Title

Racial Disparities in Breast Cancer: An Analysis of Treatment and Timelines of Care

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Racial Disparities in Breast Cancer: An Analysis of Treatment and Timelines of Care

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Honors Thesis

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I-Introduction

Breast cancer is the second leading cause of death due to cancers in women, after lung cancer, killing about 43,700 women per year. However, existing literature reveals that these deaths, as well as diagnoses, are not uniform across all races; rather, rates of cancer and mortality differ based on race. Consequently, understanding the reasons behind these disparities in breast cancer has garnered increasing attention.

Despite the growing body of literature exploring the relationship between race and breast cancer, some important questions remain unanswered. Few studies in existing literature focus on socioeconomic variables when forming risk assessments of breast cancer, and the ones that do assess factors that contribute to breast cancer incidence in the country-wide or state-wide context. In light of these knowledge gaps, we contribute to the existing literature by exploring the use of mammography in specific Southern California communities, such as Laguna Hills and Long Beach.

The present study aims to analyze racial differences in breast cancer stage and treatment across the study population. We will examine the relationship between an individual's race and their insurance type, their age at diagnosis, the stage of their cancer, as well as the location where their mammogram is taken. Additionally, we will explore the time differences between an individual's screening mammograms and between their screening mammogram and diagnosis, comparing across racial groups to determine if treatment timelines differ.

By advancing our understanding of the ways in which racial differences affect rates of breast cancer, this study can expose whether physicians at MemorialCare breast centers provide differential treatment based on race. The findings may also point to pre-existing differences that impact the rate of a breast cancer diagnosis, such as insurance type and location of the facility.

In the following sections, we will provide background on relevant topics, a comprehensive review of existing literature, an outline of our methodology, and present the results and implications of our study.

II-Background

Breast cancer is a disease characterized by uncontrolled, rapid cell growth in breast tissue, creating a mass of cells called a tumor. According to the Centers for Disease Control and Prevention (CDC), about 246,000 women and 2,400 men are diagnosed with breast cancer each year in the United States (US)– 42,000 and 500 of whom, respectively, die from the disease.[1]

While there is no singular cause for all cases of breast cancer, there are several risk factors that can contribute to and interact in each case, including lifestyle, genetic, and environmental factors. Common factors associated with increased breast cancer risk include being female, increasing age, a personal and/or familial history of breast cancer, inherited gene mutations, radiation exposure, and obesity.[2]

A mammogram, or X-ray of the breast, is the optimal method of discovering breast cancer before symptoms present themselves in women of screening age. According to the US Preventive Services Task Force (USPSTF), a panel of national experts in disease prevention and evidence-based medicine, women with an average risk of breast cancer are recommended to begin getting screening mammograms at age 40. As such, women age 40 to 74 are recommended to screen biennially.[3]

Should a mammogram or other breast imaging study show an abnormal area in the breast, a healthcare provider will perform a biopsy, taking a sample of tissue from said area and sending it to a laboratory for testing. A biopsy is the only definitive way of diagnosing breast cancer as the taken sample is analyzed to determine the cell type and aggressiveness (grade) of the cancer,

as well as whether the cancer cells have hormone receptors– influencing treatment options.[4] After diagnosis, the extent (stage) of breast cancer can be labeled as one of five stages, including zero through four. Stage 0 describes breast cancer that is contained in the milk ducts of the breast and has not spread to surrounding tissue.[5] Stage I, which has two types, describes either when the tumor is up to 20 millimeters (mm) and has not spread to the lymph nodes or when the lymph nodes have cancer evidence with small clusters of cells. [5,6] Stage II, which also has two types, describes either when the tumor is 20 to 50 mm and/or the disease has spread to 1 to 3 lymph nodes under the arm. Further, Stage III, which has three types, describes variations of when the disease has spread to more than four lymph nodes and/or the tumor is larger than 50 mm.[6] Stage IV, the most advanced stage of breast cancer, describes any size tumor that has metastasized or spread to other organs and tissue.

Generally, there are five treatment options for breast cancer, whose use varies on the stage at which the cancer is present, including surgery, chemotherapy, radiation therapy, hormone therapy, and targeted therapies.[7] According to the most recent estimates from the Surveillance, Epidemiology, and End Results (SEER) program, in 2019, 31% of female patients with stage I or II breast cancer underwent a mastectomy– or surgery to remove the breast– 51.9% underwent breast-conserving surgery (BCS) with radiation therapy, and 17.1% underwent BCS without radiation therapy.[8] Further, the SEER data evinces the percentage of female patients who received chemotherapy in 2015 by the age of diagnosis as 64.2% for women ages 20 and older, 82.4% for women ages 20 to 64, and 40.7% for women ages 65 and older.[8]

Upon understanding how breast cancer is detected, staged, and treated, one can then look at *who* is being diagnosed with the disease. Specifically, previous findings suggest that rates of breast cancer are unequally distributed across racial groups. Recent incidence rates of breast

cancer obtained from SEER Explorer reveal that for those under 40, the highest incidence rates are among Black women, while for all other age groups, the incidence of breast cancer is highest for White women.[13] Despite these patterns of incidence, at all ages, Black women have the highest mortality rate from breast cancer.[14] For other racial groups– including Hispanic, American Indian/Alaskan Native, and Asian/Pacific Islander– incidence and mortality are lower than that of Black and White women.[13,14]

III-Previous literature

Previous scholarship commonly finds that there are large and persisting racial differences in health.[21] In fact, some of these differences can be traced back to disparities in access to healthcare as racial minorities do not have access to services at the rate White individuals do.[22] People of color and low-income individuals face greater barriers to accessing care partly due to insurance coverage. Despite the Affordable Care Act's (ACA) Medicaid expansion in 2010 that provided large coverage gains to minority and low-income groups, most minority groups were more likely to be uninsured compared to White individuals in 2018. Consistently, low-income groups were also more likely to remain uninsured compared to those in high-income groups. Thus, minority and low-income groups are more likely to delay or even go without necessary treatment and are less likely to have a consistent source of care than White individuals, resulting in poorer health outcomes.[23] Moreover, patients of color also experience disparities in the quality of care they receive in comparison to White patients. Existing scholarship finds that an implicit bias exists against Black, Hispanic, and dark-skinned individuals among many healthcare providers, resulting in significant differences across patient-provider interactions, health outcomes, and treatment processes.[24]

Further, such health disparities are particularly apparent among cancer patients. Across many types of cancers, Black women experience higher cancer-specific mortality rates compared to other racial groups. Additionally, previous literature documents that this high mortality across minority groups is due to both patient-specific factors like socioeconomic status as well as provider-level factors like the underuse of screening.[25]

With regards to breast cancer specifically, the subject of this study, existing scholarship suggests that disparities in breast cancer incidence and mortality can be partly explained by differences in screening behavior across racial groups. Minority women undergo mammograms less frequently than White women.[9] Moreover, this lack of mammography use by minority women may be further explained by poor access to healthcare resources along with lower socioeconomic status.[9] Black and Hispanic women, specifically, have been shown to possess increased odds of late-stage breast cancer diagnosis due to fewer periodic mammograms.[10] This distribution of tumor stage across racial groups– which was especially different in Black and White women– is highly statistically significant and contributes to the notion of an expanding and persisting screening gap due to disparities in socioeconomic status.[12] Consequently, a negative correlation exists between the risk of breast cancer and socioeconomic status as minority women are more likely to face late detection of the disease along with poorer prognosis.[9,11]

IV-Data

a. Data Source

For this study, we have obtained data from the MagView® mammography reporting and tracking system of the MemorialCare Breast Centers in Southern California. The data covers the years 2015 to 2022 and contains a total of 7,668 observations. Each observation correlates to one

patient and the information regarding their diagnosis with breast cancer. The final analytic sample consists of 1,413 observations due to exclusions from listwise deletions. Observations with missing values for any variable were excluded from our analysis to ensure the reliability and accuracy of our results.

b. Key Variables and Definitions

i. Main Outcome Measures

Time differences between screening mammograms as well as between a screening mammogram and diagnosis were the primary outcomes of interest. These measure the adequacy of care. Our primary objective is to determine if there are racial differences in how providers treat patients.

The time between abnormal mammography and a biopsy, which thus leads to a definitive diagnosis, is often marked as an indicator of the quality of care received, making it a relevant source of information for our study. Notably, in the US, it takes approximately 28 days on average to receive a biopsy from the time of abnormal mammography.[15]

ii. Primary Predictor: Race/Ethnicity

Race/ethnicity was the primary predictor used with the analytic sample. The observed racial/ethnic groups examined were categorized as non-Hispanic white (reference group and from here referred to as “White”), non-Hispanic black (from here referred to as “Black”), Asian American, and Pacific Islander (from here referred to as “Asian/ Pacific Islander”) and Hispanic. Further, as race is self-reported at MemorialCare breast centers, some patients did not provide this information; thus, we also categorize those of unspecified origin (from here referred to as “Undisclosed”). It is also important to note that the MagView system does not possess the ability

to select multiple races in its self-report, so— for the purposes of this study— the categories of race/ethnicity are mutually exclusive.

iii. Covariates

We also observe insurance level, screening location, age at diagnosis, and extent (stage) of cancer.

Regarding insurance, we categorized the levels of coverage as Health Maintenance Organization (HMO) plans (from here referred to as "Private HMO"), Preferred Provider Organization (PPO) plans (from here referred to as "Private PPO"), Medicare, Medicaid, and those whom we do not have information on (from here referred to as "no information"). After first establishing which patients were on Medicare (covering seniors and those with disabilities) and Medicaid (covering those with low income), we then separated those who had other forms of private insurance into either HMO or PPO plans with the understanding that HMO plans typically have lower monthly premiums.

Notably, while Medicaid is generous to the person whom it covers, with lower monthly premiums and no copays, it reimburses providers very little, so many do not accept this form of insurance. On the other hand, PPO plans, which generally have the highest monthly premiums, are the most generous of the insurance types we review. PPO plans also reimburse providers most heavily, resulting in users having increased access to treatment as their insurance is most likely to be accepted by different providers.

With these definitions, we use insurance type as a reflection of socioeconomic status as well as reflecting access to health care. Specifically, we are able to distinguish those on government insurance plans from those on private insurance, as well as those who are below the poverty line from those who pay higher premiums.

When considering where each woman obtained their screening mammogram, we view three different MemorialCare center locations in Southern California: Long Beach (also referred to as "center 1"), Laguna Hills (also referred to as "center 2"), and Fountain Valley (also referred to as "center 3"). We use the center that each patient attends as a reflection of their socioeconomic status, as each of these cities has widely different demographics and average household incomes. Laguna Hills, being the most affluent area, has an average household income of $109,750, followed by Fountain Valley with $92,765, and then Long Beach with $71,150, according to the US Census Bureau.[20] Notably, Long Beach has the largest Black (12.1%) and Hispanic (43.9%) populations, while Laguna Hills has the largest White population (64%).[20]

We observe two measures that indicate the severity of the cancer at the time of diagnosis. First is the age at the time of diagnosis (measured in years), and the second is the stage of the cancer. The stage of breast cancer at the time of diagnosis is broken up into stages 1, 2, and 3 in this study. We define stages based on the tumor size, where stage 1 is any tumor between 1mm and 20 mm, stage 2 is between 20mm and 50mm, and stage 3 is 50 mm and larger.

c. Summary Statistics

Descriptive characteristics of the study population are summarized below in Table 1. With regards to prognoses-specific statistics, we find that, on average, patients are diagnosed at approximately 63 years old with early-stage cancer. Most of these patients adhere to general screening recommendations as the average time between mammograms is about two years; however, the average time between screening and diagnosis appears high due to outliers. While the median value of days describing this duration in our data is 29 days (similar to the nationwide average), the mean is about 138 days, as displayed in Table 1. This high number can be partially explained by the difference between screening mammography and diagnostic

Table 1
Summary statistics

	Mean	SE	N
Age	62.7 years	13.32 years	7668
Tumor Size	17.34 mm	15.32 mm	1413
Tumor Stage	1.33	0.54	1413
Time between screenings	560.56 days	326.67 days	1413
Time between screening and diagnosis	137.37 days	260.27 days	1413
Race Variables			
White =1	71.27%	0.4527	1007
Black = 1	2.41%	0.1533	34
Asian/ Pacific Islander = 1	15%	0.3572	212
Hispanic = 1	10.97%	0.3126	155
Undisclosed = 1	0.35%	0.0594	5
Center Location Variables			
Center 1: Long Beach = 1	21.02%	0.4076	297
Center 2: Laguna Hills = 1	55.41%	0.4972	783
Center 3: Fountain Valley = 1	23.28%	0.4228	329
Cetner 0: Other = 1	0.28%	0.0531	4
Insurance Level Variables			
Medicaid =1	1.49%	0.121	21
Medicare = 1	28.80%	0.453	407
Private HMO =1	16.77%	0.3738	237
Private PPO =1	15.15%	0.3586	214
No Insurance Information = 1	37.79%	0.485	534

Note: Sample demographics for women with breast cancer from pooled MagView data. Computations by author (2015-2022).

mammography. While screening mammography is routinely administered to detect breast cancer when no symptoms are present, diagnostic mammography is used when signs of breast cancer, like a lump in the breast, alert a physician to check the tissue.[17] In the case of our data, outliers of patients whose previous screening mammography was, for example, six years ago increase the mean time difference between screening and diagnosis. It is likely that these patients did not adhere to yearly screening recommendations, and— after having waited years for a routine check-up— these women discovered a lump in their breast and were administered a diagnostic mammogram upon their visit rather than a screening mammogram. As we only have data for screening mammography and not diagnostic mammography, the median duration between screening and diagnosis is more reflective of treatment than the mean duration.

Table 1 shows that, in the analytic sample of 1,413 patients, 71.27% are White, 2.41% are Black, 15% are Asian/Pacific Islander, 10.97% are Hispanic, and 0.35% are of Undisclosed races. Further, breaking down the number of patients who attend each MemorialCare location, Table 1 reveals that 21.02% attend the Long Beach location, 55.41% attend the Laguna Beach location, 23.28% attend the Fountain Valley location, and 0.28% use an outside facility. Table 1 also provides insight into the distribution of insurance levels among patients, with 1.49% on Medicaid, 28.80% on Medicare, 16.77% on a private HMO plan, and 15.15% on a private PPO plan. Among the analytic sample, however, there is no insurance information for 37.79% of patients.

d. Representativeness of the Analytic Sample

It is interesting to compare the study sample with the cancer population more broadly. To do this additional data was collected and presented in Table 2.

Table 2
Racial representativeness of the study sample

	Sample	County	State	Nation
Total (all races)	884	2,455	27,737	253,845
White	590 (67%)	1499 (61%)	15466 (56%)	187549 (74%)
Black	39 (4.4%)	37 (1.5%)	1711 (6.2%)	29185 (11%)
Asian/ Pacific Islander	145 (16%)	429 (17%)	4151 (15%)	11153 (4.4%)
Hispanic	103 (12%)	433 (18%)	5904 (21%)	22588 (8.9%)

Note: Sample data comes from MagView system. County, state, and nation data comes from SEER Explorer program. Computations by author (2015-2019).

We procured an incidence rate report of breast cancers for California by county from the 2015-2019 National Cancer Institute, which obtains its information from the Surveillance, Epidemiology, and End Results (SEER) program. When viewing the average annual count of breast cancers in Orange County across all races, stages, and ages from 2015-2019, we found that our data— encompassing cancers diagnosed at MemorialCare centers— accounted for about 36% (884/2,455) of the total diagnoses in the county. When controlling for different races across the latest five-year average, our data accounts for about 39.4% (590/1,499) of White patients, 105% (39/37) of Black patients, 33.8% (145/429) of Asian/Pacific Islander patients, and 23.8% (103/433) of Hispanic patients in Orange County.

As seen through the percentage values in Table 2, there are more White and Black women and fewer Asian/ Pacific Islander and Hispanic women in the sample than in the county. Further, the sample includes more White and Asian/ Pacific Islander women and fewer Black and Hispanic women when compared to the state of California. When compared to the nation as a whole, there are more Asian/Pacific Islander and Hispanic women and fewer White and Black women in the sample.

In sum, the population we study is mostly representative of Orange County, though there are more Hispanics in our sample. However, the patients in Orange County are not representative of the breast cancer patients in the state of California or the nation.

V-Methods

The objective of this study is to analyze racial differences in breast cancer in the study population. To do this, we estimate the following regressions. First, we estimate

$$y_i = c + b_1 * D(Black_i = 1) + b_2 * D(Asian_i = 1) + b_3 * D(Hispanic_i = 1) + e_i$$

(1)

where y is an outcome of interest for a woman with breast cancer. The first two outcomes, the time difference between screening mammograms and the time difference between screening mammograms and diagnosis, are helpful in understanding whether women of different races are treated differently by providers. The second set of outcomes (insurance type, biopsy location, age at diagnosis, and stage at diagnosis) investigates whether Black women have pre-existing differences that impact the rate of a breast cancer diagnosis. The differences in the second set of outcomes are of interest individually, but they also help us understand if the differential treatment we might observe is explained by these differences.

In this first regression, the only explanatory variable is a set of dummies for race. Thus the coefficient b captures the mean difference in the outcome between White and Black patients. We are interested in whether this coefficient is statistically significant. As reviewed above, previous work has shown that some racial differences are only apparent at some ages, so we will re-estimate equation (1) separately by age.

To understand if differences in insurance and in the stage of the disease at the time women come to the center could explain differential treatment, we estimate a second regression:

$$y_i = c + b_1 * D(Black_i) + b_2 * D(Medicaid) + b_3 * D(stage\,1_i) + b_4 * D(center\,1) + e_i$$

(2)

In comparing this regression to that of equation (1), we can better understand whether providers discriminate solely based on race, or whether patients experience differential treatment because of their insurance type and the location of the MemorialCare center they attend.

Further, we continued to inspect whether there are differences in the stage of the disease based on race, but this time through the ordered probit model, which models the underlying probability y* of falling into a lower versus a higher category as follows:

$$y^* = x_i b_1 + e_i, e_i \sim N(0,1), \forall\, i = 1,\ldots, N \quad (3)$$

This ordered probit model will provide coefficient estimates that display the effect of each race category, compared to the reference level of stage 1, on the probability of having a different stage of breast cancer. The ordered probit model is appropriate in this instance due to the ordinal nature of the stage variable and the limited number of discrete categories within it.

VI-Results

Table 3, column 1, shown below, displays the results of the regression of the time difference between a patient's two most recent screening mammograms (serving as a measurement of screening patterns and behavior) on race. As previously noted, the American Cancer Society recommends that women of average risk for breast cancer obtain a mammogram every 1-2 years.[18] This suggestion is reflected in the results of our regression, which reveal a mean duration between screenings of about 568 days, or approximately a year-and-a-half, for the reference group of White women. As there is no statistical significance seen across the coefficients of each dummy race variable, we find that there is no statistically significant time

Table 3
Race as a predictor for provider behavior

	Time between screenings (days)		Time between screening and diagnosis (days)	
	1	2	3	4
Constant	568.35	918.73	124.97	120.22
	56.1	84.37	44.65	67.58
Race (omitted category is Black)				
White	-12.58	31.5	10.11	13.09
	57.04	57.49	45.39	46.05
Asian/ Pacific Islander	-9.14	27.05	29.44	29.02
	60.43	60.66	48.09	48.59
Hispanic	23.32	63.47	0.96	0.42
	61.95	62.09	49.3	49.74
Insurance status (omitted cateogry is Medicaid)				
Private PPO		-384.57 ***		-0.004
		74.36		59.56
Private HMO		-377.67 ***		1.39
		74.05		59.32
Medicaire		-394.46 ***		6.19
		73.03		58.5
Center location (omitted category is Center 1: Long Beach)				
Center 2: Laguna Hills		17.25		3.7
		22.47		18
Center 3: Fountain Valley		4		7.31
		26.44		21.18
Stage of cancer (omitted category is Stage 1)				
Stage 2		-1.95		65.44 ***
		19.79		15.85
Stage 3		83.7		-5.59
		48.02		38.47
R-squared or Pseudo R2	0.001169	0.037	0.001139	0.02429
N	1408	1399	1408	1399

Note: Results are from linear regression models using pooled MagView data. Computations by author. Standard errors reported below estimates (2015–2022).
***P<0.001.

difference across screenings compared to White women for all other races. Not only are the coefficients insignificant in Column 1, but they are also small in magnitude. These findings suggest that, despite differences in race, patients at MemorialCare Breast Centers are displaying similar patterns of screening behavior in adhering to recommended mammography schedules.

Following this assessment of screening patterns, we assessed whether or not the timeline of diagnosis differs across racial groups by running a linear regression analysis on the variable explaining the time difference between screening mammography and the date of diagnosis of breast cancer with respect to race. The results are displayed in Table 3, column 3. None of the coefficients are statistically significant, and the magnitudes are small, indicating no substantial time difference across racial groups with respect to White women and implying that MemorialCare Breast Centers in Orange County do not differ in their diagnosis timeline across racial groups. This result reflects positively on the quality of care these centers provide despite race – contrary to previous scholarship.

In attempting to assess whether other factors not included in the previous model might contribute to the time differences between screenings as well as between screening and diagnosis, we added the predictors of insurance level, center location, and stage of the disease to the previous regression. In Table 1, columns 2 and 4, we continue to see a lack of statistical significance across our dummy variables for race, emphasizing further that race does not predict differential treatment whether or not we condition on the added factors.

Table 3 also reveals relatively small changes in time across racial groups in reference to the constant, further bolstering the notion that race does not predict provider behavior. With these insignificant differences, our results suggest that all races screen similarly at MemorialCare breast centers.

On the other hand, we do find that insurance matters a great deal. After the covariate of insurance level was added to the previous model displayed in Table 3, column 1, we see statistical significance for every dummy insurance variable in Table 3, column 2. As we still do not see statistical significance for dummy race variables, we can infer that— while providers at MemorialCare do not discriminate based on race— barriers exist in terms of patient insurance. We find that the time difference between screening mammograms is significantly less for women on Medicare, Private HMO, and Private PPO insurance in comparison to women on Medicaid, who serve as the omitted category in the regression. These time differences are also very large, depicting that women on insurance plans other than Medicaid get screening mammograms over a year earlier. This reflects the existing scholarship that low-income women undergo mammograms less frequently, potentially due to the lower likelihood of their insurance being accepted.

Next, we analyze whether race predicts the age at which women are being diagnosed, along with the severity of the disease upon diagnosis. In Table 4, we find that Asian/Pacific Islander patients and Hispanic patients are contracting breast cancer at an earlier age. In order to discern this, we considered whether these women were actually getting breast cancer younger or if providers were merely diagnosing them sooner by interpreting the results of Table 4 in conjunction with those of Table 5. Conditional on being diagnosed at the same time, Table 5 reveals that there is no statistically significant difference in the severity of breast cancer by race. Thus, the significance that we see in the age of diagnosis in Table 4 is not due to the timing of diagnosis but rather to the age at which people get the disease.

Table 4
Race as a predictor for age at diagnosis

	Age at diagnosis (years)	Woman diagnosed at ages 40-49	Woman diagnosed at ages 50-74	Woman diagnosed at age 75 and above
Constant (reference White)	66.74	45.91	63.68	79.37
	0.34	0.3	0.27	0.25
Black	-2.04	1.79	-1.62	-0.36
	1.86	1.61	1.44	1.55
Asian/ Pacific Islander	-6.21***	-0.31	-2.41***	-1.94*
	0.81	0.45	0.66	0.76
Hispanic	-2.76**	0.46	-2.08**	0.63
	0.92	0.71	0.72	0.78
R-squared	0.04293	0.02283	0.02028	0.02779
N	1408	110	963	326

Note: Results are from linear regression models using pooled MagView data. Computations by author (2015–2022).
***P<0.001; **P<0.01; *P<0.05.

Table 5
Race as a predictor for severity of breast cancer

Dependent variable:	**Size of Tumor (mm)**	**Stage 1, 2 or 3**	**Stage 1, 2 or 3**
Model:	**OLS**	**OLS**	**Probit**
Constant	17.11	1.32	
	0.48	0.02	
Black	-0.14	-0.02	-0.06
	2.67	0.09	0.23
Asian/ Pacific Islander	1.36	0.07	0.16
	1.16	0.04	0.09
Hispanic	0.02	0.02	0.05
	1.32	0.05	0.11
R-squared or Pseudo R2	0.001639	0.002987	
N	1408	1408	

Note: Results are from linear regression models and generalized linear model using pooled MagView data. Computations by author (2015–2022).

Further, the observed differences in Table 4 are large, with Asian/Pacific Islander women diagnosed more than six years younger and Hispanic women diagnosed almost three years younger. While Black women are also diagnosed about two years earlier than White women, this difference is not statistically significant. This suggests that race is a significant factor in explaining the incidence of the disease.

VII-Discussion

Disparities in mammography rates are observed such that low-income women on Medicaid screen less frequently than women with access to other, more frequently accepted, insurance plans. We also find that these disparities at MemorialCare breast centers are not due to differences in race, as previous scholarship conveys, which further suggests that differential mammogram timelines are due to the barriers that exist in terms of patient insurance, at least in Orange County. MemorialCare breast centers are more likely to accept patients on Medicare, Private HMO, and Private PPO insurance, as seen through their screening more frequently than those on Medicaid. These findings, combined with the knowledge that Medicaid is used by low-income individuals, suggest that the disparities we observe are due to differing socioeconomic statuses as well as access to healthcare resources.

We also find that Asian/Pacific Islander and Hispanic women are getting breast cancer sooner than women in other racial groups. This is consistent with existing scholarship that depicts the age distribution of breast cancer in Asian/Pacific Islander and Hispanic women as peaking in younger women.[26,27] Further, previous literature that explores reasons as to why this occurs highlights a limitation of our study in that we can not distinguish between foreign-born and native-born women. Specifically, it has been shown that Asian/Pacific Islander and Hispanic women's risk for breast cancer increases when they immigrate to the US from their native

countries as they are exposed to a more fattening diet and sedentary lifestyle.[28] Thus, our study population may potentially include more immigrant women in Asian/Pacific Islander and Hispanic racial groups than other groups. This could be an interesting path for future study in that collecting nativity data can result in a clearer understanding of why Asian/Pacific Islander and Hispanic women are getting breast cancer at a younger age.

Further, another limitation of our study is that— while the communities in Orange County that we observe possess different demographics— it is geographically biased towards a predominantly White and relatively affluent sample. While the median household income in the US falls around $70,000, the median household income in Orange County, specifically, is about $100,000.[20] This can partially explain why there are very few Medicaid patients in our sample, as Orange County is relatively wealthy in comparison to the rest of the nation.

Moreover, with regards to Asian/Pacific Islander and Hispanic women, Orange County has a higher proportion of both groups in comparison to the nation.[20] This fact also points to a potential future direction of study whereby the Orange County population is used more often to look specifically into factors affecting Asian/Pacific Islander and Hispanic women, given their high frequency.

Based on the finding that women on Medicaid are screening less frequently than women on other insurance plans, policymakers should target the reasons why Medicaid insurance is a major barrier to accessing screening mammograms. By focusing on low reimbursement rates and even non-monetary factors like lofty paperwork requirements, policymakers can help alleviate physician aversion to accepting Medicaid insurance. Further, as Medicaid is given to low-income individuals, policymakers can help improve screening rates specifically by educating

underserved communities more thoroughly on suggested screening regimens through campaigns and patient-provider outreach.

Further, the finding that Asian/Pacific Islander and Hispanic women are getting breast cancer younger suggests that policymakers must consider better strategies to encourage earlier screening among these groups. In screening Asian/Pacific Islander and Hispanic women younger, providers can hopefully catch cancer at an earlier stage, resulting in better health outcomes. Clinicians and policymakers must also look further into why these women are contracting the disease earlier and closely explore their associated risk factors to better understand how to help them.

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