Distribution of Breast Cancer Stage at Diagnosis and Socioeconomic Status in Oregon

By

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Background and Significance

Breast cancer is a leading cause of morbidity and mortality in women in the United States. It is the second most common form of cancer in women (non-melanoma skin cancer is the most common) and is the second leading cause of cancer mortality with only lung cancer causing more cancer related deaths in women. It is estimated that about 40,000 women will die from breast cancer in the United States in 2012.[1, 2]

Socioeconomic status (SES) is important in determining the health outcomes from disease, particularly from chronic disease. It also plays an important role in breast cancer prevention, diagnosis, and treatment. Breast cancer incidence overall is known to vary among SES categories and overall incidence has been shown to be greater among geographic areas with higher SES than areas with lower SES.[16, 17] Disparities in disease progression by individual level SES markers are well documented. According to Sprague et al, women who had no education beyond high school were 1.39 times more likely to die from a breast cancer diagnosis than women with a college education.[10] This disparity was also mimicked by poverty level, another marker of SES.

Community level variables for SES measurement are common among studies investigating the association between SES and breast cancer.[10, 11,12] Often summary variables such as poverty level, family income, and education level are used to estimate the SES of a particular geographic location as individual level SES indicators are generally absent from cancer registry data.[19] SES has been associated with breast cancer incidence on a community or neighborhood level, though published literature specific to Oregon has been missing until very recently with Henry et al.[21, 22,25,30]

The stage at which breast cancer is diagnosed plays a large role in predicting health outcomes, including mortality. Women who are diagnosed with late stage breast cancer (stage 3 and stage 4 cancer) have poorer health outcomes than women diagnosed with early stage breast cancer (in situ, stage 1 and stage 2). The five-year relative survival rate for women with regional breast cancer (stage 3) is 83.6% and is 23.4% for women with distant cancer (stage 4). This is compared to women with early stage cancer who have a survival rate of 98%.[2] Women with low SES often have poorer health outcomes as a result of late stage breast cancer diagnosis than women with higher SES.[18]

Screening mammograms increase early stage breast cancer rates by identifying potential cancer prior to a patient developing symptoms.[18] Due in part to the widespread use of mammography screening, the rate of early stage breast cancer detection has improved steadily. In 2009 the U.S Preventive Services Task Force reviewed available data and recommended biennial mammograms for the general population of women ages 50 – 74 to reduce harms associated with false positive exams.[8]

In 2010, the overall prevalence of mammography usage was estimated to be 72.7% for women ages 50-74 (women obtaining a mammogram in the last two years).[9] While mammogram prevalence remains fairly high among the general population, the prevalence varies based on many factors among different subgroups, particularly among women with factors contributing to low SES.[7,9]

Mammography screening varies by education level. According to the Centers for Disease Control in 2010, women without a high school diploma had a prevalence of mammography screening of 58.3%, women with a high school diploma had a prevalence of 69.5% and women

with some college or more had a prevalence of 73.9%. College graduates had the highest prevalence of 80.8%.[7] These prevalence estimates are calculated using the Behavioral Risk Factor Surveillance System (BRFSS) and are subject to social response bias as the BRFSS is a self-reported health survey. For this reason, the BRFSS tends to overestimate the true proportion of mammography screening rates among women.

Women who are diagnosed with breast cancer while enrolled in the Medicaid system tend to have larger tumors than women with private insurance and have lower levels of SES.[3] Larger breast tumors are correlated with late stage breast cancer.[6] In 2007, Halpern et al, found that the odds of having late stage breast cancer (stage 3 and stage 4) among women enrolled in Medicaid were about 2.5 times the odds of having early stage cancer (stage 1) (OR= 2.5, 95% CI: 2.4 – 2.6).[3] Women in Medicaid who are diagnosed with breast cancer tend to have later stage cancer than women with private insurance.[3,20] In addition, these women have a much lower mammography screening prevalence. One study found that only 31.7% of women over age 50 in Medicaid received a mammogram every two years.[4] Women enrolled in Medicaid typically fall into a lower SES category and face greater health disparities.

Community level SES has also been shown to be associated with stage of breast cancer at diagnosis. et al, found that the incidence of late stage breast cancer increased when the neighborhood SES (at the census tract level) decreased.[23] Lobb et al demonstrated a similar result; the incidence of late stage breast cancer was higher within census tracts (CT) with lower SES.[24] Most recently, Henry et al found a significant association between CT poverty and late stage breast cancer diagnosis (defined as regional or distant stage).[30]

Rationale for Current Study

Socioeconomic status affects the overall health of a population and is associated with breast cancer health outcomes.[17] Oregon is a diverse state with a large geographic area comprised of both highly urban and rural areas. Oregon has consistently had a higher breast cancer incidence than the national average.[26] This study aims to highlight the association between SES and breast cancer stage of diagnosis in Oregon to identify areas of the state that could benefit from targeted health promotion interventions to reduce breast cancer health disparities (an overarching goal of Healthy People 2020).[28]

Research Question and Specific Aims

Are Oregon women living in lower SES areas diagnosed with breast cancer at a later stage on average than women in higher SES areas?

Specific Aim 1: Identify SES in Oregon based on poverty status and group the state into four poverty categories (<5% poverty, 5-10%, 10-20% and >20%) based on CT.

Specific Aim 2: Determine whether stage of disease at diagnosis is associated with SES by calculating the relative risk of late stage breast cancer within the different poverty categories. I hypothesize that late stage breast cancer is more likely among lower SES and less likely among higher SES.

Specific Aim 3: Map the geographic distribution of stage of diagnosis and SES.

Methods

Overview

This cross-sectional ecological study uses data collected by the Oregon State Cancer Registry (OSCaR) participating in the National Program of Cancer Registries (NPCR) of the

Centers for Disease Control and Prevention (CDC) and the 2000 US Census to analyze the geographic distribution of breast cancer diagnosis and SES in Oregon. The study group was stratified according to 5 year age categories for women 40 and older to more closely evaluate the effect of SES and to avoid confounding by age. Since women ages 65 and older are often covered by Medicare, they were not grouped with younger women and were analyzed separately to avoid bias. Breast cancer outcome is grouped into two categories, early stage (in situ and localized) and late stage (regional and distant) based on the SEER summary staging models. SES was estimated by the Poverty and Census Tract Linkage Program from the North American Association of Central Cancer Registries (NAACCR). Each cancer case was geocoded using the Texas A&M University Geoservices[27] and linked to the poverty data from the 2000 US Census or the 2005-2009 American Community Survey. Zip code level geocoding was accepted to obtain a sample of cases that was entirely geocoded. Due to the ecological nature of the study, zip code level of geocoding was appropriate.

Study sample

Women 40 and older with a new primary breast cancer diagnosis during the study period of 2000-2009 were included. Women with previous breast cancers, women who had a primary diagnosis of ovarian or uterine cancer, and women who had two or more diagnoses of cancer without a matched primary in the database were excluded. These women were excluded to avoid bias of the sample since they are more likely to undergo cancer screening (specifically mammograms) and would not accurately represent the general population of Oregon women. Women who were diagnosed with a secondary breast cancer tumor may be a recurrence and not a primary lesion so they were excluded to enable analyzing incident cases

only. Women with a matched primary cancer in the database that was not ovarian, uterine, or a previous breast cancer, were included for analysis. A total of 27,242 cases matched the inclusion definition and were included in further analysis.

Variables

Predictor

The primary predictor in the analysis is SES. SES was estimated using the Poverty and Census Tract Linkage Program from the North American Association of Central Cancer Registries (NAACCR). This program determines percent of residents in a given CT that live below the federal poverty level and groups this percent into four categories (<5%, 5-9.9%, 10-19.9%, >20%) using data from the 2000 Census and the 2005-2009 American Community Survey(ACS) based on year of diagnosis. Women who were diagnosed from 2000-2004 were assigned a poverty category from the 2000 Census, and women who were diagnosed between 2005-2009 were assigned a poverty category based on the 2005-2009 ACS. 2.49% of the study sample's poverty category was "unknown" (n=677) due to incorrect or missing county and/or CT information and were excluded from further analysis.

Outcome

Breast cancer stage of diagnosis is the outcome of interest for this study. A dichotomous variable was created to assess breast cancer diagnosis by stage (early stage and late stage diagnosis). A breast cancer case was considered "early stage" if it was an in situ or localized cancer and a case was considered "late stage" if it was regional or distant based on the SEER summary staging models. Early stage cancers are more amenable to treatment whereas late stage cancers are more likely to be invasive and malignant. Cases whose stage at diagnosis was

"unstaged" were excluded from this analysis (n=415, 1.52% of the study sample were unstaged).

Other variables

Age at diagnosis (grouped into 5 year age categories), race, and Hispanic ethnicity were evaluated as covariates in the analysis.

Statistical Analysis

Overview

Statistical analyses were performed using SAS version 9.22, Stata version 11.0 and ArcGIS version 9. The prevalence of late stage cancer was calculated within each poverty category and age category. Logistic regression models were built using breast cancer stage (early stage vs. late stage) as the outcome of interest with poverty status as the primary predictor.

Hypothesis Testing

Primary hypothesis: Among women with breast cancer, the relative risk of having a late stage diagnosis of breast cancer is higher among CTs with lower SES.

To address this hypothesis, logistic regression was used to estimate odds of late stage breast cancer diagnosis. The odds ratio estimates were used to approximate relative risk. SES was estimated using the percent poverty categories determined by the NAACCR poverty and census tract linkage program and was used as the primary predictor. Age, race, and ethnicity were evaluated as potential confounders to this relationship.

Results

Summary

A total of 27,242 women met the criteria for the study and were included in the analysis. The mean age of diagnosis was 62.7 (SD 12.8). The average age of diagnosis tends to increase as poverty level increases. Most lived in CTs with poverty levels of 10-20% (43%) or 5-10% (32.4%). 13% lived in CTs with less than 5% poverty and 11.6% lived in CTs with greater than 20% poverty. Almost three quarters (72.3%) of the breast cancer diagnoses were considered early stage. The proportion of late stage diagnoses increased as the poverty level increased. Women who had an early stage cancer were more likely to be white, non-Hispanic, and live in a CT with lower poverty level. See Tables 1 and 2.

Table 1 Age, race, and ethnicity by poverty category

Variables		Poverty Categories				Total Sample n= 27,242
		>20% n=3,090	**10-20%** n=11,429	**5-10%** n=8,617	**<5%** n=3,429	
Age at diagnosis	mean (SD)	63.5 (13.0)	63.6 (12.9)	62.3 (12.7)	62.3 (12.7)	60.5 (12.4)
	Categories % (n)					
	40-44	6.0% (185)	5.6% (638)	6.6% (569)	8.5% (293)	6.3% (1,726)
	45-49	11.5% (355)	10.4%(1,192)	11.5% (994)	13.5% (463)	11.3%(3,077)
	50-54	11.1% (344)	12.1%(1,388)	13.5%(1,163)	14.8% (507)	12.8%(3,484)
	55-59	12.8% (396)	13.6%(1,549)	14.2%(1,224)	15.4% (529)	13.9%(3,796)
	60-64	13.3% (410)	13.1%(1,497)	13.0%(1,117)	12.3% (422)	13.1%(3,555)
	65-69	12.1% (375)	11.8%(1,352)	11.3% (971)	11.6% (398)	11.7%(3,190)
	70-74	10.2% (314)	10.4%(1,190)	9.7% (832)	8.1% (276)	9.8% (2,674)
	75-79	9.8% (302)	9.6%(1,093)	9.1% (782)	7.0% (239)	9.1% (2,470)
	80-84	7.2% (221)	7.4% (847)	6.4% (554)	4.6% (159)	6.7% (1,814)
	85-89	4.5% (140)	4.1% (469)	3.2% (274)	2.9% (100)	3.7% (1,005)
	90+	1.6% (48)	1.9% (214)	1.6% (137)	1.3% (43)	1.7% (451)
	100%					
Race	White	94.2%(2,992)	96.1%(11,179)	97.0%(8,443)	95.0%(3,291)	96.0%(25,590)
	Black	2.9% (92)	1.0% (116)	0.7% (57)	0.4% (14)	1.0% (261)
	American Indian/Alaska Native	0.9% (30)	0.9% (100)	0.5% (43)	0.3% (11)	0.7% (192)
	Asian/Pacific Islander	1.9% (61)	2.0% (236)	2.0% (172)	4.2% (145)	2.3% (555)
	100%					
Ethnicity	Non-Hispanic	97.3%(3,059)	98.1%(11,358)	98.7%(5,565)	98.8%(3,407)	98.5%(26,076)
	Hispanic	2.7% (86)	1.9% (220)	1.3% (109)	1.2% (40)	1.5% (513)
	100%					

Table 2 Stage at diagnosis by poverty category

Variable		Poverty Categories				Total Sample n= 27,242
		>20% n=3,090	**10-20%** n=11,429	**5-10%** n=8,617	**<5%** n=3,429	
Stage at diagnosis % (n)	Early (in situ and localized)	67.6%(2,062)	72.2%(8,107)	73.6%(6,258)	74.0%(2,510)	72.3%(19,402)
	Late (regional and distant)	32.4%(987)	27.8%(3,116)	26.4%(2,240)	26.0% (882)	27.7%(7,425)

Logistic Regression

As the level of poverty in a given geographic area increases, the odds of a late stage diagnosis of breast cancer also increases. Poverty status was independently associated with late stage diagnosis of breast cancer at the 10-20% and greater than 20% levels using <5% poverty as the reference group (Adjusted OR 1.1 95% CI: 1.0-1.2, p=0.015 and Adjusted OR 1.4 95% CI: 1.2-1.5, p<0.0001 respectively). This association remained after controlling for age, race, and ethnicity. See Table 3.

Each age group was significantly less likely to be diagnosed with a late stage cancer than the reference group (ages 40-44), except for ages 45-49 and 90+ which did not reach significance likely due to sample size. There are known biologic mechanisms that may explain these results. Younger, premenopausal women tend to have denser breast tissue and therefore tumors are more difficult to visualize via mammography. Tumors are often larger when discovered among younger women and tend to be more invasive and aggressive.[31] Mammography screening recommendations generally start at age 50 and younger women are getting routine mammograms less often than older women.[8]

Race and ethnicity were also associated with late stage at diagnosis. Both black women (OR 1.5 95%CI: 1.1-1.9, p=0.003) and Native American/Alaskan Native women were more likely than white women to have a late stage diagnosis (OR 1.4 95%CI: 1.0-1.9, p=0.03). Hispanic women (any race) were more likely than Non-Hispanic women to have a late stage diagnosis (OR 1.5 95%CI: 1.2-1.9, p<0.0001).

Table 3 Adjusted odds ratio estimates for late stage breast cancer diagnosis by poverty level, age group, and race/ethnicity

Variables	Odds Ratio	95% Confidence Interval	p-value
Poverty			**<0.0001**
<5% (n=3,429)	1.0 (ref)		
5-10% (n=8,617)	1.03	0.94-1.13	0.49
10-20% (n=11,429)	1.11	1.02-1.21	0.018
>20% (n=3,090)	1.37	1.23-1.53	<0.0001
Age Groups			**<0.0001**
40-44 (n=1,726)	1.0 (ref)		
45-49 (n=3,077)	0.92	0.81-1.05	0.20
50-54 (n=3,484)	0.85	0.75-0.96	0.009
55-59 (n=3,796)	0.78	0.69-0.88	<0.0001
60-64 (n=3,555)	0.71	0.63-0.81	<0.0001
65-69 (n=3,190)	0.66	0.58-0.75	<0.0001
70-74 (n=2,674)	0.61	0.54-0.70	<0.0001
75-79 (n=2,470)	0.63	0.55-0.73	<0.0001
80-84 (n=1,814)	0.64	0.55-0.75	<0.0001
85-89 (n=1,005)	0.74	0.62-0.88	<0.0001
90+ (n=451)	0.89	0.70-1.13	0.33
Race			**<0.0001**
White (n=25,590)	1.0 (ref)		
Black (n=261)	1.44	1.11-1.87	0.006
American Indian/Alaska Native (n=192)	1.43	1.04-1.96	0.026
Asian/Pacific Islander (n=555)	0.92	0.76-1.13	0.421
Other (n=644)	0.59	0.48 – 0.73	<0.0001
Ethnicity			**0.0001**
Non-Hispanic (n=26,729)	1.0 (ref)		
Hispanic (n=513)	1.42	1.18-1.71	<0.0001

Spatial Analysis

To view the distribution of breast cancer in Oregon in more detail, I mapped the poverty level and proportion of late stage diagnosis by CT using geographic information system

software (ArcMap). The proportion of late stage breast cancer diagnosis was greater among CTs reporting higher poverty status in both of the two time periods (using 2000 Census and 2005-2009 American Community Survey data on poverty status).

I stratified the dataset into women who were diagnosed between the years 2000-2004 and those diagnosed between the years 2005-2009 to be able to view the differences (if any) that were present in the different time periods. Approximately half were in each time period with 13,436 (49%) women in the 2000-2004 time period and 13,806 (51%) in the 2005-2009 time period.

I then plotted the poverty by CT based on the year of diagnosis for all of Oregon and a zoom to the Portland Metro region. I assigned each CT a poverty score based on the percent poverty previously calculated (1= <5%, 2= 5-10%, 3= 10-20%, 4=>20%). The mean poverty score between the two different time periods was significantly different (2.55 for 2000-2004, 2.77 for 2005-2009, paired 2-sided t-test $p<0.05$). I excluded one entry for Malheur County from the analysis as this CT did not have data available. This shows that the poverty level has increased from the 2000 Census, which is shown on the map. See figures 1-2. I repeated this analysis for the Portland Metro Region (Multnomah, Washington, and Clackamas counties--PMR). In this subset the mean poverty score between the two different time periods was also significantly different (2.26 for 2000-2004, 2.58 for 2005-2009, paired 2-sided t-test $p<0.05$). See figures 3-4 for maps. 55% of the study CTs had no change in poverty, 12% had a decrease in poverty, and 33% had an increase in poverty. See figures 5 and 6 for graphic distribution of the change in poverty level between the study time periods.

I also plotted the percent of late stage diagnosis for each time period and mapped it based on CT. I found that the mean percent of late stage diagnosis between the two time periods was significantly different (28.2% for 2000-2004, 29.2% for 2005-2009, $p<0.05$). See figures 7-8. I repeated this analysis for the PMR and found a similar result (27.7% for 2000-2004, 28.9% for 2005-2009, $p<0.05$) as well as the rest of the state without the PMR (28.5% for 2000-2004, 29.4% for 2005-2009, $p<0.05$). See figures 9-10 and Table 4. I also tested if the mean percent late stage diagnosis was significantly different between the PMR and the rest of the state without the PMR. For both time periods the mean percent was significantly different ($p<0.05$). See Table 5. See figures 11 and 12 for graphic distribution of the change in late stage diagnosis between the study time periods.

Of the CTs that increased in poverty between the two time periods (n=248 CTs) all also had an increase in late stage diagnosis between the two time periods. This supports my hypothesis that women living in higher poverty areas would have increased late stage diagnosis.

Table 4 Comparison of mean percent late stage breast cancer diagnosis in each time period by geographic region

Geographic Area	**Percent late stage diagnosis by year of diagnosis**				**p-value**
	2000-2004	**95% Confidence Interval**	**2005-2009**	**95% Confidence Interval**	
Entire State of Oregon (n=755 CTs)	28.2%	27.9% - 28.3%	29.2%	28.9% - 29.3%	<0.0001
PMR (n=313 CTs)	27.7%	27.5% - 27.9%	28.9%	28.6% - 29.1%	<0.0001
Outside of PMR (n=442 CTs)	28.5%	28.2% - 28.7%	29.4%	29.1% - 29.6%	<0.0001

Table 5 Comparison of mean percent late stage diagnosis between PMR and the rest of Oregon by time period

Year of diagnosis	Geographic location				p-value
	PMR (n=313 CTs)	**95% Confidence Interval**	Outside of PMR (n=442 CTs)	**95% Confidence Interval**	
2000-2004 (n=13,436)	27.7%	27.5% - 27.9%	28.5%	28.2% - 28.7%	<0.0001
2005-2009 (n=13,806)	28.9%	28.6% - 29.1%	29.4%	29.1% - 29.6%	0.003

Discussion

Strengths and Limitations

This study on the link between stage at diagnosis and the geographic distribution of socioeconomic status is the first one to focus on Oregon State alone. Since Oregon is very diverse geographically and socially, the results found here can be used to inform other studies in additional geographic areas. The sample of cases was geocoded to a high degree, which allowed me to examine the data spatially without missing data. In the process of geocoding the dataset, I accepted zip code levels of geocoding, which are not as accurate as other methods. Since I was examining the spatial data at the level of CT, I was not concerned with individual level geocoding so for the purposes of this study, zip code geocoding was sufficient. When examining the data spatially, it is difficult to grasp the population density differences since population sizes differ within CTs and this is an inherent limitation to using spatial data at the CT level.

The study has the strength of having two different datasets for measuring poverty status that closely correspond to the date of diagnosis of breast cancer for each case. The year the

case was diagnosed determined which set of poverty status indicators it received. This reduces bias due to population changes and makes the poverty status variable a better estimator of SES.

One key limitation to this study is that it is ecological; it is not possible to ascertain the individual poverty level of a particular woman from my results. In addition, it is not known from these results if it is the poverty level of the neighborhood or the poverty level of the individual woman that drives the increase in late stage breast cancer diagnosis. However, these results can contribute to the overall knowledge base of breast cancer and can generate hypotheses for more robust studies.

A known limitation of ethnicity data for cancer registries is the data is often based on a "best guess" of a person's ethnicity. A person is coded as Hispanic if they have Hispanic ethnicity stated in their medical record or death certificate, their birthplace is of Hispanic origin, if Spanish is their preferred spoken language, or their last name appears to be Hispanic. The Hispanic ethnicity data in the OSCaR database is potentially problematic and could introduce some misclassification bias. However, I did not include in the analysis those who were coded as Hispanic based on their last name only (n=128) to avoid some of this potential misclassification bias. Given the limitations of these data, the results still help show the underlying association between stage at diagnosis and Hispanic ethnicity. Since Oregon's largest minority group is comprised of people with Hispanic ethnicity, I felt it was important to include this variable in the analysis.

Early stage breast cancer does not always turn into late stage breast cancer if left to its natural progression. It is not known exactly why some tumors become invasive when others do

not. It is possible that an early stage breast cancer will be detected that would not have become invasive but will still often be treated.

With the changing climate of public health and healthcare corresponding to the implementation of the Affordable Care Act, monitoring health outcomes overtime is very important to evaluate if the changes made a difference in the health of the population. Breast cancer is a suitable health outcome to follow in part due to its powerful advocacy groups and political support.

Conclusion & Public Health Implications

The geographic distribution of stage at diagnosis helps to illustrate the known association between SES and cancer. I found that poverty status is significantly associated with late stage breast cancer diagnosis in Oregon. This result stayed consistent after examining race/ethnicity and age, so the association was not caused by these covariates. In addition, the results highlighted known disparities in late stage breast cancer diagnosis for black women and Native American/Alaska Native women.

Poverty and late stage breast cancer diagnosis increased in Oregon over the two time periods for the entire state of Oregon, the PMR and outside of the PMR. Late stage breast cancer diagnosis is known to have a worse prognosis than earlier stage diagnosis with lower rates of survival.

The results shown from this study support the need for interventions aimed at women living in higher poverty CTs to mitigate the poor health outcomes that often result from having a late stage diagnosis of breast cancer. Targeted research with more robust study designs may

help to demonstrate a causal relationship between poverty status and late stage breast cancer diagnosis.

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Appendix

Figure 1 Poverty Status 2000-2004

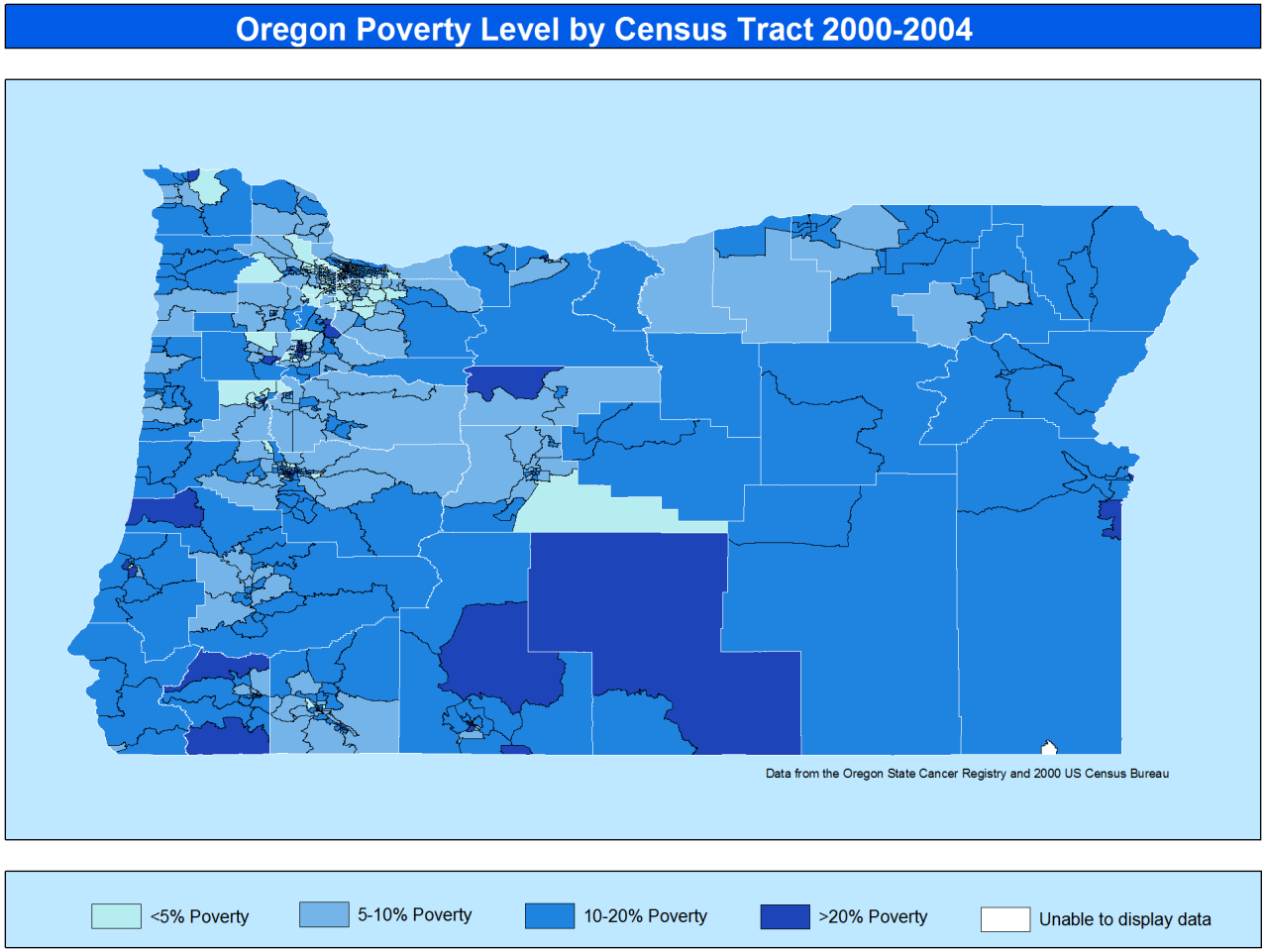

Figure 2 Poverty Status 2005-2009

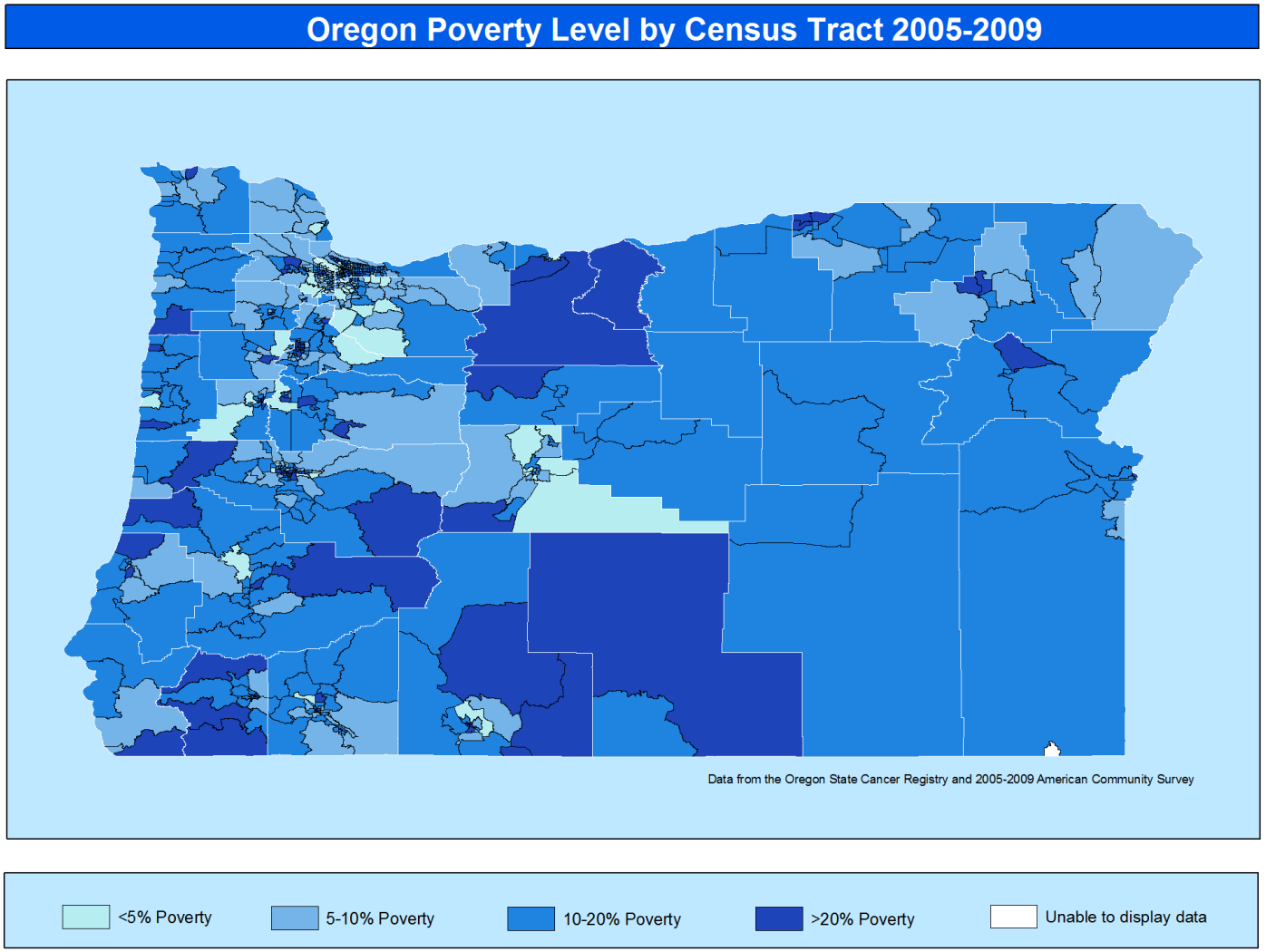

Figure 3 Poverty Status in Portland Metro 2000-2004

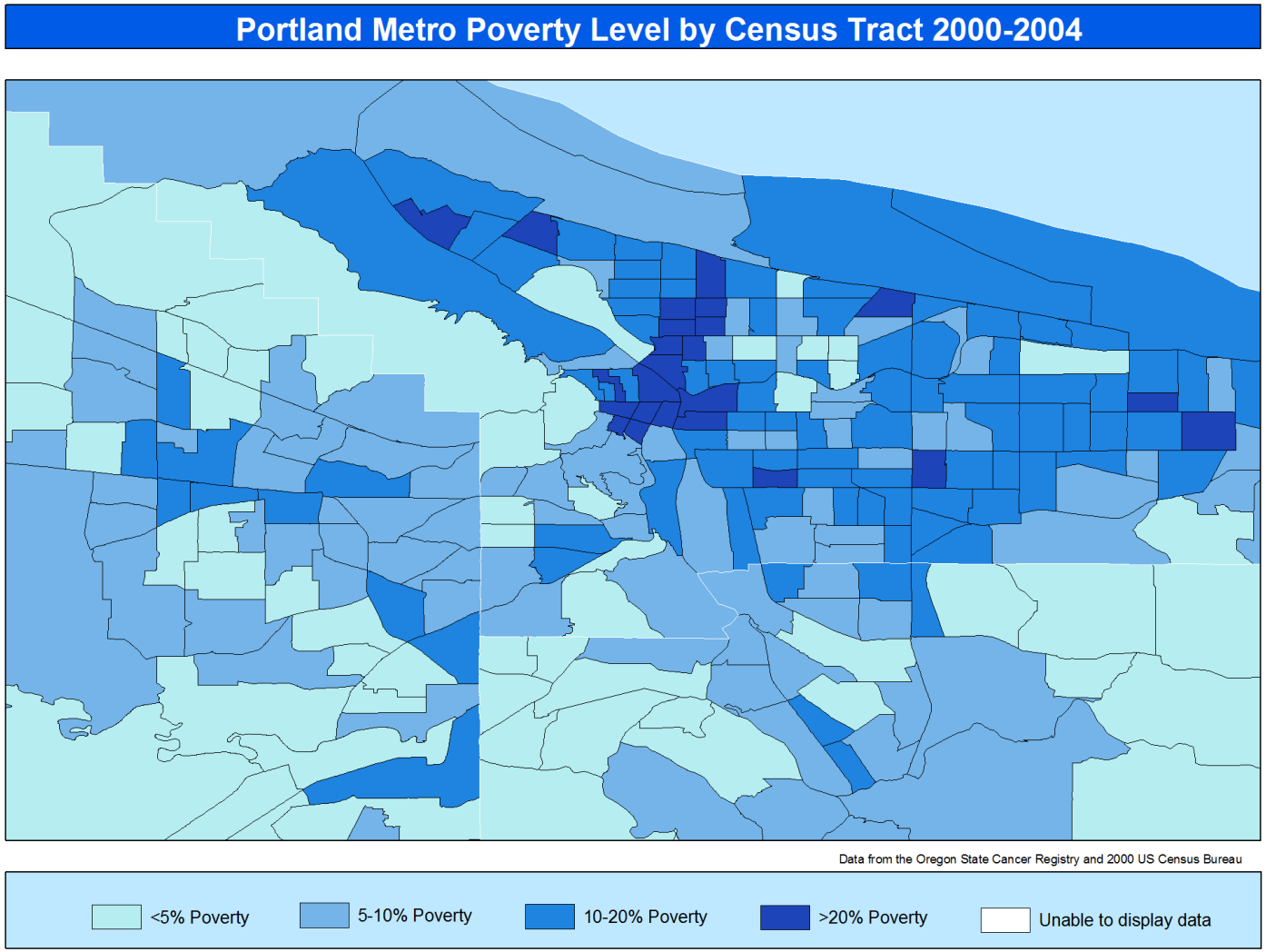

Figure 4 Poverty Status in Portland Metro 2005-2009

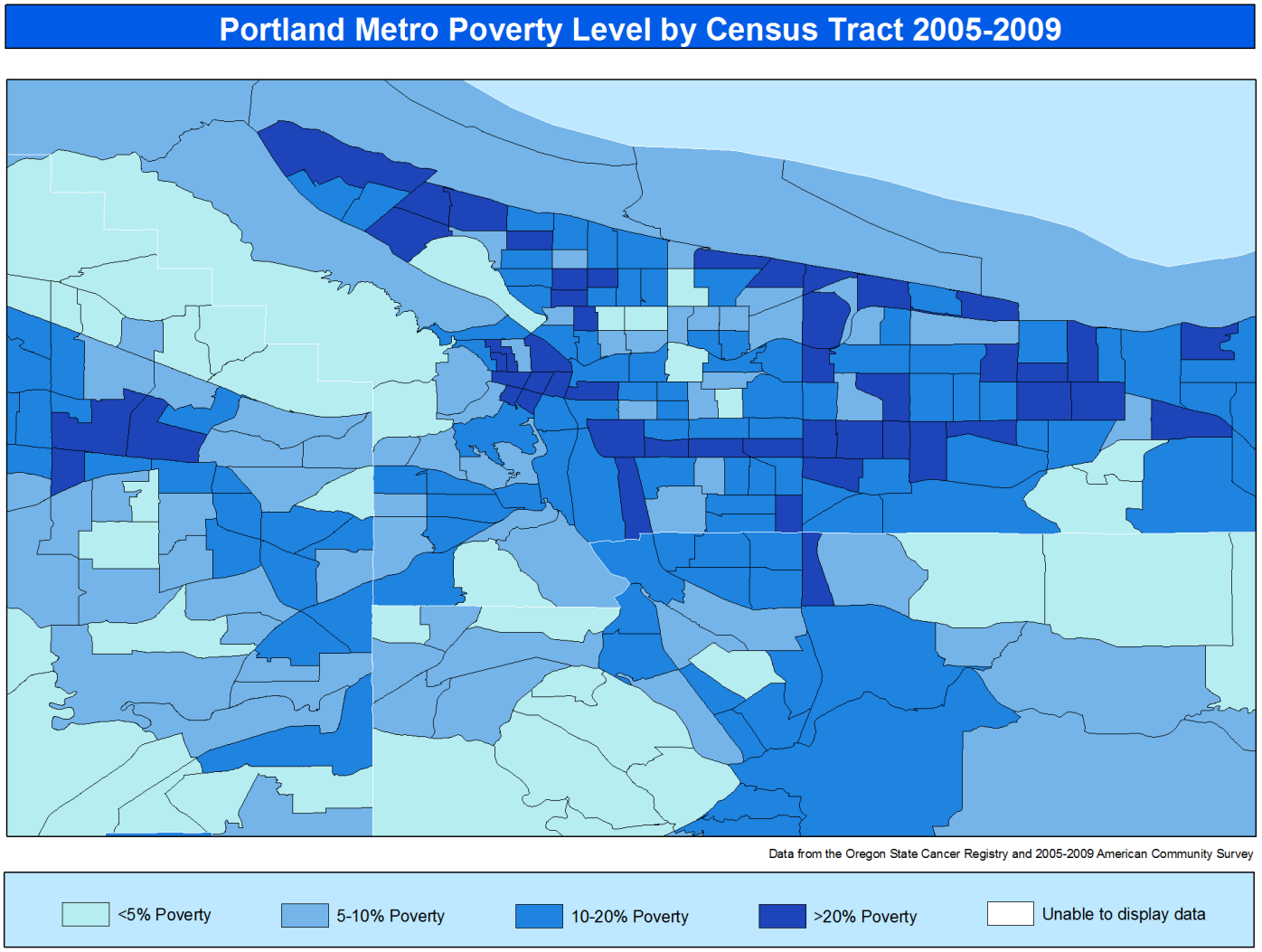

Figure 5 Difference in poverty level between study time periods (2000-2004 and 2005-2009)

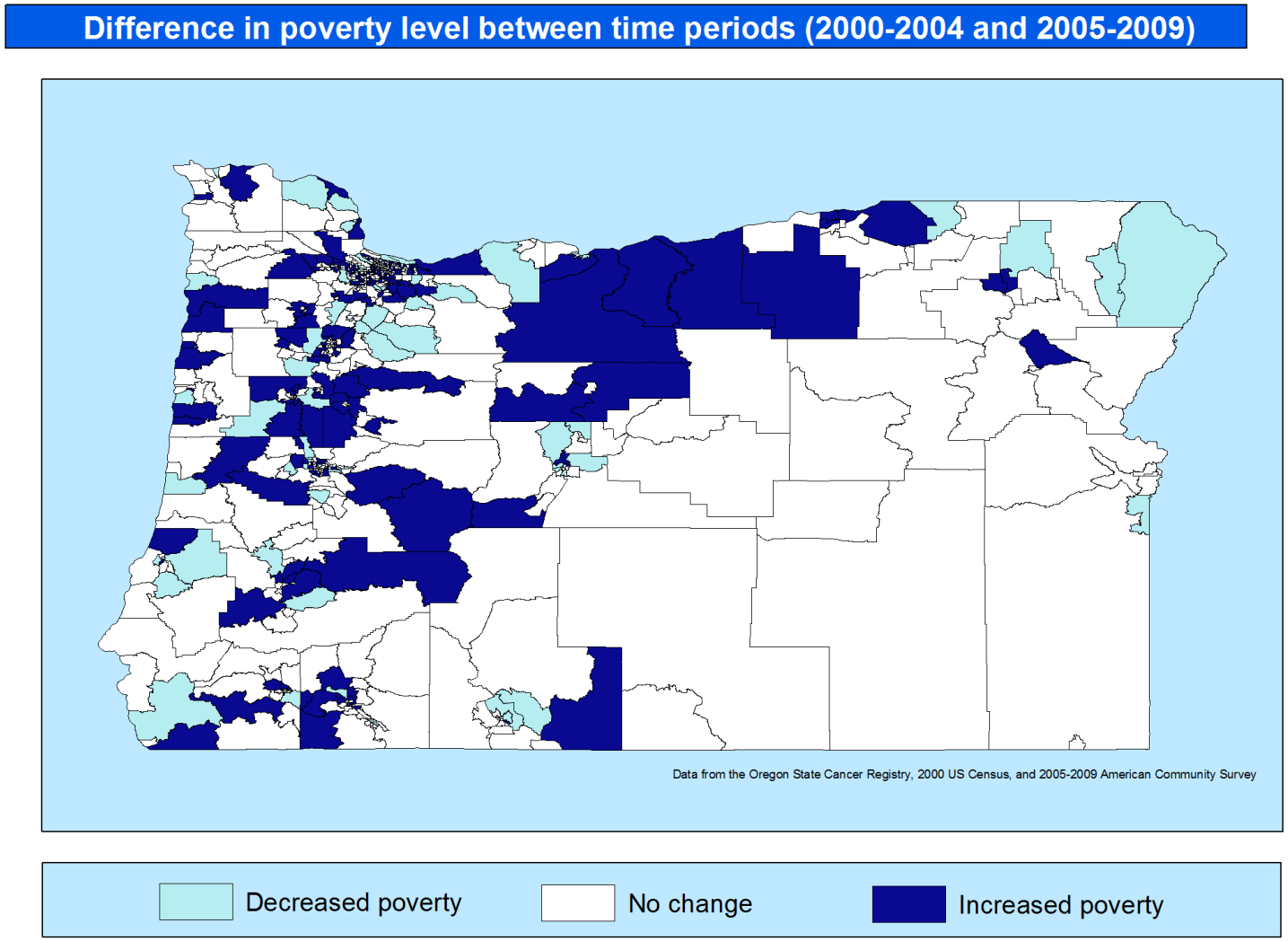

Figure 6 Difference in poverty level between study time periods (2000-2004 and 2005-2009) for PMR

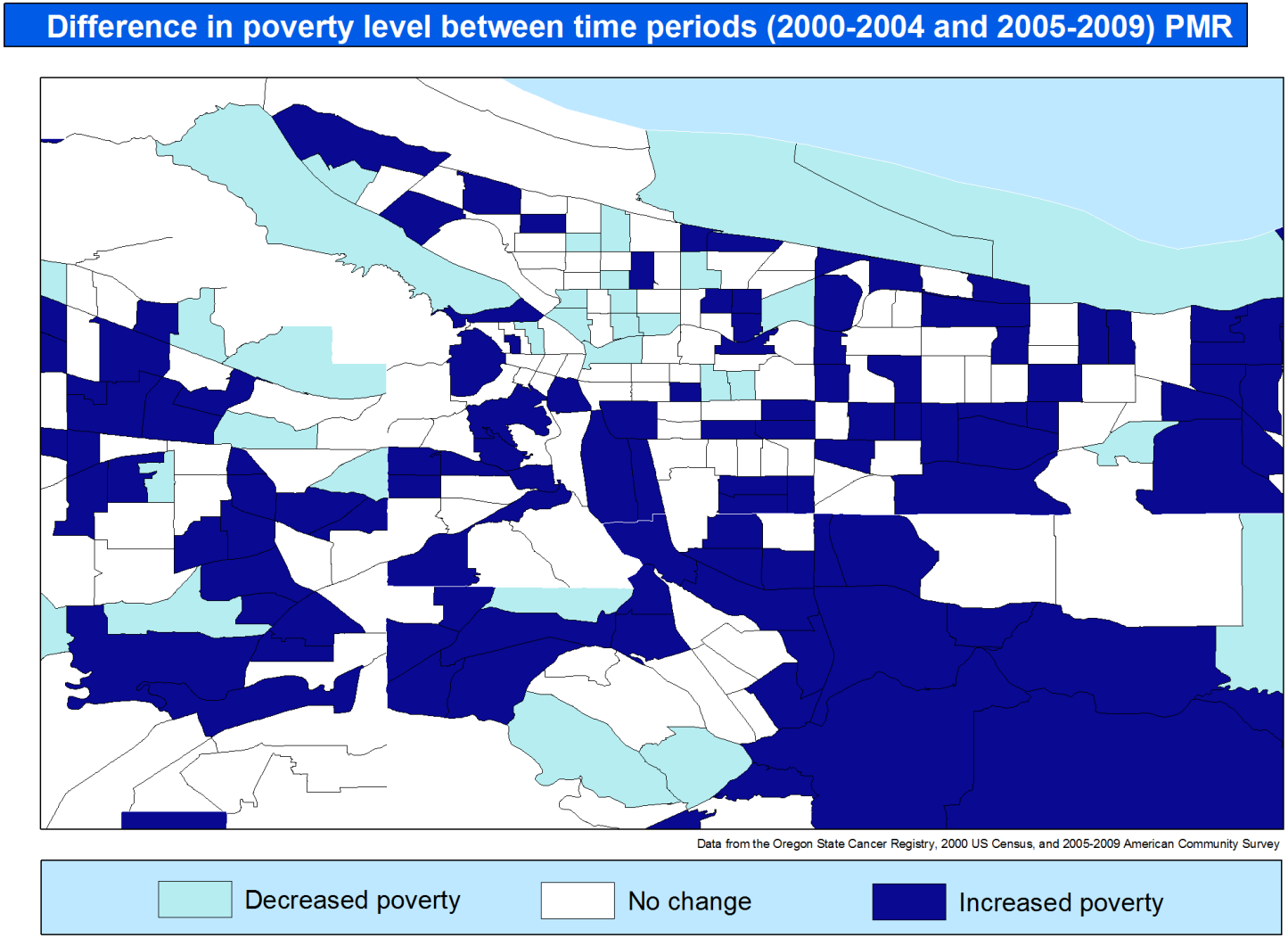

Figure 7 Percent Late Stage Diagnosis 2000-2004

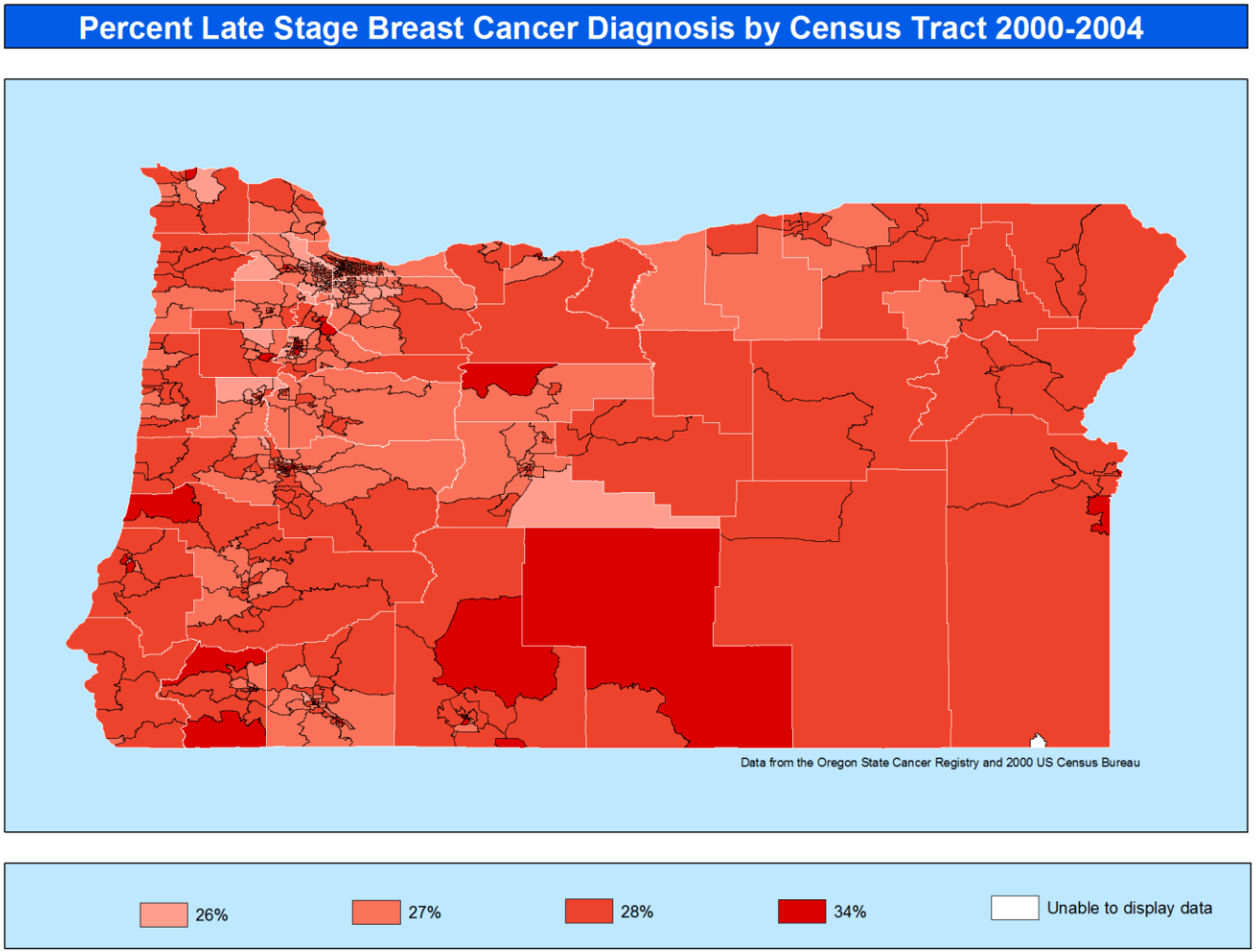

Figure 8 Percent Late Stage Diagnosis 2005-2009

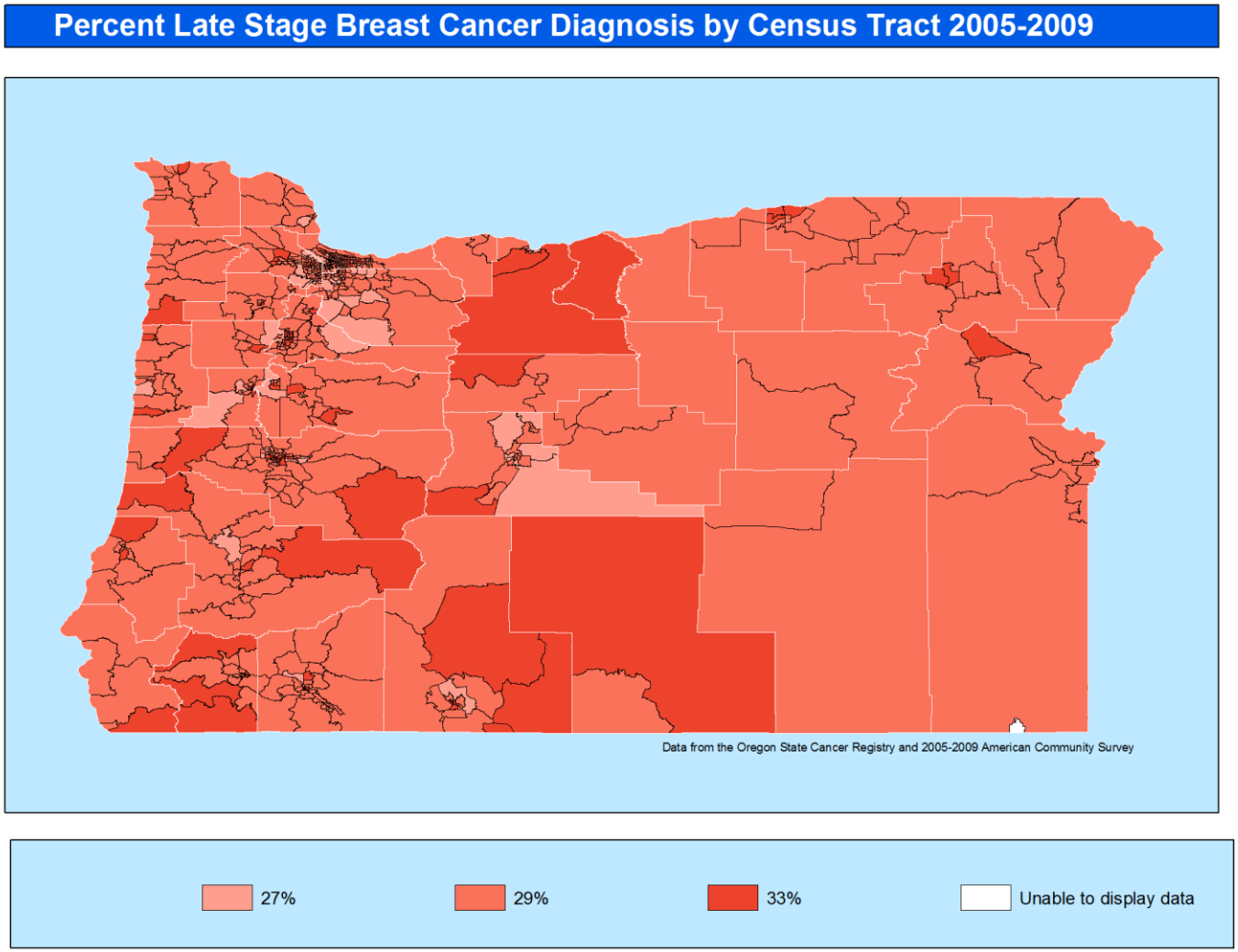

Figure 9 Percent Late Stage Diagnosis in Portland Metro 2000-2004

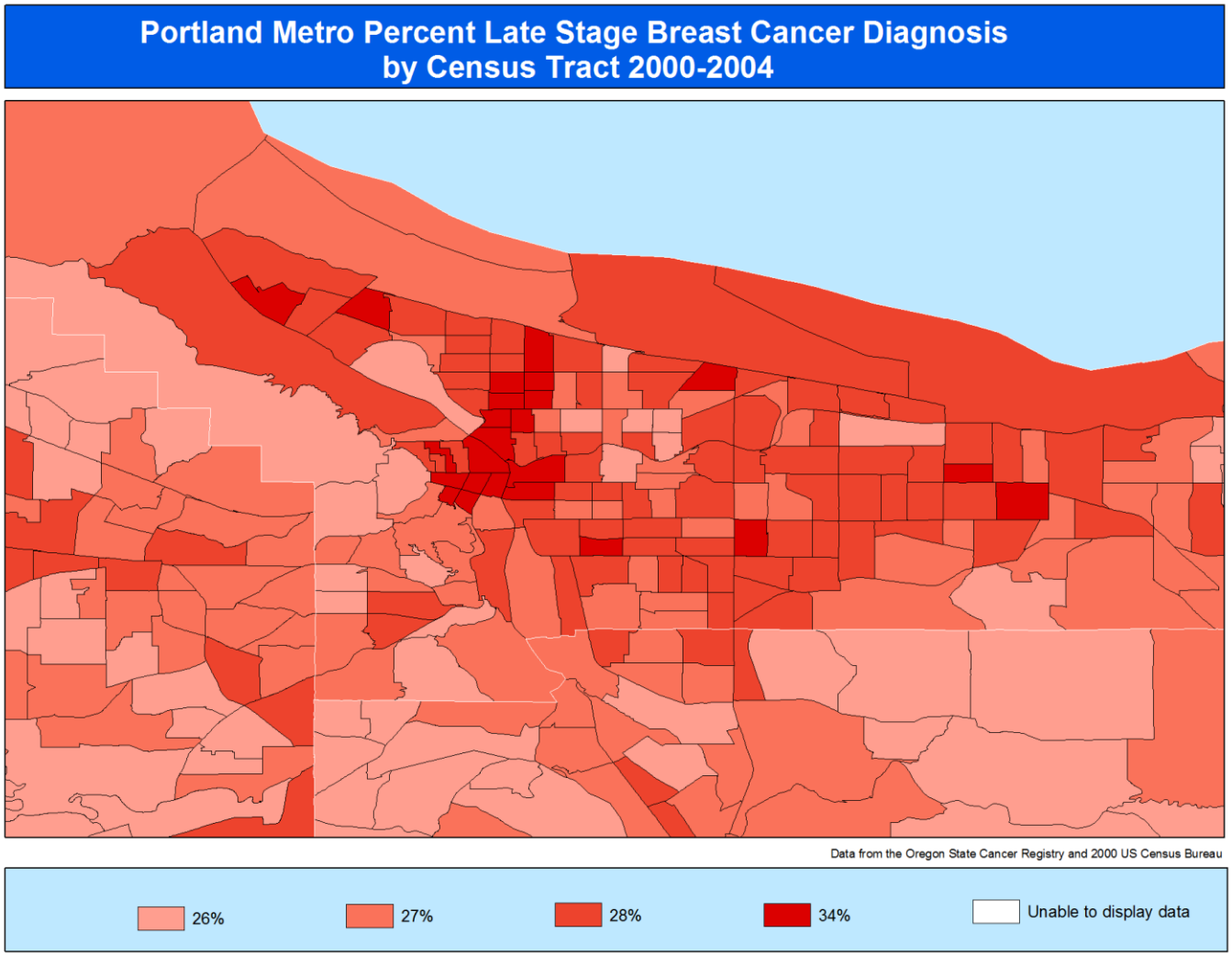

Figure 10 Percent Late Stage Diagnosis in Portland Metro 2005-2009

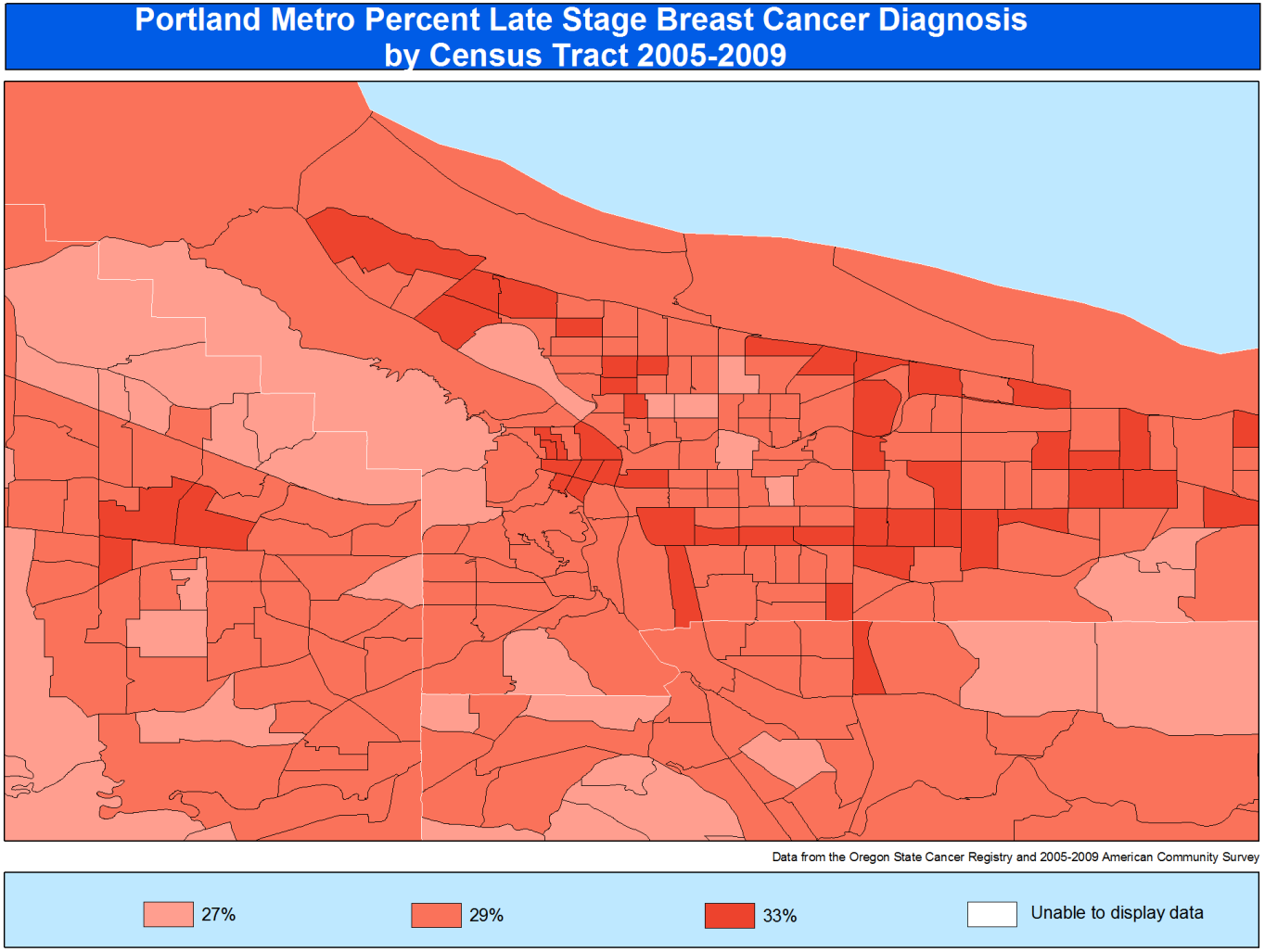

Figure 11 Difference in late stage breast cancer diagnosis between study time periods (2000-2004 and 2005-2009)

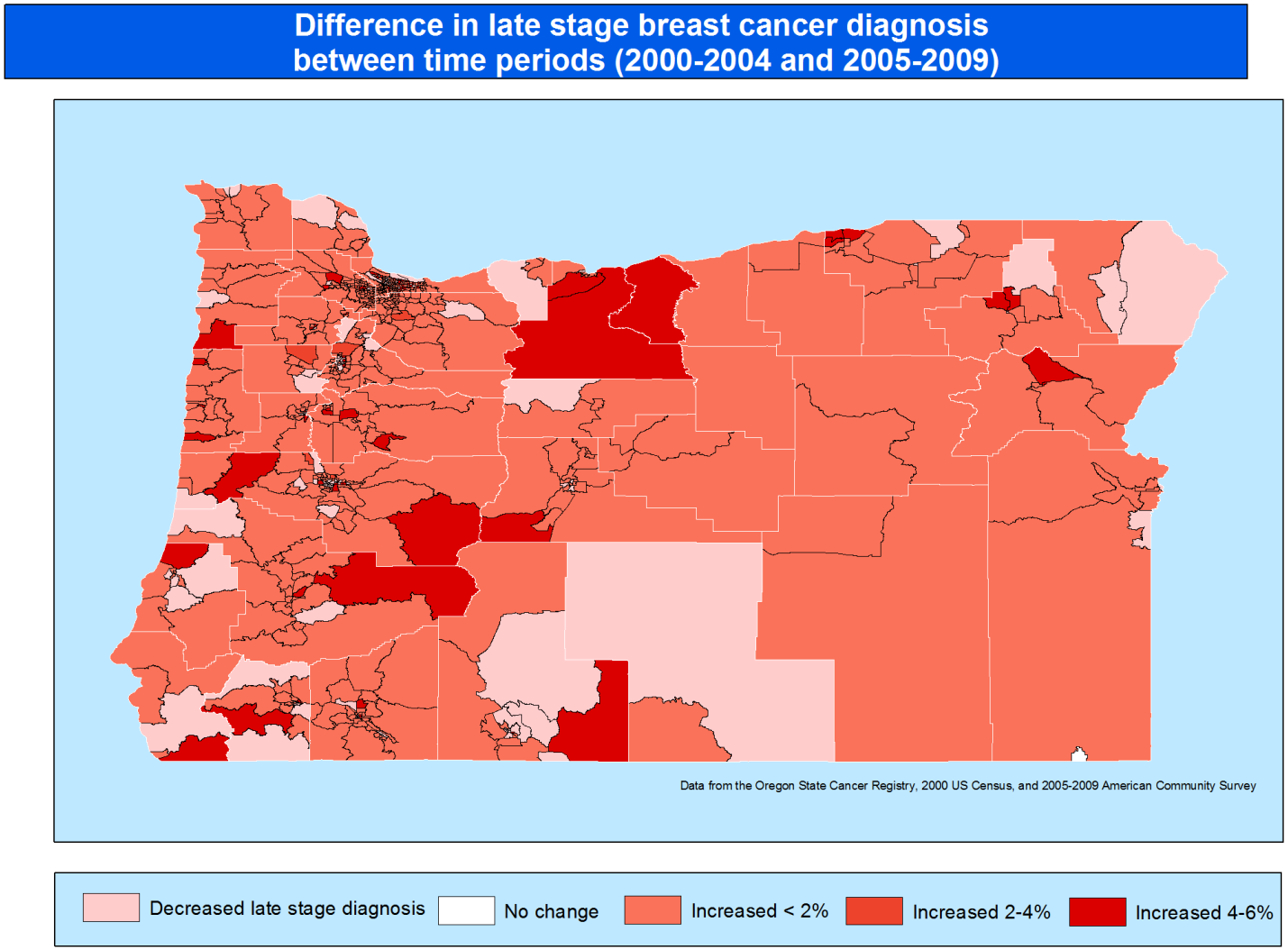

Figure 12 Difference in late stage breast cancer diagnosis between study time periods (2000-2004 and 2005-2009) for PMR