, Farabee-Lewis RI, Neuhaus CE, Zabora JR, et al. A culturally targeted intervention to promote breast cancer screening among low-income women in East Baltimore, Maryland. Cancer Control 2005;12 Suppl 2:34-41.
10. Ahmed NU, Fort JG, Elzey JD, Belay Y. Empowering factors for regular mammography screening in under-served populations: pilot survey results in Tennessee. Ethn Dis 2005;15(3):387-94.
11. Lobb R, Ayanian JZ, Allen JD, Emmons KM. Stage of breast cancer at diagnosis among low-income women with access to mammography. Cancer 2010;116(23):5487-96.
12. Ahmed NU, Fort JG, Fair AM, Semenya K, Haber G. Breast cancer knowledge and barriers to mammography in a low-income managed care population. J Cancer Educ 2009;24(4):261-6.
13. Bennett KJ, Probst JC, Bellinger JD. Receipt of cancer screening services: surprising results for some rural minorities. J Rural Health 2012;28(1):63-72.
14. Davis TC, Arnold CL, Rademaker A, Bailey SC, Platt DJ, Reynolds C, et al. Differences in barriers to mammography between rural and urban women. J Womens Health (Larchmt) 2012;21(7):748-55.
15. Nguyen-Pham S, Leung J, McLaughlin D. Disparities in breast cancer stage at diagnosis in urban and rural adult women: a systematic review and meta-analysis. Ann Epidemiol 2014;24(3):228-35.
16. Keeton KM, Jones ES, Sebastian S. Breast cancer in Mississippi: impact of race and residential geographical setting on cancer at initial diagnosis. South Med J 2014;107(8):510-2.
17. Doescher MP, Jackson JE. Trends in cervical and breast cancer screening practices among women in rural and urban areas of the United States. J Public Health Manag Pract 2009;15(3):200-9.
18. Marchick J, Henson DE. Correlations between access to mammography and breast cancer stage at diagnosis. Cancer 2005;103(8):1571-80.

19. Coughlin SS, Thompson TD, Seeff L, Richards T, Stallings F. Breast, cervical, and colorectal carcinoma screening in a demographically defined region of the southern U.S. Cancer 2002;95(10):2211-22.
20. Coughlin SS, Thompson TD, Hall HI, Logan P, Uhler RJ. Breast and cervical carcinoma screening practices among women in rural and nonrural areas of the United States, 1998-1999. Cancer 2002;94(11):2801-12.
21. Rauscher GH, Hawley ST, Earp JA. Baseline predictors of initiation vs. maintenance of regular mammography use among rural women. Prev Med 2005;40(6):822-30.
22. Onega T, Hubbard R, Hill D, Lee CI, Haas JS, Carlos HA, et al. Geographic access to breast imaging for US women. J Am Coll Radiol 2014;11(9):874-82.
23. Huang B, Dignan M, Han D, Johnson O. Does distance matter? Distance to mammography facilities and stage at diagnosis of breast cancer in Kentucky. J Rural Health 2009;25(4):366-71.
24. Jackson MC, Davis WW, Waldron W, McNeel TS, Pfeiffer R, Breen N. Impact of geography on mammography use in California. Cancer Causes Control 2009;20(8):1339-53.
25. Royse D, Dignan M. Fatalism and cancer screening in Appalachian Kentucky. Fam Community Health 2011;34(2):126-33.
26. Crosby R.A. WML, Vanderpool R.C., Casey B.R. Rural Populations and Health: Determinants, Disparities, and Solutions; 2012.
27. Hall HI, Uhler RJ, Coughlin SS, Miller DS. Breast and cervical cancer screening among Appalachian women. Cancer Epidemiol Biomarkers Prev 2002;11(1):137-42.
28. Howe HL, Johnson TP, Lehnherr M, Warnecke RB, Katterhagen JG, Ford L. Patterns of Breast Cancer Treatment: A Comparison of a Rural Population With an Urban Population and a Community Clinical Oncology Program Sample. Cancer Control 1995;2(2):113-120.
29. Vanderpool RC, Kornfeld J, Mills L, Byrne MM. Rural-urban differences in discussions of cancer treatment clinical trials. Patient Educ Couns 2011;85(2):e69-74.
30. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Survey Data. In. Atlanta, Georgia; 2012.
31. Kamel AA, Ford PB, Kaczynski AT. Disparities in park availability, features, and characteristics by social determinants of health within a U.S.-Mexico border urban area. Prev Med 2014;69 Suppl 1:S111-3.
32. Martinez D, Giraldez-Garcia C, Miqueleiz E, Calle ME, Santos JM, Regidor E. The role of population change in the increased economic differences in mortality: a study of premature death from all causes and major groups of causes of death in Spain, 1980-2010. BMC Public Health 2015;15(1):321.
33. Health Resources and Services Administration. How is rural defined? In; 2014.
34. Bennett KJ. Rural population estimates: an analysis of a large secondary data set. J Rural Health 2013;29(3):233-8.
35. IBM Corp. IBM SPSS Statistics for Macintosh. Version 22.0. In; 2013.
36. Friedell GH, Rubio A, Maretzki A, Garland B, Brown P, Crane M, et al. Community cancer control in a rural, underserved population: the Appalachian Leadership Initiative on Cancer Project. J Health Care Poor Underserved 2001;12(1):5-19.

37. Gilliland FD, Mahler R, Hunt WC, Davis SM. Preventive health care among rural American Indians in New Mexico. Prev Med 1999;28(2):194-202.
38. Andersen MR, Hager M, Su C, Urban N. Analysis of the cost-effectiveness of mammography promotion by volunteers in rural communities. Health Educ Behav 2002;29(6):755-70.
39. Andersen MR, Yasui Y, Meischke H, Kuniyuki A, Etzioni R, Urban N. The effectiveness of mammography promotion by volunteers in rural communities. Am J Prev Med 2000;18(3):199-207.
40. Davis TC, Rademaker A, Bennett CL, Wolf MS, Carias E, Reynolds C, et al. Improving mammography screening among the medically underserved. J Gen Intern Med 2014;29(4):628-35.
41. Coleman EA, Lord J, Heard J, Coon S, Cantrell M, Mohrmann C, et al. The Delta project: increasing breast cancer screening among rural minority and older women by targeting rural healthcare providers. Oncol Nurs Forum 2003;30(4):669-77.
42. Ka'opua LS, Park SH, Ward ME, Braun KL. Testing the feasibility of a culturally tailored breast cancer screening intervention with Native Hawaiian women in rural churches. Health Soc Work 2011;36(1):55-65.
43. Roth R, Newhouse R, Robinson B, Faulkner S, Remick SC. Bonnie's Bus--cancer disparities in West Virginia, philanthropy and opportunities to build lasting partnerships. W V Med J 2009;105 Spec No:68-72.
44. Briss P, Rimer B, Reilley B, Coates RC, Lee NC, Mullen P, et al. Promoting informed decisions about cancer screening in communities and healthcare systems. Am J Prev Med 2004;26(1):67-80.
45. Grindel CG, Brown L, Caplan L, Blumenthal D. The effect of breast cancer screening messages on knowledge, attitudes, perceived risk, and mammography screening of African American women in the rural South. Oncol Nurs Forum 2004;31(4):801-8.
46. McLafferty S, Wang F. Rural reversal? Rural-urban disparities in late-stage cancer risk in Illinois. Cancer 2009;115(12):2755-64.
47. Howe HL, Katterhagen JG, Yates J, Lehnherr M. Urban-rural differences in the management of breast cancer. Cancer Causes Control 1992;3(6):533-9.
48. Monroe AC, Ricketts TC, Savitz LA. Cancer in rural versus urban populations: a review. J Rural Health 1992;8(3):212-20.
49. Anderson RT, Yang TC, Matthews SA, Camacho F, Kern T, Mackley HB, et al. Breast cancer screening, area deprivation, and later-stage breast cancer in Appalachia: does geography matter? Health Serv Res 2014;49(2):546-67.
50. LeMasters T, Madhavan S, Atkins E, Vyas A, Remick S, Vona-Davis L. "Don't know" and accuracy of breast cancer risk perceptions among Appalachian women attending a mobile mammography program: implications for educational interventions and patient empowerment. J Cancer Educ 2014;29(4):669-79.

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