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Addressing the Barriers to Mammography Screening in Rural and Urban Ohio Counties

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ADDRESSING THE BARRIERS TO MAMMOGRAPHY SCREENING IN RURAL AND URBAN OHIO COUNTIES

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Abstract

Mammography screenings have the potential to protect individuals from the burden of cancer and can even save lives. However, in Ohio, many women are not receiving regular screenings. Recent research indicates that social determinants of health, such as income and education, can impact an individual's ability to access mammography. Yet, we lack a comprehensive understanding of how these factors hinder an individual's ability to obtain mammography screenings, particularly in urban and rural areas of Ohio. The introduction of mammography has facilitated early detection of breast cancer in women. By identifying gaps in access to mammography and implementing changes to improve accessibility for underserved populations, we can significantly improve morbidity and mortality outcomes related to breast cancer.

Objective: To identify gaps in access to mammography screening in patients experiencing social determinants of health living in urban and rural counties of Ohio.

Methods: We evaluated mammography screening rates among Medicare patients in rural and urban Ohio counties for 2016 and 2022. Our analysis explored the correlation between screening rates and primary care physician availability, median household income and high school completion. Data was extracted from County Health Rankings and Roadmaps.

Results: Our results indicated that patients with lower median household income in urban areas of Ohio experienced more difficulty in obtaining mammography services. Additionally, a high patient to primary care physician (PCP) ratio was correlated with lower rates of mammography in urban regions of Ohio.

Conclusions: Understanding an individual's socioeconomic barriers can empower physicians to recognize health disparities and advocate for preventive mammography screenings. Increasing mammography rates for patients affected by social determinants of health requires a comprehensive, patient-centered approach.

Key Words: breast cancer; education; income; primary care; social determinants of health; Medicare

Introduction

Second to skin cancer, breast cancer is the next most diagnosed cancer amongst women in the United States annually[1]. According to the American Cancer Society, about 298,000 new cases of invasive breast cancer and about 56,000 new cases of ductal carcinoma in situ (DCIS) are diagnosed annually[1], making it the second leading cause of cancer-related death among women in the United States[2].

The introduction of mammography has been associated with a reduction in mortality[3]. Randomized trials comparing health outcomes of current screening measures to patient outcomes prior to 1985, when therapeutic options for breast cancer were more limited, showed a consistent and significant improvement in the effectiveness of screening for reducing breast cancer mortality[4]. Since then, the use of advanced therapeutic modalities has contributed to the decrease in breast cancer mortality after diagnosis, and continued implementation of mammography worldwide has been linked to improved outcomes[4].

Despite improvements in technology and increased emphasis on early detection, racial and ethnic disparities in breast cancer diagnosis persist[5]. Previous research has demonstrated that disparities in breast cancer mortality and screening rates are associated with factors such as poverty, social injustice, and biological and environmental influences[6]. Women with one or more of the social determinants of health[5], continue to face barriers likely due to inadequate addressing of factors that influence access and adherence to screening tests[7].

As it is generally accepted that social determinants of health affect a patient's health outcomes, it is important to continue the search for solutions to these issues[8]. The social determinants of health (SDOH) embody the nonmedical factors present in an individual's environment, including their residential, occupational, recreational, and religious settings which influence a person's well-being[9]. These factors which influence health equity include a person's socioeconomic status, lived environment, education, employment and insurance status, income, social support systems, healthcare access and food insecurity[10]. Additionally, zip code is a strong indicator of a person's health outcomes and has been shown to predict adherence to health screenings, as it can determine access to healthcare facilities, availability of preventive services and other social and environmental factors that influence health behaviors[11]. To add to the current discussion of breast cancer screening adherence, consideration of a patient's residence, such as living in a rural or urban county, as an area of interest is necessary.

As Ohio ranks 9th in the United States for most reported new cases of cancer, it is critical for current and future physicians practicing in the state to have a thorough understanding of how social determinants of health can impact a patient's access to mammography screenings [2]. Greater than 12.7% of people in Ohio are classified as poor, which is slightly greater than the national poverty rate[12]. Additionally, about a quarter of working Ohioans make less than or equal to 138% of the federal poverty line (FPL) and lower socioeconomic status was strongly linked to higher rates of poor health and unmet healthcare needs. About 65% of minority poverty in Ohio is accounted for in metropolitan areas and women have notably higher poverty rates than men[12].

Based on these statistics, we have chosen to investigate the impact of socioeconomic status and access to primary care physicians in regard to breast cancer screening frequency.

Our objective is to further elucidate the individual factors that influence the utilization of mammography screenings by patients in urban and rural Ohio counties.

Research Questions

We chose to evaluate how three different significant social determinants of health influence the mammography screening rates in rural and urban Ohio counties. We used median household income, high school completion percentage, and primary care physician ratio as variables in relation to the frequency of annual mammography. Additionally, we investigated the difference in mammography screening rates and median household income from 2016 to 2022 to determine how these factors have changed over the years.

RQ1a. How have mammography screening rates changed from 2016 to 2022 in rural Ohio counties?

RQ1b. How have mammography screening rates changed from 2016 to 2022 in urban Ohio counties?

RQ2a. What is the correlation between median household income and the frequency of annual mammography in rural Ohio counties in 2022?

RQ2b. What is the correlation between median household income and the frequency of annual mammography in urban Ohio counties in 2022?

RQ3a. What is the correlation between high school completion percentage and the frequency of annual mammography in rural Ohio counties in 2022?

RQ3b. What is the correlation between high school completion percentage and the frequency of annual mammography in urban Ohio counties in 2022?

RQ4a. What is the correlation between the primary care physician ratio and the frequency of annual mammography in rural Ohio counties in 2022?

RQ4b. What is the correlation between the primary care physician ratio and the frequency of annual mammography in urban Ohio counties in 2022?

RQ5a. What is the difference in median household income between the years 2016 and 2022 in rural Ohio counties?

RQ5b. What is the difference in median household income between the years 2016 and 2022 in urban Ohio counties?

RQ6. What is the difference in frequency of annual mammography between rural and urban counties in Ohio in 2022?

RQ7a. How do median household income, primary care physician ratio, and high school completion percentage predict the frequency of annual mammography in rural Ohio counties in 2022?

RQ7b. How do median household income, primary care physician ratio, and high school completion percentage predict the frequency of annual mammography in urban Ohio counties in 2022?

Methods

Data Collection

Data were collected from County Health Rankings and Roadmaps (https://www.countyhealthrankings.org) (CHR&R), which is a program from the University of Wisconsin Population Health Institute. CHR&R gathers data from various national and state data sources. Specifically for mammography screening data, we extracted information from Mapping Medicare Disparities and included screening for women aging from 65-74 as a percentage of the women from the fee-for-service Medicare enrollees who receive an annual mammogram. The data pertaining to median household income levels is from the US Census Bureau which used the Small Area and Income Poverty Estimates. Data regarding high school completion is from American Community Survey (ACS) and is the percentage of the population ages 25 and over to receive at least a high school diploma. Lastly, data pertaining to primary care physicians is a ratio of the population to physicians and was collected from the Area Health Resource File and American Medical Association. The primary care physician ratio is defined by CHR&R as "the number of individuals served by one physician in a county, if the population was equally distributed across physicians. For example, if a county has a population of 50,000 and has 20 primary care physicians, their ratio would be: 2,500:1"[13].

We included data from 2016-2022 covering urban and rural counties in Ohio. To establish counties as rural or urban, we used Ohio Department of Health's classification and included partially rural counties in the rural section. The Ohio Department of Health Primary Care office collected this data in December of 2020. Our variables are the social determinants of health including healthcare access, education, income, and socioeconomic status (SES) compared to the percentage of patients who receive annual mammograms. Socioeconomic status is defined as "the position of an individual or group on the socioeconomic scale, which is determined by a combination of social and economic factors such as income, amount and kind of education, type and prestige of occupation, place of residence, and—in some societies or parts of society—ethnic origin or religious background," per the American Psychological Association[14]. Exclusion criteria is recognized as patients who did not qualify as low socioeconomic status, women and men outside of the age range 65-74, and individuals who were not living in the state of Ohio. Additionally, the data pertaining to mammography screening includes females only. Inclusion criteria for mammography screening in 2022 is females enrolled in Medicare between the age of 65 and 74, and data for mammography screening in 2016 is females enrolled in Medicare between the ages of 67 to 69.

Data Analysis

All data were analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 29.0.0.0. P values less than 0.05 were determined to be statistically significant. Values representing significant Pearson correlations were deemed as weak ($r \geq 0.3$), moderate ($r \geq 0.5$), or strong ($r \geq 0.7$), and r values below 0.3 indicated there was no correlation. To answer how mammography screening rates and median household income have changed between 2016 and 2022 and to evaluate the difference in annual mammography rates in rural and urban Ohio counties in 2022 (RQ1a, RQ1b, RQ5a, RQ5b, and RQ6), we used paired t- tests. We used Pearson Correlations to answer RQ2a, RQ2b, RQ3a, RQ3b, RQ4a, and RQ4b. A regression was used to answer RQ7a and RQ7b to determine if a relationship existed between median household income, primary care physician ratio, and rate of high school completion and the likelihood to obtain annual mammography.

Results

To gain a better understanding of any changes in mammography screenings over the years (RQ1a), we performed a paired t-test to compare the rate of screening between 2016 and 2022. We found that there was a significant relationship between the two variables ($t = -37.035$, two-sided $p < 0.001$) in rural Ohio counties (Table 1). We performed the same test amongst urban Ohio counties (RQ1b), and we found that there was a significant difference in mammography screening rates from 2016 to 2022 ($t = -26.824$, two-sided $p < 0.001$) (Table 2).

Table 1: Mammography Screening Rates in Ohio Rural Counties

Year	n	Mean	SD
2016	66	82.491%	7.8041%
2022	66	42.15%[a]	4.115%

Abbreviation: SD, Standard Deviation

[a] statistically significantly different from 2016 ($p < 0.001$)

Table 2: Mammography Screening Rates in Ohio Urban Counties

Year	n	Mean	SD
2016	14	83.579%	3.4710%
2022	14	45.29% [a]	4.340%

Abbreviation: SD, Standard Deviation

[a] statistically significantly different from 2016 ($p < 0.001$)

For the following correlations (RQ2a – RQ4b), frequency of annual mammography was plotted against each dependent variable to confirm a normal fit and the use of Pearson's correlation.

We performed a Pearson correlation to assess the relationship between median household income and frequency of annual mammography in rural Ohio counties (RQ2a). The Pearson correlation indicates a weak but statistically significant correlation between median household income and frequency of annual mammography ($r = 0.447$, $p = <0.001$), meaning that as median household income increases, frequency of mammography also increases (Figure 1).

We performed the same Pearson correlation for urban Ohio counties (RQ2b) and found a statistically significant and moderate correlation between median household income and frequency of annual mammography ($r = 0.621$, $p = 0.010$) (Figure 2).

Figure 1

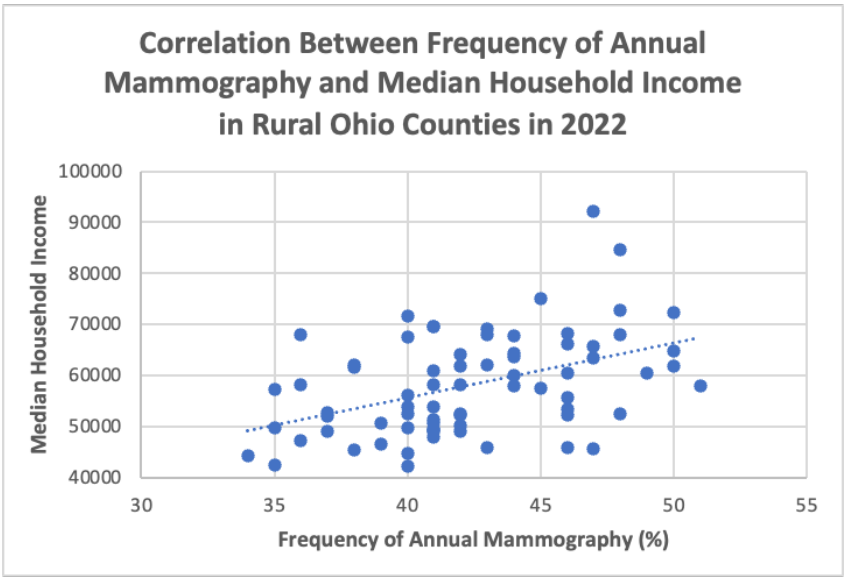
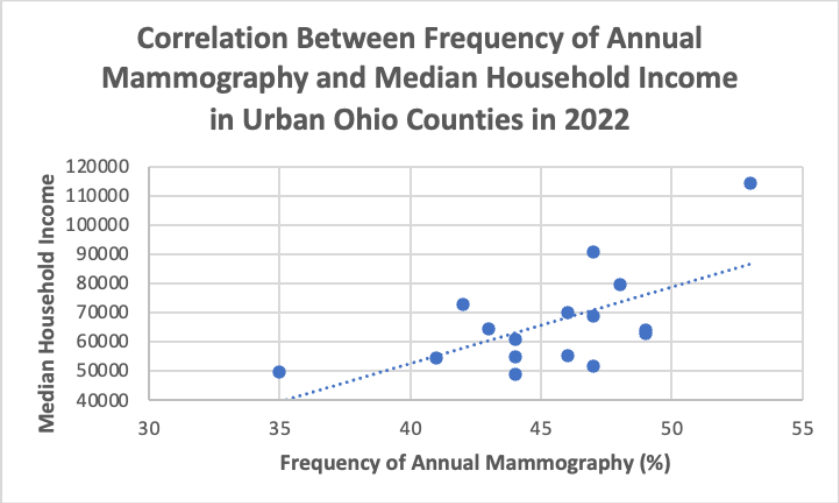


Figure 2



To assess the relationship between education level and frequency of annual mammography in rural Ohio counties in 2022 (RQ3a), we used a Pearson correlation comparing the percentage of people receiving an annual mammography and the percentage of people who completed high school. The results were not statistically significant ($r = -0.072$, $p = 0.572$), indicating that there was no significant correlation between high school completion and mammography screening in rural counties (Figure 3).

We performed the same Pearson correlation for urban Ohio counties in 2022, and the results were statistically significant with a moderate correlation ($r = 0.541$, $p = 0.031$) (Figure 4).

Figure 3

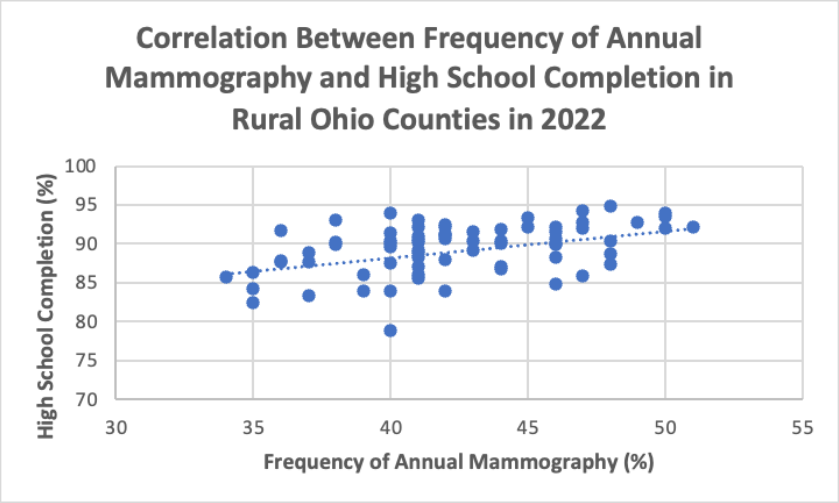
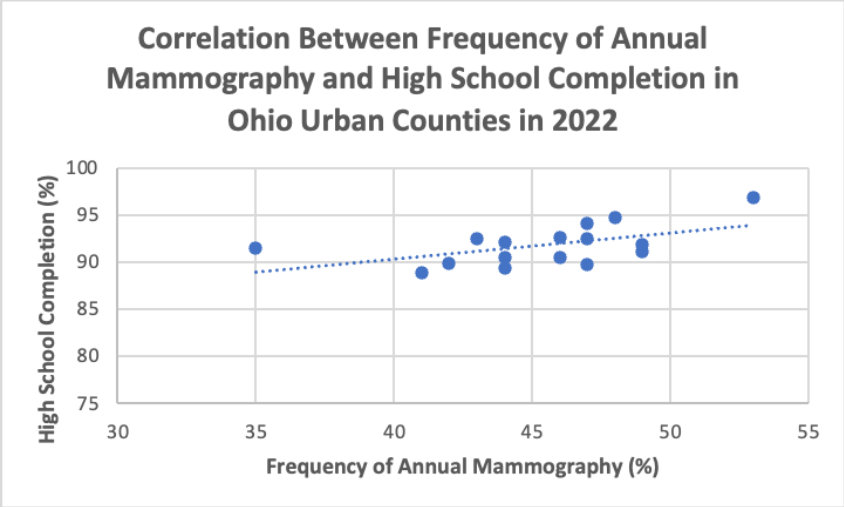


Figure 4



To better understand the relationship between the primary care physician ratio and the frequency of annual mammography in rural Ohio counties we used a Pearson correlation (RQ 4a). The results were not significant ($r = 0.132$, $p = -0.179$) (Figure 5). The same test was run for urban Ohio counties (RQ 4b), and we found that the results were statistically significant with a moderate correlation between the primary care physician ratio and the frequency of annual mammography ($r = -0.619$, $p= 0.011$) (Figure 6).

Figure 5

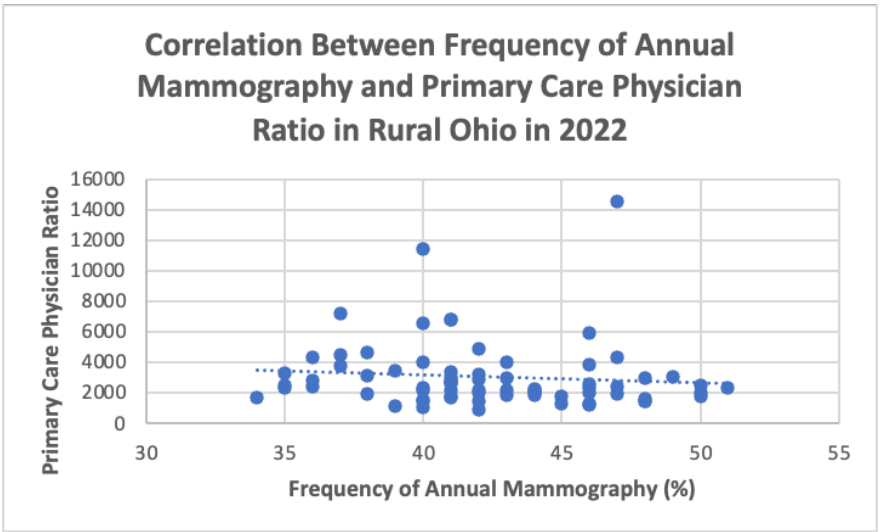
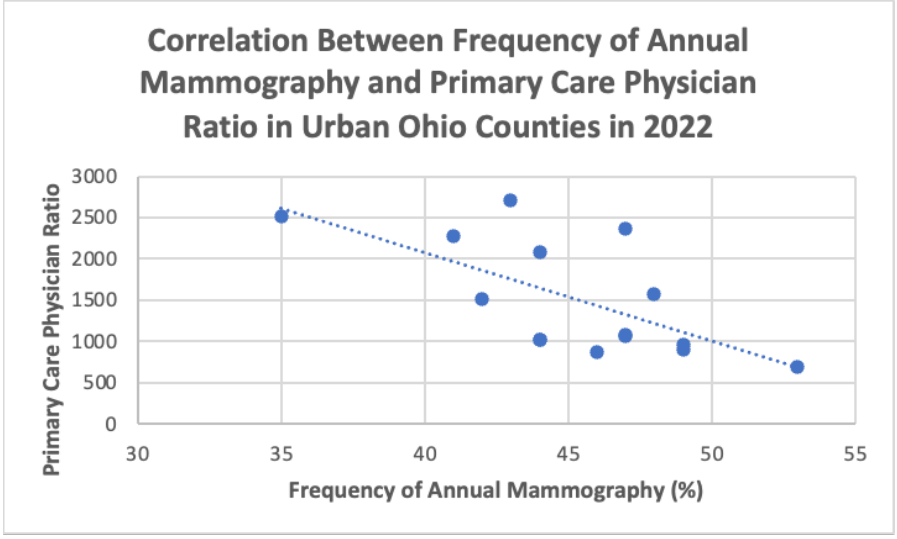


Figure 6



To further understand the relationship between income and mammography screening, we also wanted to know how income levels have changed between 2016 and 2022. We used a paired t- test to compare median household income between 2016 and 2022 in Ohio rural counties (RQ5a). The results indicate that there are statistically significant differences between the income in 2016 and 2022 ($t = 7.155$, $p < 0.001$), showing that the median household income increased significantly from 2016 to 2022 (Table 3).

We performed another paired t-test to assess the income levels between 2016 and 2022 in Ohio urban counties (RQ5b). We found that there is a statistically significant difference between income levels in 2016 and 2022 in Ohio urban counties ($t = 4.228$, $p < 0.001$), and our data shows that income increased from 2016 to 2022 (Table 4).

Table 3 Median Household Income in Rural Ohio Counties

Year	n	Mean	SD
2016	71	$44,562.54	$13,631.789
2022	71	$58,134.66[a]	$9,957.143

Abbreviation: SD, Standard Deviation

[a] statistically significantly different from 2016 ($p < 0.001$)

Table 4 Median Household Income in Urban Ohio Counties

Year	n	Mean	SD
2016	15	$41,052.07	$13,183.445
2022	15	$66,763.60[a]	$17.636.614

Abbreviation: SD, Standard Deviation

[a] statistically significantly different from 2016 ($p < 0.001$)

To interpret the difference in mammography screening rates between rural and urban counties in Ohio, we used an independent t-test (RQ6). Our results indicate that there is a statistically significant difference between the percentage of women receiving an annual mammography in rural and urban counties of Ohio ($t = -2.601$, $p = 0.011$). Women in urban counties have a higher average percentage of annual mammograms than women in rural counties (Table 5).

Table 5: Frequency of Annual Mammography Between Rural and Urban Ohio Counties

County	**N**	**Mean**	**SD**
Rural	72	42.35%	4.136%
Urban	16	45.31%[a]	4.078%

Abbreviation: SD, Standard Deviation

[a] statistically significantly different from 2016 ($p = 0.011$)

To answer our final research question (RQ 7) we performed a stepwise linear regression to analyze how the median household income, the primary care physician ratio, and the percent completed high school would account for the frequency of annual mammography in both rural (RQ 7a) and urban (RQ7b) Ohio counties.

The regression analysis for rural counties indicates that the best fitting model was significant, ($F_{1,70} = 17.453$, $p < 0.001$) and accounts for 20.04% of the variances in frequency of annual mammography. However, median household income is the only variable to have a statistically significant impact on the frequency of annual mammography ($B = 0.000185$, $t = 4.178$, $p<0.001$). This indicates that for every $1,000 increase in median household income, the frequency of annual mammography increases by .185%. The other two variables, percent completed high school and primary care physician ratio, did not have significant results in rural counties.

The regression analysis for urban counties also indicates that the model is significant, ($F_{2,13} = 9.037$, $p = 0.003$), and accounts for 58.2% of the variance in the percentage of women receiving an annual mammogram. The primary care physician ratio accounts for most of the variance ($B = -0.003$, $t = -2.465$, $p = 0.028$) and median household income accounts for the second-most variance ($B= 0.00011$, $t = 2.481$, $p = 0.028$). This means that as the primary care physician ratio increases by one point, the frequency of annual mammography decreases by

0.003%, and that as the median household income increases by $1,000, the frequency of annual mammography increases by .11%.

Discussion

Screening mammography has transformed the landscape of women's health and is widely recognized as a significant contributor to reducing mortality due to breast cancer[3]. However, despite improvements in screening tools, disparities in breast cancer mortality rates and utilization of preventive screenings still exist among patients of different racial, ethnic, and socioeconomic backgrounds[15]. Our study aimed to further identify the individual social determinants of health that impact a patient's likelihood of obtaining preventive mammography screenings.

The results of our study showed women living in urban counties in Ohio were more likely to receive mammograms compared to those in non-urban counties. However, when evaluating women in Ohio based on individual social determinants of health, we found that women residing in urban areas of Ohio with low median household income, lower rates of high school completion, and limited access to primary care physicians were statistically less likely to undergo mammography screenings. This led us to conclude that social determinants of health play a significant role in explaining disparities in breast cancer outcomes, particularly among women residing in metropolitan areas of Ohio.

Understanding how the social determinants of health influence the utilization of mammography screenings in patients is critical for health care providers. This knowledge can help physicians recognize health inequities in their patients and advocate for the importance of preventive mammography screenings. Increased awareness of the factors that influence access to mammography screenings can guide physicians in providing tailored care to patients facing barriers to access.

While our study sheds light on the social determinants of health that impact access to mammography screenings among women in Ohio, there are several limitations to consider. First, our study was limited to one geographical region and may not be generalizable to other populations. Additionally, the source from which we obtained our data only collects information from people who currently have Medicare, therefore, we were unable to assess uninsured patients or Ohioans who are insured by other companies. This poses a gap in the understanding of how insurance status affects access to mammography in Ohioans, though larger studies in the past have demonstrated that uninsured patients are less likely to forgo preventive screenings. Moreover, as our data only evaluated women aged 65-74 years old and current guidelines suggest women should start screening with a mammogram at 45 years old, our results may fail to capture the experiences of younger women. Furthermore, we classified the 88 counties of Ohio by "urban" and "non-urban" or "rural" according to The Ohio Department of Health without further sub-categorization of low-income rural areas. As a result, individuals residing in economically disadvantaged rural regions of Ohio were not delineated as a distinct category, but instead were grouped together with potentially higher-income, non-urban areas. Because of this

limitation, the analysis of non-urban areas may not have accurately captured the disparities of those living in low-income, rural counties of Ohio, potentially leading to incomplete findings.

Finally, data collection metrics utilized by CHR&R were inconsistent between 2016 and 2022, where in 2016 a smaller cohort of women were included (67-69 years old) and in 2022 a larger cohort (65-74). However, our data showed a smaller percentage of women in 2022 received mammograms despite the larger cohort. This incidental discrepancy in data collection points to a potential area of interest that may be a compelling topic for future study. We hypothesize the decline in mammogram rates may be due to a multitude of factors, including patients rejecting care due to high out-of-pocket costs, variability in screening guidelines for women greater than 70 years old, decline in health literacy among aging women, and socioeconomic factors of women aged 70-74 who are more likely to have retired and face different financial or insurance-related barriers to care[15–17].

Future studies should aim to define how these factors impact accessibility to mammography in larger populations, such as uninsured women, women with private insurance, and women under the age of 65. Another potential area of interest would be to compare data for women in urban, sub-urban and rural areas by re-classifying Ohio counties into each category and evaluating how the social determinants of health relate to mammography rates in each.

Conclusion

Understanding how the social determinants of health influence the utilization of mammography screenings in patients is critical for health care providers and can be life saving for patients. Our goal was to explore the relationship between patients with one or more of the social determinants of health and mammography rates. We found that women in urban areas of Ohio with low median household income, lower rates of high school completion and limited access to primary care physicians were less likely to undergo mammography screenings.

Physicians can utilize this knowledge to identify health inequities among their patients and advocate for the necessity of preventive mammography screenings. Improved awareness of the factors that impact access to mammography screenings can guide physicians in delivering personalized care to patients who face barriers. Our investigation suggests that further research and public health funding are needed in Ohio to address the accessibility of annual mammograms.

Possible avenues of improvement could include partnering with local, community-based health initiatives to provide easily understood educational materials and resources, increasing accessibility of mobile diagnostics, improving access to transportation to and from appointments, utilizing culturally tailored messaging, and providing services to reduce language barriers like translators. Overall, increasing mammography rates in patients with social determinants of health is a task that requires a holistic, patient-centered approach and a collaborative effort between physicians, their patients, and the community.

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