Disparities among hispanic ethnicity and stage at diagnosis for invasive breast and colorectal cancer

Raquel Velazquez
University at Albany, State University of New York, rvelazquez@albany.edu

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DISPARITIES AMONG HISPANIC ETHNICITY AND STAGE AT DIAGNOSIS FOR INVASIVE BREAST AND COLORECTAL CANCER

by

RAQUEL L. VELAZQUEZ

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ABSTRACT

**Objective:** To assess the relationship between ethnicity and stage at diagnosis among invasive cases of breast and colorectal cancer.

**Design:** Cross-sectional, case-only study design

**Methods:** Data from the New York State Cancer Registry for breast and colorectal cancer cases diagnosed in 2004-2011 was linked with 2006-2010 American Community Survey data. Multinomial logistic regression was used to examine associations of Hispanic ethnicity and other sociodemographic factors of interest with cancer stage at diagnosis. Separate analyses were performed for breast and colorectal cancer.

**Results:** *Breast cancer*- Among whites, Puerto Ricans (OR=1.22, 95% CI=1.06-1.39) and Dominicans (OR=1.23, 95% CI=1.04-1.45) were more likely than non-Hispanics to be diagnosed with regional stage disease compared to local stage disease. No significant associations were observed for Mexicans and Central/South Americans with regional stage disease or for Mexicans, Puerto Ricans, Cubans, or Central/South Americas with distant stage disease. Among blacks, Central/South Americans (OR=0.72, 95% CI=0.53-0.98) were less likely than non-Hispanics to be diagnosed with regional stage disease. No significant associations were observed for Mexicans, Puerto Ricans, Cubans, Dominicans, and other Hispanics with regional stage disease or for Mexicans, Puerto Ricans, Cubans, Central/South Americans, or other Hispanics with distant stage disease.

*Colorectal Cancer*- Among whites, Puerto Ricans were more likely to be diagnosed with regional (OR=1.29, 95% CI=1.10-1.51) or distant (OR=1.92, 95% CI=1.61-2.30) stage disease. Central/South Americans (OR=1.28, 95% CI=1.05-1.55) were more likely to be
diagnosed with regional stage disease. No significant associations were observed for Mexicans, Cubans, and Dominicans with regional stage disease or for Mexicans, Cubans, Central/South Americans, or other Hispanics with distant stage disease. Among blacks, Dominicans (OR=0.51, 95% CI=0.32-0.81) and other Hispanics (OR=0.56, 95% CI=0.35-0.90) were less likely to be diagnosed with distant stage disease. No other significant associations were observed among blacks with colorectal cancer.

**Conclusions:** Hispanics comprise a heterogeneous ethnic group with differing breast and colorectal cancer burdens. Puerto Ricans, Central/South Americans, and Dominicans were most likely to present with regional or distant stage breast and colorectal cancer than other subgroups of Hispanic ethnicity. Based on previous literature regarding Hispanics, targeted education and screening programs could improve early diagnosis rates among these vulnerable subgroups.
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BACKGROUND

Overview of Cancer Sites

Breast Cancer

Breast cancer is both the most common form of cancer as well as the second leading cause of cancer death in U.S. women (Centers for Disease Control and Prevention, 2013; American Cancer Society, 2014e). While men can develop breast cancer, it is extremely rare. In 2014, it is estimated that 2,360 new cases of invasive breast cancer will be diagnosed in men while 232,670 new cases will be diagnosed in women (American Cancer Society, 2014e; American Cancer Society, 2014f). There are numerous forms of breast cancer, although a majority of diagnoses fall within two categories.

Among women, nearly 8 out of 10 invasive breast cancer cases are ductal carcinomas, which originate in the milk ducts of the breast, whereas 1 out of 10 invasive breast cancer cases are lobular carcinomas, which begin in the milk producing lobules (American Cancer Society, 2014d). Rarer forms of breast cancer include; inflammatory breast cancer, triple-negative breast cancer, Paget disease of the nipple, phyllodes tumor, and angiosarcoma (American Cancer Society, 2014d). Only 5% to 10% of all breast cancer cases are due to inherited genetic mutations (American Cancer Society, 2014g). About 20% to 25% of these hereditary breast cancer cases are due to mutations in the tumor suppressor genes, BRCA1 and BRCA2 (National Cancer Institute, 2014a).

The risk of breast cancer increases with age, with 89% of cases occurring after age 45, with the median age at diagnosis being 61 (National Cancer Institute, 2014c).
Between 2006 and 2010 the average annual female breast cancer incidence rate was highest in non-Hispanic whites (127.3 cases per 100,000 women per year) and lowest for Asian Americans/Pacific Islanders (84.7 cases per 100,000 women per year) (Desantis et al., 2014). Additional factors can increase breast cancer risk, such as a family or personal history of breast cancer, dense breast tissue, and the presence of a benign breast condition (i.e., radial scar or atypical ductal hyperplasia) (American Cancer Society, 2014g).

Previous studies have shown that having one first-degree relative with breast cancer doubles a woman's risk while having two first-degree relatives nearly triples a woman’s risk of breast cancer (American Cancer Society, 2014g). However, it is important to note that fewer than 15% of women diagnosed with breast cancer have a relative with the disease (American Cancer Society, 2014g). Modifiable risk factors for breast cancer include alcohol consumption, obesity, oral contraceptive use, and lack of physical activity (American Cancer Society, 2014g).

An estimated 12.3% of women will be diagnosed with breast cancer within their lifetime (National Cancer Institute, 2014c). The most common methods of breast cancer screening include mammography, clinical breast exams, and breast self-exams (American Cancer Society, 2014a). Cancer found during routine screenings is more likely to be small and non-metastatic, which increases the likelihood of successful treatment and survival (American Cancer Society, 2014a). Broken down by stage at diagnosis, the 5-year relative survival for localized, regional, and distant cases is 98.5%, 84.6%, and 25.0%, respectively (National Cancer Institute, 2014c). Overall, an estimated 430 men and 40,000 women will die from breast cancer in 2014 (American Cancer Society, 2014e; American Cancer Society, 2014f).
Colorectal Cancer

Colorectal cancer occurs within the large intestine. Over 95% of colorectal cancers are adenocarcinomas (Memorial Sloan Kettering Cancer Center, 2014). Like breast cancer, about 5 to 10% of colorectal cancer cases are due to inherited genetic mutations (Memorial Sloan Kettering Cancer Center, 2014). These include familial adenomatous polyposis and hereditary non-polyposis colorectal cancer (Memorial Sloan Kettering Cancer Center, 2014). Colorectal cancer is the third leading cause of cancer death in both men and woman in the U.S. (Centers for Disease Control and Prevention, 2013).

Colon and rectal cancers are most often seen in those ages 65-74, with a median age of 68 (National Cancer Institute, 2014d). This age group comprises 23.9% of new cases (National Cancer Institute, 2014d). When examining all races, men experienced 50.6 new cases per 100,000 person-years while women experienced 38.1 new cases per 100,000 person-years (National Cancer Institute, 2014d). Colorectal cancer is most commonly seen among blacks, with a rate of 62.3 new cases per 100,000 person-years for men and 47.5 new cases per 100,000 person-years for women (National Cancer Institute, 2014d). Other risk factors for colorectal cancer include a family or personal history of colorectal cancer and diabetes. Modifiable risk factors include obesity, lack of physical exercise, smoking, and alcohol use (American Cancer Society, 2014h). A diet high in red or processed meats has also been associated with increased colorectal cancer risk (American Cancer Society, 2014h).

In 2014, it is estimated that there will be 136,830 new cases of colon and rectal cancer in the U.S., as well as 50,310 deaths from these diseases (National Cancer
Institute, 2014b). This is approximately 8.2% of all new cases of cancer and 8.6% of all cancer deaths (National Cancer Institute, 2014d). The most common forms of colorectal screening include fecal occult blood tests, sigmoidoscopy, and colonoscopy (National Cancer Institute, 2014e). Multiple studies have shown that regular screening and early identification and removal of precancerous polyps decreases colorectal cancer incidence and mortality (Baxter et al., 2012; Brenner et al., 2014; Heresbach et al., 2006; Kahi et al., 2014). Broken down by stage at diagnosis, the 5-year relative survival for localized, regional, and distant cases is 89.8%, 70.5%, and 12.9%, respectively (National Cancer Institute, 2014d).
INTRODUCTION

Public Health Significance

In the U.S., it is estimated that there will be 1,665,540 new cancer cases and 585,720 cancer deaths in 2014 (American Cancer Society, 2014b). Currently, cancer is the second most common cause of death in the U.S. and accounts for 1 out of every 4 deaths (American Cancer Society, 2014b). In New York State alone, nearly 100,000 individuals are diagnosed with cancer each year (New York State Department of Health, 2014).

However, between 1990 and 2009, overall death rates decreased by 20%, which translated into almost 1.2 million deaths from cancer avoided (American Cancer Society, 2013b). This dramatic decline has been partially attributed to improvements in early detection and screening for colorectal and breast cancer (American Cancer Society, 2013b). Particularly, for women under 50, the death rate for breast cancer has been declining 3.2% per year since the early 1990’s (Simon, 2011). Unfortunately, cancer disproportionately burdens those in minority and low-income groups and not all have benefitted equally from these improvements (Bradley, Given, & Roberts, 2001; American Cancer Society, 2013b). This is particularly true of breast and colorectal cancer, where access to and utilization of screening measures is not consistent across racial/ethnic groups (American Cancer Society, 2013b).

Notably, Hispanics in the United States face numerous disadvantages when it comes to taking care of their health. Factors such as acculturation, low socioeconomic status, limited education or English proficiency, insufficient access to health care, and discrimination are substantial issues in the lives of many Hispanic Americans (Gallo et
In 2012, the average Hispanic median household income was $40,417 compared to $56,565 among non-Hispanic whites (U.S. Department of Health and Human Services, 2014). Further, only 13.8% of Hispanics had completed a bachelor’s degree or higher compared to 32.5% among non-Hispanic whites (U.S. Department of Health and Human Services, 2014). Also notable is that, in 2012, Hispanics had the highest uninsured rates of any racial or ethnic group, with 29% of Hispanics not having health insurance coverage compared to 10.4% among non-Hispanic whites (U.S. Department of Health and Human Services, 2014). Among Hispanic subgroups, 31.6% of Mexicans, 14.1% of Puerto Ricans, 23.8% of Cubans and 38.8% of Central Americans were without health insurance coverage (U.S. Department of Health and Human Services, 2014).

Hispanics represent the largest, youngest, and fastest growing minority group in the U.S. (American Cancer Society, 2014c). The U.S. Hispanic population is primarily comprised of those who are of Mexican (63%), Puerto Rican (9%), Central American (8%), South American (6%), and Cuban descent (4%) (American Cancer Society, 2014c). As of 2012, 53 million individuals in the US identified themselves as Hispanic (U.S. Census Bureau, 2013). Among Hispanics, cancer is the leading cause of mortality, comprising 21% of deaths overall (American Cancer Society, 2014c). Nearly 1 in 2 men and 1 in 3 women of Hispanic ethnicity are expected to be diagnosed with cancer in their lifetime (American Cancer Society, 2014c).

Currently, in Hispanics compared to non-Hispanic whites, incidence and mortality rates are lower for prostate, female breast, colorectal, and lung cancer, while higher for stomach, cervix, liver, acute lymphocytic leukemia, and gallbladder cancer (American
Cancer Society, 2014c). However, these statistics are limited as data reported for all Hispanics masks substantial disparities in cancer burden that exist among subgroups of Hispanic ethnicity (American Cancer Society, 2014c).

Breast Cancer and Hispanic Ethnicity

Breast cancer is currently the leading cause of cancer death among Hispanic women (American Cancer Society, 2014c). Previous studies have indicated that Hispanic women tend to present at a more advanced stage of breast cancer compared to their non-Hispanic white counterparts (Daly, Clark, & McGuire, 1985; Lantz et al., 2006; Richardson et al., 1992; Warner et al., 2012; Zaloznik, 1997). Despite the lower incidence rate of breast cancer among Hispanic women compared to non-Hispanic white women, delayed diagnosis contributes to a higher mortality rate among Hispanic women (Malley et al., 1999). A retrospective cohort study by Li and colleagues (2003) found that compared to non-Hispanic whites, Mexicans, South and Central Americans, and Puerto Ricans had a 1.6-2.6 fold increased risk (p<0.05) for presenting with stage IV breast cancer, after adjusting for age at diagnosis, year of diagnosis, and Surveillance, Epidemiology, and End Results Program (SEER) registry. Additionally, Lantz et al. (2006) found that after controlling for study site, age, and socioeconomic factors, Hispanic women were 45% less likely to be diagnosed at an early stage than non-Hispanic white women.

Numerous factors have been associated with the delayed diagnosis of breast cancer among Hispanics. Firstly, previous literature has indicated that factors related to screening behaviors may vary among different subgroups of Hispanic women (Austin et al., 2002; Ramirez et al., 2000). Ramirez et al. (2000) found that Mexican Americans and
Puerto Ricans had a more fatalistic view of breast and cervical cancer than Cuban or Central Americans. Additionally, they found that the level of knowledge regarding screening guidelines varied widely among Hispanic subgroups (from 58.3% for Mexican Americans to 71.8% for Cubans).

Additionally, lack of proficiency in the language of the host country has been found to be a critical barrier to cancer screening. Stein and Fox (1990) found that less acculturated Hispanics (as determined by English proficiency) were less likely to have ever received a mammogram compared to more acculturated Hispanics (13.7% compared to 47.1%, respectively). Likewise, previous studies have shown that foreign-born Hispanics are less likely to be diagnosed at an early stage of breast cancer than native-born Hispanics (Hedeen & White, 2001; Kouri et al., 2010). Kouri et al. (2010) found that foreign-born Hispanics had lower adjusted proportions of stage I breast cancer at diagnosis compared to both US-born Hispanics and non-Hispanic whites (35.4% versus 40.6% and 47.4%, respectively).

A study by Rosales and Gonzalez (2013) found that among Mexican and South and Central American women, those who were not U.S. citizens were 37% less likely to report a recent mammogram, compared to naturalized citizens (OR= 0.63, 95 % CI= 0.62–0.64). Further, the authors found that Mexican born women were 28% less likely to report receiving a recent mammogram compared to South Americans (OR=0.72, 95 % CI= 0.71–0.75).

Breast Cancer and Race

Female breast cancer rates also vary substantially by race, making it an important factor to address when analyzing cancer trends by ethnicity. In the U.S., white women
have the highest rate of breast cancer with 128 new cases per 100,000, while black
women are diagnosed at a rate of 122.8 per 100,000, followed by Asian/Pacific Islander
women with a rate of 93.6 per 100,000 (National Cancer Institute, 2014c). Surprisingly,
while white women are more likely to develop breast cancer, black women are more
likely to die of the disease (1 in 37 versus 1 in 31, respectively) (American Cancer
Society, 2013a). This is due in part to black women being more likely to be diagnosed
with regional and distant stage breast cancer compared to white women (see Appendix A,
Figure 1).

Until the late 1980’s, breast cancer mortality rates were similar among black and
white women. However, with the implementation of improved screening measures, lack
of access to and utilization of these measures among black women contributed to an
increased gap in breast cancer mortality (American Cancer Society, 2013a). However,
screening is not the only factor related to the widening disparity of breast cancer
mortality by race, as a majority of this inequality is still unexplained after accounting for
differences in screening utilization (American Cancer Society, 2013a).

An early review conducted by Ijaduola and Smith (1998) found that the most
common feature of breast cancer among both African Americans and native West
Africans was more advanced breast cancer and higher tumor burden than their white
counterparts. This also resulted in poorer survival rates. More recent studies have also
found that black women are more likely to be diagnosed with late stage breast cancer
than white women (Aizer et al., 2014; Bradley, Given, & Roberts, 2001; Johnson, 2002;
Keeton, Jones, & Sebastian, 2014; Li, Malone, & Daling, 2003; Schwartz et al., 2003;
Shavers, Harlan, & Stevens, 2003). A study conducted by Aizer et al. (2014) concluded
that blacks presented at a more advanced disease stage (P < .001) and received definitive therapy less frequently (P < .001) than whites for lung, breast, prostate, and colorectal cancer combined. Further, for breast cancer in particular, the authors found that the survival disparity increased over time between blacks and whites (hazard ratio [HR] from 1988-1997: 1.37, HR from 1998-2007: 1.53, p<001), even after adjusting for disease stage at diagnosis and treatment.

Conversely, while breast cancer is the most commonly diagnosed cancer among Asian women, this group is still 30% less likely to develop breast cancer than white women (Office of Minority Health, 2013). In addition, Asian women have the lowest death rates due to breast cancer among all races (Office of Women’s Health, 2010). Between 2005 and 2009, Asian women had a death rate of 11.5 per 100,000 person-years, while non-Hispanic white women had double the death rate at 22.7 per 100,000 person-years (Office of Minority Health, 2013). Though, some studies have suggested that acculturation has a substantial effect on breast cancer risk in Asian immigrants in the U.S. (Deapen et al., 2002; Ziegler et al., 1993). A study by Ziegler et al. (1993) found that Asian women born in the West had a breast cancer risk 60% higher than Asian women born in the East.

Interestingly, the stage distribution for breast cancer in Asian women closely resembles that of white women (see appendix A, figure 1). A study Hsu, Glaser, and West (1997) also found that when Asian race was stratified by subgroup the percentage of those diagnosed at each stage still closely resembled the distribution for white women. However, a study conducted by Li, Malone, and Daling (2003) found that among subgroups of Asian race, Japanese women were less likely to be diagnosed with late stage
breast cancer compared to non-Hispanic whites (OR: 0.7, 95% CI: 0.5-0.9).

Unfortunately, limited literature is available regarding breast cancer stage at diagnosis among Asians, particularly among subgroups.

**Colorectal Cancer and Hispanic Ethnicity**

Among Hispanics, colorectal cancer is the second most common cancer in both men and women (American Cancer Society, 2014c). Colorectal cancer is also the leading cause of cancer death in Hispanic men and the third leading cause of cancer death in Hispanic women (American Cancer Society, 2014c). However, even with clear evidence supporting the effectiveness of screening in the prevention and early identification of colorectal cancer, utilization remains low among Hispanics (Fenton et al., 2008; Pollack et al., 2006; Shah, Zhu, & Potter, 2006; Thompson et al., 2005).

Similar to factors affecting breast cancer screening, Shah, Zhu, and Potter (2006) found that Hispanics with lower acculturation were more likely than Hispanics with moderate to high acculturation to have not received a fecal occult blood test within the past year or an endoscopy within the last five years (85%, 80.3%, and 73.6%, respectively). After adjusting for sociodemographic factors, Hispanics with higher acculturation were still 51% less likely to have not received a fecal occult blood test within the last year or endoscopy within the previous five years, compared to lower acculturated Hispanics (OR=0.49, 95% CI=0.34-0.72). Also, Thompson et al. (2005) showed that Hispanics were less likely than non-Hispanic whites to have ever received a fecal occult blood test (40.6% versus 55.7, p=0.003) or a sigmoidoscopy/colonoscopy (26.9% versus 44.4%, p=0.001). Not having health insurance coverage and low education
were found to be important factors in never having received colorectal cancer screening among this population.

Further, Hispanics are also more likely to be diagnosed with late stage colorectal cancer than non-Hispanic whites (Chien et al., 2005; Stefanidis et al., 2006). A study by Chien et al. (2005) found that Hispanics were 20%-40% (p<0.05) more likely to be diagnosed with stage IV colorectal cancer than non-Hispanic whites, after adjusting for age at diagnosis, year of diagnosis, and SEER registry. Similarly, Stefanidis and colleagues (2006) found that Hispanics had a greater incidence of stage IV colorectal cancer compared to non-Hispanic whites (32% versus 19%; p = 0.02).

**Colorectal Cancer and Race**

In addition to ethnicity, colorectal cancer rates also vary considerably by race. In the U.S., black men and women have the highest rates of colorectal cancer (62.3 and 47.5 per 100,000 person-years, respectively). Comparatively, white men and women experience 49.6 and 37.3 new cases per 100,000 person-years while Asian/Pacific Islander men and women experience 43.1 and 32.0 new cases per 100,000 person-years (National Cancer Institute, 2014d). Further, nearly 1 in 41 black men and 1 in 44 black women will die of colorectal cancer within their lifetime, versus 1 in 48 white men and 1 in 53 white women (American Cancer Society, 2013a). In fact, for every stage of colorectal cancer, blacks have a lower probability of five year cause-specific survival (local: 87.2%, regional: 64.7%, distant: 9.7%) compared to whites (local: 89.3%, regional: 70.0%, distant: 13.0%) (Siegel, Desantis, & Jemal, 2014).
Prior to the late 1980’s, colorectal cancer was more common among whites than blacks; however, over time the racial inequality has reversed (American Cancer Society, 2013a). This change in disparity has been primarily attributed to screening, where guideline recommended colorectal screening rates among those 50 years and older are lower in blacks compared to whites (56% vs. 62%, respectively) (DeSantis, 2013). Due to this, 40% of colorectal cancer in whites is diagnosed at the local stage, while only 36% of colorectal cancer in blacks is diagnosed at the same stage (American Cancer Society, 2013a). Differences in screening utilization as well as treatment have shown to explain over half of the racial inequality seen in colorectal cancer mortality rates (American Cancer Society, 2013a).

Numerous studies have shown that blacks are more likely to be diagnosed at a more advanced stage of colorectal cancer than whites (Chien et al., 2005; Doubeni et al., 2007; Mostafa et al., 2004; Wassira et al., 2013; Wu et al., 2001). Chien et al. (2005) found that blacks were 40% more likely to be diagnosed with late stage colorectal cancer compared to whites (OR: 1.40, 95% CI: 1.40-1.50, p<0.05). Further, a study by Lieberman et al. (2014) found that compared to white men, black men had a higher prevalence of large polyps (>9mm) in the following age groups; 50-54 years (7.1% vs. 6.2%, OR: 1.17, 95% CI: 1.02-1.35), 60-64 years (11.5% vs. 8.6%, OR: 1.38, 95% CI: 1.18-1.61), and 65-69 years (12.0% vs. 9.7%; OR: 1.27; 95% CI: 1.09-1.56). Further, compared to white women, black women had a higher prevalence of large polyps between the ages of 50-54 years (5.2% vs. 4.2%, OR: 1.25, 95% CI: 1.06-1.47), 55-59 years (6.6% vs. 4.5%, OR: 1.51, 95% CI: 1.25-1.82), and 60-64 years (6.9% vs. 5.2%; OR: 1.35; 95% CI: 1.09-1.67). The presence of large polyps was used as a proxy for
advanced neoplasia. The authors state that these data provide evidence for the need to intensify colorectal screening efforts among blacks.

Conversely, Asian/Pacific Islanders have the lowest incidence and mortality rates for colorectal cancer compared to blacks and whites (Siegel, Desantis, & Jemal, 2014). The stage at which Asians/Pacific Islanders are diagnosed with colorectal cancer also closely resembles that of whites. 39% of Asian/Pacific Islanders are diagnosed at the local stage, 38% are diagnosed at the regional stage, and 19% are diagnosed at the distant stage. Comparatively, 40% of whites are diagnosed at the local stage, 36% are diagnosed at the regional stage, and 19% are diagnosed at the distant stage (Siegel, Desantis, & Jemal, 2014). However, Asian/Pacific Islanders have greater 5-year survival for all stages of colorectal cancer (local: 92.3%, regional: 74.3%, distant: 15.7%) compared to whites (local: 89.3%, regional: 70.0%, distant: 13.0%) (Siegel, Desantis, & Jemal, 2014). Interestingly, colorectal cancer screening among those 50 years and older is substantially lower among Asians than whites (45.9% versus 61.5%, respectively) (Siegel, Desantis, & Jemal, 2014).

Among subgroups of Asian race, Chien et al. (2005) found that Japanese individuals were less likely to be diagnosed with late stage colorectal cancer (OR: 0.80, 95% CI: 0.70-0.90, p<0.05) while Filipinos (OR: 1.20, 95% CI: 1.10-1.40, p<0.05) and Hawaiians (OR: 1.6, 95% CI: 1.2-2.0, p<0.05) were more likely to be diagnosed with late stage colorectal cancer compared to whites, though the sample sizes for Asian subgroups analyzed were small. Screening rates have also been shown to vary among subgroups of Asian race. Lee et al. (2011) found that Koreans (OR: 0.60, 95% CI: 0.50-0.80, p<.001), Filipinos (OR: 0.60, 95% CI: 0.50-0.80, p<.001), and South Asians (OR: 0.60, 95% CI:
0.40-0.90, p<0.05) were significantly less likely to be screened for colorectal cancer than non-Hispanic whites. These disparities persisted even after the authors adjusted for relevant confounding variables, such as insurance status, English proficiency, usual source of care, and poverty income ratio.

**Research Gaps**

While there are a considerable number of studies examining cancer stage at diagnosis in Hispanics versus non-Hispanics, the Hispanic community is comprised of “many diverse subgroups with distinct cancer patterns” that require closer examination (Siegel, 2012). Previous literature substantially lacks in examining the heterogeneity of cancer burden among subgroups of Hispanic ethnicity.

In addition, a majority of the previous literature does not adjust for foreign birthplace, which has been shown to be an important predictor of cancer screening and access to care (Goel et al., 2003). New York State presents a unique opportunity to investigate differences in cancer stage at diagnosis among foreign-born and native individuals, as 22% of the population is foreign-born compared to 12.9% for the U.S. overall (U.S. Census Bureau, 2014).

Further, previous studies of this nature have not consistently adjusted for tumor characteristics such as laterality, histology, and grade. With regards to breast cancer, tumor characteristics have been shown in previous studies to affect the efficacy of mammographic screening (Ma et al., 1992; Porter et al., 1999; Roubidoux et al., 2004). For example, lobular carcinomas are less likely to appear on a mammogram (College of American Pathologists, 2010). Due to the potential effect tumor characteristics have on
the ability of mammography to detect breast cancer, these factors are important to consider when assessing cancer stage at diagnosis.

Research Objectives

The objective of this study is to analyze the association between Hispanic ethnicity subgroups, related sociodemographic factors, and stage at diagnosis for invasive female breast and colorectal cancer. The U.S. Hispanic population is projected to increase to 128.8 million by 2060, and 21.2% of these individuals will be over 65 years of age (U.S. Census Bureau, 2012). As the aging Hispanic population increases, it is imperative to better understand what factors contribute to delayed cancer diagnosis, as this impacts both treatment and survival outcomes.

Data from the New York State Cancer Registry will be used to assess the relationship between Hispanic ethnicity and cancer stage at diagnosis. Further, this data will allow for an evaluation of whether this association is confounded or modified by birthplace, age, race, marital status, and/or tumor characteristics. 2006-2010 American Community Survey (ACS) five year estimates will also be used to further assess potential confounding by census tract level variables of interest. The analyses will be performed separately for breast and colorectal cancer due to the availability and routine use of screening tests to identify these cancers, in addition to their high incidence and survival rates.
METHODS

Study Population

Public Health Law Section 2401 requires that all health care providers and laboratories in New York State report every case of cancer or malignant disease to the Department of Health (New York State Department of Health, 2013). The data for this analysis are comprised of invasive cases of breast and colorectal cancer diagnosed between 2004 and 2011 and reported to the New York State Cancer Registry. The 2010 census tract for each patient’s residence was used to link 2006-2010 ACS five year estimates to the New York State Cancer Registry data.

Specific information regarding step by step exclusion is provided in Appendix C, figure 1. A total of 197,022 individuals were eligible after restricting the analysis to the first primary tumor for each patient. Additionally, patients missing census tract information were excluded as they could not be linked to the census data (n=1,556). Patients were also excluded if the only available evidence of Hispanic ethnicity was a Spanish surname (n=627). According the U.S. Census Bureau (1963), surnames are common to numerous languages making it impossible to categorize surnames as Spanish or non-Spanish. Additionally, there has been Anglicization of initially Spanish surnames. Previous literature has shown that using only a Spanish surname as an indicator for Hispanic ethnicity has limited accuracy (Perez-Stable et al., 1995).

Since the primary outcome of interest was invasive breast and colorectal cancer all patients who were missing a SEER cancer stage diagnosis or were diagnosed with in situ cancer were excluded. The data were then restricted to patients 18 years of age and
older. Due to the rare incidence of breast cancer among men the breast cancer study population was also restricted to women. This resulted in a final sample size of 91,319 for the breast cancer analysis. The colorectal cancer analysis, which includes both sexes, had a final sample size of 58,484.

**Variables**

Variables obtained at the individual level through the New York State Cancer Registry were age, birthplace, ethnicity, race, sex, disease stage at diagnosis, marital status, and tumor characteristics (histology, grade, and laterality). The New York State Cancer Registry collects data according to the North American Association of Central Cancer Registries (NAACCR) volume II version 13 criteria. The data for the diagnosis years reported in this study meet NAACCR gold certification. This means that (1) case ascertainment achieved 95% or higher completeness, (2) all data variables used to create incidence statistics by cancer type, sex, race, age, and county are 100% free of error, (3) less than 2% of the cases are missing information on age, sex, and county, and (4) less than 3% of the cases are missing information on race (US only) (NAACCR, 2014; New York State Department of Health, 2013).

Variables obtained at the population level using 2006-2010 ACS five year estimates included percent with no college education, percent with low English proficiency, population density, and median household income. These covariates are reported at the census tract level in which the individual resided at the date of cancer diagnosis.
Ethnicity

Ethnicity was categorized as non-Hispanic, Mexican, Puerto Rican, Cuban, Central or South American, Dominican Republic, other specific Hispanic origin, Spanish not otherwise specified (NOS), and Spanish surname only. Ethnicity was obtained by birth place or was self-reported. Individuals with ‘Spanish surname only’ were excluded from the analysis. ‘Other specific Hispanic origin’ and ‘Spanish, NOS’ were merged to create an ‘other Hispanic’ category.

Race


Birthplace

Birthplace was categorized as foreign-born or native-born. Only individuals born within the United States were considered native-born. Native-born status was imputed for missing values. Based on previous observations, the New York State Cancer Registry has
found that native-born individuals are more likely than foreign-born individuals to exclude place of birth when completing medical documentation (F. Boscoe, personal communication, July 16, 2014). In addition, Gomez and Glaser (2005) found that in a SEER population-based cancer registry unrecorded birthplace among Hispanics was associated with factors such as English language preference and U.S. birthplace. Further, within the New York State Cancer Registry data, persons missing birthplace information and native-born individuals tend to be more similar with regards to sociodemographic characteristics. A comparison of native-born, foreign-born, and those with missing nativity was performed using the variables age, race, and ethnicity. For these study populations, the distributions of individuals missing birthplace more closely resembled native-born individuals than foreign born (see appendix C, figures 2-4).

Age

Age refers to the age of an individual at the date of the cancer diagnosis, expressed in years.

Grade

Grade refers to the amount of differentiation of the tumor. It is a measure of how much the tumor cells look like the cells of the organ of origin. The variable is categorized as grade I-IV. Grade I refers to well-differentiated cells, grade II refers to moderately differentiated cells, grade III refers to poorly differentiated cells, and grade IV refers to undifferentiated cells (National Cancer Institute, n.d.a). Well-differentiated cells closely resemble normal cells while undifferentiated cells are abnormal compared to surrounding cells and tissue (National Cancer Institute, 2013).
**Histology**

Histologic type of the tumor was reported using the International Classification of Diseases for Oncology (ICD-O), third edition. For the breast cancer analysis, histology was categorized as either ‘ductal or lobular’ or ‘other neoplasm’. Invasive ductal carcinoma comprises 65%-80% of all breast cancer cases while invasive lobular carcinoma accounts for 10%-15% of all breast cancer cases (College of American Pathologists, 2010; College of American Pathologists, 2011). Other histologic types include colloid (mucinous), medullary, micropapillary, papillary, and tubular (Argani & Cimino-Mathews, 2012). Due to the rarity of histologic types other than ductal or lobular, the presence of a histologic type other than invasive ductal or lobular carcinoma was categorized as ‘other neoplasm’.

For the colorectal cancer analysis, histology was categorized as ‘adenoma or adenocarcinoma’ or ‘other neoplasm’. Since adenocarcinomas represent over 95% of all colorectal cancers cases, the presence of any other histologic type other than adenoma or adenocarcinoma was categorized as ‘other neoplasm’ (American Cancer Society, 2014).

**Laterality**

Laterality refers to the side of the body on which the tumor originally developed. Laterality was reported as; (1) not a paired organ, (2) right: origin of primary, (3) left: origin of primary, (4) only one side involved, (5) bilateral involvement, and (6) paired site, midline tumor. Due to particularly small sample sizes among some of the subgroups for laterality, the variable was condensed into fewer categories. For the breast cancer analysis, laterality was categorized into three groups; right: origin of primary, left: origin of primary, and other. For the colorectal cancer analyses, laterality was defined using
three categories; not a paired organ, right: origin of primary, left: origin of primary.

**Marital Status**

Marital status was categorized as (1) single, (2) married, (3) separated or divorced, and (4) widowed. It refers to the marital status of the individual at the date of the cancer diagnosis.

**Median Household Income**

Median household income was retrieved using 2006-2010 ACS five year estimates. It refers to the median household income over the last twelve months of the census tract within which the individual resided at the date of cancer diagnosis.

**No College Education**

No college education was retrieved using 2006-2010 ACS five year estimates. It refers to the percent of individuals ages 25 and older in each census tract who have completed high school but have not attended college.

**Poor English Proficiency**

Poor English proficiency was retrieved using 2006-2010 ACS five year estimates. It refers to the percent of people ages 18-64 in each census tract who reported speaking a language other than English and speaking English “not well” or “not at all”.

**Poverty Level**

Poverty level was retrieved using 2006-2010 ACS five year estimates. Following the practice of previous census publications, a census tract was considered a “poverty area” if the poverty rate was 20% or higher (Bishaw, 2011). Individuals living in poverty
are typically found to be clustered in particular neighborhoods as opposed to being evenly dispersed across geographic areas (Bishaw, 2011).

**Sex**

Sex was categorized as (1) male, (2) female, (3) other (hermaphrodite), (4) transsexual, and (5) not stated/unknown. All study subjects eligible for inclusion identified themselves as either male or female.

**Stage**

SEER summary stage 2000 coding was used to define disease stage at diagnosis. Categories include; (1) in situ, (2) local, (3) regional, (4) distant, and (5) unknown. In situ refers to the existence of malignant cells within the cell group from which they developed without evidence of metastasis to the basement membrane of the tissue or stromal invasion (National Cancer Institute, n.d.b). Cancer at the local stage has penetrated through the basement membrane but is still contained within the organ of origin (National Cancer Institute, n.d.b).

Regional cancer has spread beyond the originally affected organ. Regional staging is broadly defined and includes; (1) regional by direct extension only, (2) regional lymph nodes involved only, (3) regional by both direct extension and lymph node involvement, and (4) regional, NOS. Cancer at the distant stage has spread from the organ of origin and begun growing in previously unaffected parts of the body (National Cancer Institute, n.d.b). Typical sites of distant metastatic cancer are the liver, lung, brain, and bones due to the blood flow these organs receive from all parts of the body, making them more susceptible to metastases (National Cancer Institute, n.d.b).
Study Design and Statistical Analyses

The analyses used a cross-sectional, case-only study design. Separate analyses were performed for breast and colorectal cancer. All individual level variables were collected at the time of or subsequent to cancer diagnosis. Additionally, census tract level variables reference where the individual resided at the time of diagnosis. SAS software version 9.3 was used to perform the statistical analyses.

Descriptive analyses were used to summarize breast and colorectal cancer cases’ sociodemographic and clinical characteristics including age, birthplace, ethnicity, race, disease stage at diagnosis, marital status, histology, grade, laterality, percent with no college education, percent with low English proficiency, population density, and median household income (see appendix A, table 1 and appendix B, table 1). Chi square statistics were used to investigate the relationship between categorical variables. A correlation test was performed on continuous variables. For the dichotomous variable sex, a two-sample t-test was performed.

Multinomial logistic regression was used to examine the association between Hispanic ethnicity, other sociodemographic factors of interest, and disease stage at diagnosis, with local stage cancer as the reference group for all analyses. P-values were two-sided with an alpha level of 0.05. A complete case analysis was performed which omits any observation that has a missing variable from the analysis (He, 2010). Using manual backwards selection sex was removed from the colorectal cancer model due to statistical insignificance. Since a mixed model was not used, census tract level covariates were only used for the purpose of assessing confounding and were not examined as predictors of stage at diagnosis.
Variables that changed the odds ratio by 10% or more were considered confounders and retained in the models. For both the breast and colorectal cancer analyses, age and birthplace were confounders. Likelihood ratio tests were used to assess interactions between Hispanic ethnicity and race in relation to disease stage at diagnosis. Based on an alpha level of 0.05, race was an effect modifier for both the breast and colorectal cancer analyses. Since the effect of Hispanic ethnicity on disease stage at diagnosis varied by levels of race, the final results for both the breast and colorectal cancer analyses were stratified by race. This resulted in separate models for whites and blacks. Due to the empty and particularly small cell sizes for Hispanic ethnicity and numerous covariates for the ‘other race’ category, a stratified analysis was not performed for this subgroup of race.
RESULTS

Breast Cancer Analysis

Among those with breast cancer were 82,764 non-Hispanics, 245 Mexicans, 1,448 Puerto Ricans, 169 Cubans, 1,746 Central/South Americans, 1,182 Dominicans, and 3,765 other Hispanics (see appendix A, table 1). The average age at diagnosis was 60.3. Mexicans had the youngest average age at diagnosis (49.8 years) while Cubans had the oldest average age at a diagnosis (65.7 years). Those who reported White race ranged from 72.3% among Dominican Republic to 91.9% among Puerto Ricans.

Those who reported being married ranged from 32.7% among Puerto Ricans to 53.5% among non-Hispanics. In contrast, those who reported being single ranged from 18.8% among non-Hispanics to 39.9% among other Hispanics. The proportion of those who were foreign-born ranged from 5.7% for other Hispanics to 97.3% for Central/South Americans. Interestingly, those living in high poverty census tracts varied substantially across subgroups of Hispanic ethnicity, with only 15.9% of non-Hispanics living in high poverty census tracts compared to 69% for Dominicans. Most women were diagnosed with local or regional stage cancer, though Puerto Ricans and Cubans had the highest proportion of distant stage breast cancer at diagnosis (8.1% and 9.5%, respectively).

Among whites, Puerto Ricans (odds ratio [OR] =1.22, 95% confidence interval [CI] =1.06-1.39), Dominicans (OR=1.23, 95% CI=1.04-1.45), and other Hispanics (OR=1.12, 95% CI =1.03-1.22) were 22%, 23%, and 12% more likely to be diagnosed with regional stage breast cancer than local stage breast cancer compared to non-Hispanics, respectively (see appendix A, table 2). In contrast, Cubans (OR=0.61, 95% CI
were 39% less likely to be diagnosed with regional stage breast cancer than local stage breast cancer compared to non-Hispanics. Further, other Hispanics (OR=0.77, 95% CI= 0.62-0.95) were 23% less likely to be diagnosed with distant stage breast cancer than local stage breast cancer compared to non-Hispanics. No significant associations were observed for Mexicans and Central/South Americans with regional stage disease or for Mexicans, Puerto Ricans, Cubans, or Central/South Americas with distant stage disease.

Compared to native-born white individuals, foreign-born whites were 35% more likely to be diagnosed with regional stage breast cancer and 34% more likely to be diagnosed with distant stage breast cancer (regional stage: OR=1.35, 95% CI=1.27-1.43; distant stage: OR=1.34, 95% CI=1.17-1.53). Further, those who reported being married were 8% less likely to be diagnosed with regional stage disease (OR=0.92, 95% CI=0.87-0.97) and 44% less likely to be diagnosed with distant stage disease (OR=0.56, 95% CI=0.50-0.62) compared to those who reported being single.

Among blacks, Central/South Americans (OR=0.72, 95% CI=0.53-0.98) were 28% less likely than non-Hispanics to be diagnosed with regional stage breast cancer compared to local stage breast cancer (see appendix A, table 3). Dominicans (OR=0.46, 95% CI=0.25-0.84) were 54% less likely than non-Hispanics to be diagnosed with distant stage breast cancer than local stage breast cancer compared to non-Hispanics. No significant associations were observed for Mexicans, Puerto Ricans, Cubans, Dominicans, and other Hispanics with regional stage disease or for Mexicans, Puerto Ricans, Cubans, Central/South Americans, or other Hispanics with distant stage disease.
Compared to native-born black individuals, foreign-born blacks were 28% more likely to be diagnosed with regional stage breast cancer and 71% more likely to be diagnosed with distant stage breast cancer (regional stage: OR= 1.28, 95% CI=1.16-1.40; distant stage: OR=1.71, 95% CI=1.45-2.01). Those who reported being married were 11% less likely to be diagnosed with regional stage disease (OR=0.89, 95% CI=0.81-0.98) and 45% less likely to be diagnosed with distant stage disease (OR=0.55, 95% CI=0.45-0.66) compared to those who reported being single.

**Colorectal Cancer Analysis**

The sample included 52,882 non-Hispanics, 131 Mexicans, 1,474 Puerto Ricans, 171 Cubans, 963 Central or South Americans, 733 Dominican Republics, and 2,130 other Hispanics (see appendix B, table 1). The average age at diagnosis was 67.3. Mexicans had the youngest average age at diagnosis (53.3 years) while Cubans had the oldest age at diagnosis (72.4 years). Those reported who reported white race ranged from 67.3% among Dominicans to 92.9% among Puerto Ricans. Those who reported being married ranged from 39.0% among Puerto Ricans to 54.6% among Mexicans. In contrast, those who reported being single ranged from 19.1% among non-Hispanics to 34.6% among other Hispanics.

Interestingly, the proportion of those living in high poverty census tracts ranged from 18.5% among non-Hispanics to 68.6% among Dominicans. The proportion of those who were foreign-born ranged from 7.3% for other Hispanics to 97.1% for Central/South Americans. The proportion of males included in the analysis ranged from 46.8% among Dominicans to 61.8% among Mexicans. While a majority of the cases were diagnosed with local and regional stage cancer, Puerto Ricans, Dominicans, and Cubans had the
highest proportion of distant stage colorectal cancer at diagnosis (32.2%, 27.7%, and 27.5%, respectively) (see appendix B, table 1).

Among whites, Puerto Ricans (OR=1.29, 95% CI=1.10-1.51), Central and South Americans (OR=1.28, 95% CI=1.05-1.55), and other Hispanics (OR=1.20, 95% CI=1.06-1.35) were 29%, 28%, and 20% more likely to be diagnosed with regional stage colorectal cancer than local stage colorectal cancer compared to non-Hispanics, respectively (see appendix B, table 2). Additionally, Puerto Ricans (OR=1.92, 95% CI=1.61-2.30) and Dominicans (OR=1.50, 95% CI=1.12-2.01) were 92% and 50% more likely to be diagnosed with distant stage colorectal cancer than local stage colorectal cancer compared to non-Hispanics. No significant associations were observed for Mexicans, Cubans, and Dominicans with regional stage disease or for Mexicans, Cubans, Central/South Americans, or other Hispanics with distant stage disease. Compared to adenomas and adenocarcinomas, those with other histologic types were 62% more likely to be diagnosed with regional stage disease (OR= 1.62, 95% CI= 1.51-1.71) and 64% more likely to be diagnosed with distant stage disease (OR=1.64, 95% CI=1.50-1.79).

Compared to native-born individuals, foreign-born persons were 23% more likely to be diagnosed with regional stage colorectal cancer and 34% more likely to be diagnosed with distant stage colorectal cancer (regional stage: OR= 1.23, 95% CI=1.14-1.32; distant stage: OR= 1.34, 95% CI=1.22-1.47). Those who reported being married were 12% less likely (OR=0.88, 95% CI=0.82-0.94) to be diagnosed with regional stage disease and 18% less likely to be diagnosed with distant stage disease (OR=0.82, 95% CI=0.76-0.89) compared to those who reported being single (see appendix B, table 2).
Among blacks, Dominicans (OR=0.51, 95% CI=0.32-0.81) and other Hispanics (OR=0.56, 95% CI=0.35-0.90) were 49% and 44% less likely to be diagnosed with distant stage colorectal cancer than local stage colorectal cancer compared to non-Hispanics (see appendix B, table 3). No other significant associations were observed among blacks with colorectal cancer by ethnicity. Compared to adenomas and adenocarcinomas, those with other histologic types were 75% more likely to be diagnosed with regional disease (OR=1.75, 95% CI=1.46-2.10) and 46% more likely to be diagnosed with distant stage disease (OR=1.46, 95% CI=1.18-1.81).

Compared to native-born individuals, foreign-born individuals were 19% more likely to be diagnosed with regional stage colorectal cancer and 53% more likely to be diagnosed with distant stage colorectal cancer (regional stage: OR= 1.19, 95% CI=1.03-1.38); distant stage: OR=1.53, 95% CI=1.29-1.80). Those who reported being married were 27% less likely to be diagnosed with distant stage colorectal cancer compared to those who reported being single (OR=0.73, 95% CI=0.62-0.85) (see appendix B, table 3).
DISCUSSION

Previous studies have shown that Hispanics are more likely to present with late stage breast and colorectal cancer than non-Hispanics whites. The findings of this study expand on previous research by demonstrating that the probability of being diagnosed with late stage breast or colorectal cancer also varies substantially among subgroups of Hispanic ethnicity. Among whites, Puerto Ricans, Central/South Americans, and Dominicans were more likely to be diagnosed with regional or distant stage breast cancer, and Puerto Ricans, Cubans, Central/South Americans, and Dominicans were more likely to be diagnosed with regional or distant stage colorectal cancer, compared to non-Hispanic whites. Further, among blacks, Central/South Americans were more likely to be diagnosed with regional or distant stage colorectal cancer, compared to non-Hispanic blacks.

Conversely, among whites, Cubans were less likely to be diagnosed with regional or distant stage breast cancer and Mexicans were less likely to be diagnosed with regional or distant stage colorectal cancer, compared to non-Hispanic whites. Among blacks, Central/South Americans, Dominicans, and other Hispanics were less likely to be diagnosed with regional or distant stage breast cancer, and Dominicans were less likely to be diagnosed with regional or distant stage colorectal cancer, compared to non-Hispanic blacks. The study also showed that foreign-born Hispanics were at higher risk for presenting with late stage breast and colorectal cancer than native-born Hispanics.

These findings coincide with previous research conducted by Li, Malone, and Daling (2003), which found that white Puerto Ricans and Central/South Americans were more likely to present with late stage breast cancer compared to non-Hispanic whites.
Though, Li, Malone, and Daling (2003) only reported associations for white Hispanics compared to non-Hispanic whites and did not provide statistics for black Hispanics. Additionally, previous studies concluded that foreign-born Hispanics were less likely to be diagnosed at an early stage of breast cancer than native-born Hispanics, which also correspond with these study results (Hedeen & White, 2001; Kouri et al., 2010). However, while previous studies have shown that Hispanics are more likely to be diagnosed with late stage colorectal cancer than non-Hispanic whites (Chien et al., 2005; Stefanidis et al., 2006), the results of this study show that certain subgroups of Hispanic ethnicity, such as white Mexicans and black Dominicans, are actually less likely to be diagnosed with regional or distant stage colorectal cancer.

It is crucial to better understand how and why cancer burden differs between Hispanic ethnic groups. In 2004, Goldman and Risica conducted qualitative interviews with immigrant Dominicans and Puerto Ricans to assess perspectives on breast and cervical cancer risk and screening. The authors found that while participants were familiar with mammography and Pap testing, they did not receive regular screening and did not fully understand screening recommendations. While many participants felt they had adequate information about breast and cervical cancer risk and screening, this frequently did not correspond with participants actually having the correct information to make properly informed decisions regarding screening. In addition, Goldman, Diaz, and Kim (2009) interviewed immigrant Dominicans and Puerto Ricans regarding viewpoints on colorectal cancer risk and screening. The authors found that stigma, misperceptions, and embarrassment were among the potential barriers to colorectal cancer screening.
A recent review of five studies by Gonzalez et al. (2010) that assessed interventions promoting colorectal cancer screening in the Hispanic population found that culturally targeted interventions improved colorectal cancer awareness and screening rates among the Hispanic population. Interventions such as culturally tailored brochures, telephone counseling, and videos on screening options have all been shown to be effective in improving colorectal cancer awareness and screening rates. Unfortunately, few studies exist which examine colorectal screening in Hispanics, let alone subgroups of Hispanic ethnicity. Further research is needed to determine if targeted education and screening programs could increase early detection rates among vulnerable subgroups, which in turn, could have a substantial impact on treatment success and survival.

**Strengths and Limitations**

This study is one of the few to examine the association between subgroups of Hispanic ethnicity and cancer stage at diagnosis. A major strength of this study was the analysis of a larger number of Hispanic ethnicity subgroups than previous research as well as the stratification of these analyses by race. Further, a strength of the use of data from the New York State Cancer Registry, which meets the highest standard for all measures of data quality with the NAACCR (New York State Department of Health, 2013). The overall completeness of the New York State Cancer Registry data resulted in little missing case information in the analysis. Additionally, since the reporting of cancer cases by physicians, dentists, laboratories, and other health care providers in New York State is required, the results of this study demonstrate the incidence of invasive female breast and colorectal cancer within the state.
In addition, New York State’s large foreign-born population allowed for an examination of the effect of birthplace, which was found to be a statistically significant predictor of cancer stage at diagnosis. Further, this study was able to assess if tumor characteristics such as histology, grade, and laterality were confounders of the observed associations between Hispanic ethnicity and cancer stage at diagnosis, which has not been examined in previous studies of this nature. Lastly, since Hispanic ethnicity and race do not change over time, the absence of longitudinal data is not a limitation for these analyses.

However, it is important to note several limitations of this study. To begin with, additional potential confounders could exist which we were unable to adjust for because of the unavailability of these data, such as individual level socioeconomic status, use of cancer screening tests, access to health care, and family history of cancer. Further, there were particularly small sample sizes for the Mexican and Cuban subgroups of Hispanic ethnicity for both breast and colorectal cancer. There was also not a large enough sample size to examine the modifying effect of races other than white and black. In addition, since the study did not utilize a mixed model approach, variables extracted from the 2006-2010 ACS five year estimates could only be used for the purposes of assessing confounding, and could not be used to infer associations between the census tract level covariates and female breast or colorectal cancer stage.

Further, results regarding Dominicans may be subject to misclassification bias. Overall, 73% of Dominicans identify as mixed race, 16% identify as white, and 11% identify as black (Central Intelligence Agency, 2014). However, mixed race was not a category available for selection. Among breast cancer cases, 72.3% of Dominicans
identified as white, 27.1% identified as black, and 0.5% identified as other race. Among, colorectal cancer cases, 67.3% identified as white, 32.4% identified as black, and 0.3% identified as other race. Therefore, the race distribution of the breast and colorectal cancer cases do not reflect what is seen in the general population. Also, due to a history of tense relations between Haitians and Dominicans, some Dominicans do not want to identify as black, as the racial category is seen as synonymous with Haitian, which can further exacerbate the issue of misclassification of race among Dominicans (Itzigsohn & Dore-Cabral, 2000; Sagas, n.d.). These factors likely produced a misclassification bias for the Dominican subgroup of Hispanic ethnicity.

Lastly, the covariate birthplace was missing for 31% of the breast cancer cases and 27% of the colorectal cancer cases. Due to this, native-born status was imputed on missing values. However, while this covariate had a high proportion of missing values, Gomez and Glaser (2005) found that in a SEER population-based cancer registry unrecorded birthplace among Hispanics was associated with factors such as English language preference and U.S. birthplace.

**Future Studies**

Important potential confounders, such as individual level socioeconomic status, use of cancer screening tests, access to healthcare, and family history of cancer, should be assessed to provide insight into how certain sociodemographic, lifestyle, and biological factors may contribute to delayed diagnosis among Hispanic subgroups. This could provide insight into potential barriers to early detection of breast and colorectal cancer among Hispanics and if these factors also differ by subgroup. Also, future research should provide an assessment of the variation of stage at diagnosis in breast and
colorectal cancer using rates. All previous studies conducted on this topic have only compared disease stage proportions, as opposed to rates by stage.

Future studies should also examine how treatment regimens and survival rates differ among subgroups of Hispanic ethnicity to better understand the implications of late stage diagnosis and its effect on risk of mortality. It is important to determine whether the observed differences in stage at diagnosis among Hispanic subgroups also translate into significant differences in survival with breast and colorectal cancer.

Additional research is also needed to better understand stage distribution as well as risk factors for delayed diagnosis of breast and colorectal cancer among Asian Hispanics. The number of Asian Hispanics in the U.S. is steadily rising. In 2000, 111,829 individuals identified as Asian Hispanic, which rose to 209,128 in 2010 (598,146 when including Asians who reported multiple races) (Grieco & Cassidy, 2001; Humes, Jones, & Ramirez, 2011). So far, previous studies have shown that subgroups of Asian race are significantly more likely to be diagnosed with late stage breast and colorectal cancer than non-Hispanic whites (Li, Malone, & Daling, 2003; Chien et al., 2005).

Further, since foreign-born Hispanics were more likely than native-born Hispanics to be diagnosed with both late stage breast and colorectal cancer, it is important to explore the potential barriers to screening and access to care that may be present among Hispanic immigrants. Additional research is needed to see if these associations are still present after adjusting for factors that could be related to immigrant status, such as socioeconomic status, use of cancer screening tests, and access to healthcare. If acculturation proves to be a significant obstacle to early cancer detection,
targeted screening programs may also be warranted for recently immigrated Hispanics.

Conclusions

Hispanics comprise a heterogeneous ethnic group with differing breast and colorectal cancer burdens. In this study, Hispanics who are foreign-born were more likely to present with advanced stage disease compared to non-Hispanics. In addition, Puerto Ricans, Central/South Americans, and Dominicans were more likely to present with late stage breast and colorectal cancer than non-Hispanic whites. Factors such as low socioeconomic status, access to medical care, misperceptions about testing and screening measures, cancer screening awareness and utilization, and acculturation may play important roles in these disparities, though further research is needed. Based on previous literature regarding Hispanics, targeted education and screening programs could improve early diagnosis rates among these more vulnerable subgroups (Gonzalez et al., 2010).
APPENDIX A. BREAST CANCER DATA

Figure 1. Breast Cancer Stage Distribution by Race

Stage Distribution (SEER Summary Stage 2000), by Race, Female Breast, All Ages, 2002-2011

- Excludes in situ and unstaged cancer cases
- Data retrieved from National Cancer Institute, Surveillance Research Program. Fast Stats: An interactive tool for access to SEER cancer statistics, 2002-2011
Table 1. Population Characteristics of Breast Cancer Cases by Ethnicity from New York State Cancer Registry, 2004-2011 (N=91,319)

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<th>Puerto Rican</th>
<th>Cuban</th>
<th>Central/South American</th>
<th>Dominican Republic</th>
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<tr>
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<tr>
<td>White</td>
<td>79.2%</td>
<td>91.0%</td>
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<td>14.1%</td>
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<tr>
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<td>Ductal &amp; Lobular</td>
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<td>96.3%</td>
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<td>91.6%</td>
<td>92.3%</td>
<td>92.9%</td>
<td>93.3%</td>
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<td>7.5%</td>
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<td>7.7%</td>
<td>7.1%</td>
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<tr>
<td>Right: origin of primary</td>
<td>48.9%</td>
<td>50.6%</td>
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<td>49.6%</td>
<td>47.4%</td>
<td>48.6%</td>
</tr>
<tr>
<td>Left: origin of primary</td>
<td>50.8%</td>
<td>49.4%</td>
<td>52.7%</td>
<td>47.3%</td>
<td>50.3%</td>
<td>52.2%</td>
<td>51.2%</td>
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<td>6.9%</td>
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<td>$187,501-$250,001</td>
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<td>No College Education*</td>
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<td>0%-25%</td>
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<td>40.1%</td>
</tr>
<tr>
<td>26%-50%</td>
<td>63.4%</td>
<td>60.0%</td>
<td>64.9%</td>
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<td>51%-75%</td>
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<td>76%-100%</td>
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<tr>
<td>Poor English Proficiency*</td>
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<td>0%-5%</td>
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<td>96.5%</td>
<td>97.6%</td>
<td>95.3%</td>
<td>97.8%</td>
<td>97.0%</td>
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<td>4.2%</td>
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</tr>
<tr>
<td>11%-15%</td>
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<td>0%</td>
<td>0.5%</td>
<td>0%</td>
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</tr>
<tr>
<td>16%-20%</td>
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<td>0%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Population Density</td>
<td></td>
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<tr>
<td>(mean)*</td>
<td>4,812</td>
<td>4,889</td>
<td>5,093</td>
<td>5,120</td>
<td>5,081</td>
<td>5,880</td>
<td>5,445</td>
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<td>Poverty Level*</td>
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<tr>
<td>Low</td>
<td>84.1%</td>
<td>58.0%</td>
<td>42.4%</td>
<td>69.2%</td>
<td>69.0%</td>
<td>31.0%</td>
<td>47.5%</td>
</tr>
<tr>
<td>High</td>
<td>15.9%</td>
<td>42.0%</td>
<td>57.6%</td>
<td>30.8%</td>
<td>31.0%</td>
<td>69.0%</td>
<td>52.5%</td>
</tr>
</tbody>
</table>

*Collected at the census tract level
Table 2. Odds Ratio (95% Confidence Interval) by Disease Stage at Diagnosis for Breast Cancer: White

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regional(^a,b)</th>
<th>p-value</th>
<th>Distant(^a,b)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birthplace</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native-born</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Foreign-born</td>
<td>1.35 (1.27-1.43)</td>
<td>&lt;.0001</td>
<td>1.34 (1.17-1.53)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Mexican</td>
<td>1.24 (0.92-1.65)</td>
<td>0.15</td>
<td>0.56 (0.24-1.29)</td>
<td>0.17</td>
</tr>
<tr>
<td>Puerto Rican</td>
<td>1.22 (1.06-1.39)</td>
<td>0.004</td>
<td>1.17 (0.89-1.52)</td>
<td>0.26</td>
</tr>
<tr>
<td>Cuban</td>
<td>0.61 (0.41-0.92)</td>
<td>0.02</td>
<td>0.51 (0.20-1.27)</td>
<td>0.15</td>
</tr>
<tr>
<td>Central/South American</td>
<td>0.91 (0.80-1.04)</td>
<td>0.15</td>
<td>0.79 (0.59-1.06)</td>
<td>0.11</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1.23 (1.04-1.45)</td>
<td>0.01</td>
<td>1.10 (0.78-1.54)</td>
<td>0.59</td>
</tr>
<tr>
<td>Other Hispanic</td>
<td>1.12 (1.03-1.22)</td>
<td>0.01</td>
<td><strong>0.77 (0.62-0.95)</strong></td>
<td>0.01</td>
</tr>
</tbody>
</table>

\(^a\) Compared to localized cancer  
\(^b\) Adjusted for age, grade, histology, and marital status

Table 3. Odds Ratio (95% Confidence Interval) by Disease Stage at Diagnosis for Breast Cancer: Black

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regional(^a,b)</th>
<th>p-value</th>
<th>Distant(^a,b)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birthplace</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native-born</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Foreign-born</td>
<td>1.28 (1.16-1.40)</td>
<td>&lt;.0001</td>
<td>1.71 (1.45-2.01)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Mexican</td>
<td>1.25 (0.47-3.33)</td>
<td>0.66</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Puerto Rican</td>
<td>0.69 (0.43-1.11)</td>
<td>0.13</td>
<td>1.30 (0.68-2.49)</td>
<td>0.43</td>
</tr>
<tr>
<td>Cuban</td>
<td>0.36 (0.07-1.74)</td>
<td>0.20</td>
<td>3.21 (0.90-11.50)</td>
<td>0.07</td>
</tr>
<tr>
<td>Central/South American</td>
<td>0.72 (0.53-0.98)</td>
<td>0.04</td>
<td>0.69 (0.40-1.17)</td>
<td>0.17</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>0.87 (0.67-1.14)</td>
<td>0.31</td>
<td><strong>0.46 (0.25-0.84)</strong></td>
<td>0.01</td>
</tr>
<tr>
<td>Other Hispanic</td>
<td>0.80 (0.64-1.01)</td>
<td>0.06</td>
<td>0.66 (0.40-1.09)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

\(^a\) Compared to localized cancer  
\(^b\) Adjusted for age, grade, histology, and marital status
APPENDIX B. COLORECTAL CANCER DATA

Figure 1. Colorectal Cancer Stage Distribution by Race

Stage Distribution (SEER Summary Stage 2000), by Race/Ethnicity,
Colon and Rectum, All Ages, Both Sexes, 2002-2011 a,b

<table>
<thead>
<tr>
<th>Cancer Stage at Diagnosis</th>
<th>Asian/Pacific Islander</th>
<th>Black</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Localized</td>
<td>30%</td>
<td>25%</td>
<td>22%</td>
</tr>
<tr>
<td>Regional</td>
<td>35%</td>
<td>30%</td>
<td>28%</td>
</tr>
<tr>
<td>Distant</td>
<td>35%</td>
<td>35%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Percent

a Excludes in situ and unstaged cancer cases
b Data retrieved from National Cancer Institute, Surveillance Research Program. Fast Stats: An interactive tool for access to SEER cancer statistics, 2002-2011
Table 1. Population Characteristics of Colorectal Cancer Cases by Ethnicity from New York State Cancer Registry, 2004-2011 (N=54,484)

<table>
<thead>
<tr>
<th></th>
<th>Non-Hispanic</th>
<th>Mexican</th>
<th>Puerto Rican</th>
<th>Cuban</th>
<th>Central/South American</th>
<th>Dominican Republic</th>
<th>Other Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>52,882</td>
<td>131</td>
<td>1,474</td>
<td>171</td>
<td>963</td>
<td>733</td>
<td>2,130</td>
</tr>
<tr>
<td>Age (mean±SD)</td>
<td>67.8</td>
<td>53.3</td>
<td>66.7</td>
<td>72.4</td>
<td>61.0</td>
<td>62.3</td>
<td>61.2</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48.8%</td>
<td>61.8%</td>
<td>55.6%</td>
<td>50.3%</td>
<td>52.0%</td>
<td>46.8%</td>
<td>52.0%</td>
</tr>
<tr>
<td>Female</td>
<td>51.2%</td>
<td>38.2%</td>
<td>44.4%</td>
<td>49.7%</td>
<td>48.0%</td>
<td>53.2%</td>
<td>48.0%</td>
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<td>Marital Status</td>
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</tr>
<tr>
<td>Single (never married)</td>
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<td>33.8%</td>
<td>23.4%</td>
<td>23.8%</td>
<td>34.0%</td>
<td>34.6%</td>
</tr>
<tr>
<td>Married</td>
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<td>44.9%</td>
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<td>Separated or Divorced</td>
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<td>10.7%</td>
<td>11.0%</td>
<td>10.4%</td>
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<tr>
<td>Native-born</td>
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<td>29.0%</td>
<td>4.1%</td>
<td>2.9%</td>
<td>3.4%</td>
<td>92.7%</td>
</tr>
<tr>
<td>Foreign-born</td>
<td>15.9%</td>
<td>69.5%</td>
<td>71.0%</td>
<td>95.9%</td>
<td>97.1%</td>
<td>96.6%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Race</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>White</td>
<td>78.5%</td>
<td>90.1%</td>
<td>92.9%</td>
<td>90.1%</td>
<td>85.2%</td>
<td>67.3%</td>
<td>79.8%</td>
</tr>
<tr>
<td>Black</td>
<td>15.6%</td>
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<td>6.4%</td>
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<td>13.5%</td>
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<td>Other</td>
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<td></td>
</tr>
<tr>
<td>Grade I</td>
<td>10.5%</td>
<td>12.3%</td>
<td>9.5%</td>
<td>9.0%</td>
<td>9.8%</td>
<td>8.0%</td>
<td>12.8%</td>
</tr>
<tr>
<td>Grade II</td>
<td>66.6%</td>
<td>58.8%</td>
<td>69.5%</td>
<td>65.7%</td>
<td>65.7%</td>
<td>69.1%</td>
<td>65.9%</td>
</tr>
<tr>
<td>Grade III</td>
<td>21.4%</td>
<td>27.2%</td>
<td>20.0%</td>
<td>23.9%</td>
<td>22.5%</td>
<td>22.3%</td>
<td>20.3%</td>
</tr>
<tr>
<td>Grade IV</td>
<td>1.5%</td>
<td>1.7%</td>
<td>1.0%</td>
<td>1.4%</td>
<td>2.1%</td>
<td>0.6%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Histology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenoma/Adenocarcinoma</td>
<td>85.5%</td>
<td>86.7%</td>
<td>84.0%</td>
<td>83.6%</td>
<td>84.2%</td>
<td>85.3%</td>
<td>87.1%</td>
</tr>
<tr>
<td>Other Neoplasm</td>
<td>14.5%</td>
<td>13.3%</td>
<td>16.0%</td>
<td>16.4%</td>
<td>15.8%</td>
<td>14.7%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Laterality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not a paired organ</td>
<td>99.7%</td>
<td>99.2%</td>
<td>99.9%</td>
<td>100%</td>
<td>99.7%</td>
<td>99.9%</td>
<td>99.3%</td>
</tr>
<tr>
<td>Right: origin of primary</td>
<td>0.2%</td>
<td>0.8%</td>
<td>0.1%</td>
<td>0%</td>
<td>0.5%</td>
<td>0.1%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Left: origin of primary</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>38.9%</td>
<td>32.8%</td>
<td>28.2%</td>
<td>31.0%</td>
<td>29.7%</td>
<td>30.4%</td>
<td>42.4%</td>
</tr>
<tr>
<td>Regional</td>
<td>40.2%</td>
<td>44.3%</td>
<td>40.0%</td>
<td>41.5%</td>
<td>44.7%</td>
<td>41.9%</td>
<td>43.7%</td>
</tr>
<tr>
<td>Distant</td>
<td>20.9%</td>
<td>22.9%</td>
<td>31.8%</td>
<td>27.5%</td>
<td>25.6%</td>
<td>27.7%</td>
<td>13.9%</td>
</tr>
<tr>
<td>Median Household Income*</td>
<td>57.0%</td>
<td>74.0%</td>
<td>80.2%</td>
<td>69.6%</td>
<td>65.7%</td>
<td>85.0%</td>
<td>76.1%</td>
</tr>
<tr>
<td>≤$62,500</td>
<td>39.6%</td>
<td>24.4%</td>
<td>19.3%</td>
<td>28.7%</td>
<td>32.0%</td>
<td>14.7%</td>
<td>22.6%</td>
</tr>
<tr>
<td>$62,501-$125,000</td>
<td>2.8%</td>
<td>1.6%</td>
<td>0.5%</td>
<td>0.6%</td>
<td>1.9%</td>
<td>0.3%</td>
<td>1.1%</td>
</tr>
<tr>
<td>$125,001-$187,500</td>
<td>0.5%</td>
<td>0%</td>
<td>0.1%</td>
<td>1.2%</td>
<td>0.4%</td>
<td>0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>No College Education*</td>
<td>31.7%</td>
<td>27.5%</td>
<td>32.8%</td>
<td>53.2%</td>
<td>34.1%</td>
<td>42.8%</td>
<td>37.8%</td>
</tr>
<tr>
<td>0%-25%</td>
<td>67.8%</td>
<td>71.8%</td>
<td>66.6%</td>
<td>46.2%</td>
<td>65.1%</td>
<td>56.9%</td>
<td>61.5%</td>
</tr>
<tr>
<td>26%-50%</td>
<td>51%-75%</td>
<td>0.5%</td>
<td>0.7%</td>
<td>0.6%</td>
<td>0.6%</td>
<td>0.3%</td>
<td>0.6%</td>
</tr>
<tr>
<td>76%-100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0.2%</td>
<td>0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Poor English Proficiency*</td>
<td>96.5%</td>
<td>98.5%</td>
<td>97.5%</td>
<td>97.1%</td>
<td>95.1%</td>
<td>98.4%</td>
<td>97.4%</td>
</tr>
<tr>
<td>0%-5%</td>
<td>2.9%</td>
<td>1.5%</td>
<td>2.3%</td>
<td>2.9%</td>
<td>4.4%</td>
<td>1.6%</td>
<td>2.1%</td>
</tr>
<tr>
<td>6%-10%</td>
<td>11%-15%</td>
<td>0.5%</td>
<td>0%</td>
<td>0%</td>
<td>0.4%</td>
<td>0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>16%-20%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Population Density (mean)*</td>
<td>4,691</td>
<td>5,062</td>
<td>5,045</td>
<td>5,417</td>
<td>4,939</td>
<td>5,937</td>
<td>5,358</td>
</tr>
<tr>
<td>Poverty Level*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>81.2%</td>
<td>57.3%</td>
<td>40.7%</td>
<td>64.9%</td>
<td>66.6%</td>
<td>31.4%</td>
<td>66.9%</td>
</tr>
<tr>
<td>High</td>
<td>18.5%</td>
<td>42.7%</td>
<td>59.3%</td>
<td>35.1%</td>
<td>33.4%</td>
<td>68.6%</td>
<td>33.1%</td>
</tr>
</tbody>
</table>

*Collected at the census tract level
### Table 2. Odds Ratio (95% Confidence Interval) by Disease Stage at Diagnosis for Colorectal Cancer: White

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regional&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>p-value</th>
<th>Distant&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birthplace</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native-born</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Foreign-born</td>
<td><strong>1.23 (1.14-1.32)</strong></td>
<td>&lt;.0001</td>
<td><strong>1.34 (1.22-1.47)</strong></td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Mexican</td>
<td>0.95 (0.60-1.50)</td>
<td>0.81</td>
<td>0.84 (0.48-1.49)</td>
<td>0.56</td>
</tr>
<tr>
<td>Puerto Rican</td>
<td><strong>1.29 (1.10-1.51)</strong></td>
<td>0.002</td>
<td><strong>1.92 (1.61-2.30)</strong></td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Cuban</td>
<td>1.27 (0.82-1.95)</td>
<td>0.29</td>
<td>1.05 (0.60-1.84)</td>
<td>0.86</td>
</tr>
<tr>
<td>Central/South American</td>
<td><strong>1.28 (1.05-1.55)</strong></td>
<td>0.01</td>
<td>1.23 (0.97-1.55)</td>
<td>0.09</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1.18 (0.92-1.52)</td>
<td>0.20</td>
<td><strong>1.50 (1.12-2.01)</strong></td>
<td>0.006</td>
</tr>
<tr>
<td>Other Hispanic</td>
<td><strong>1.20 (1.06-1.35)</strong></td>
<td>0.005</td>
<td>0.72 (0.60-0.86)</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

<sup>a</sup> Compared to localized cancer  
<sup>b</sup> Adjusted for age, grade, histology, and marital status

### Table 3. Odds Ratio (95% Confidence Interval) by Disease Stage at Diagnosis for Colorectal Cancer: Black

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regional&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>p-value</th>
<th>Distant&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birthplace</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native-born</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Foreign-born</td>
<td><strong>1.19 (1.03-1.38)</strong></td>
<td>0.02</td>
<td><strong>1.53 (1.29-1.80)</strong></td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>1.0</td>
<td>ref</td>
<td>1.0</td>
<td>ref</td>
</tr>
<tr>
<td>Mexican</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Puerto Rican</td>
<td>0.92 (0.54-1.57)</td>
<td>0.77</td>
<td>0.98 (0.53-1.81)</td>
<td>0.96</td>
</tr>
<tr>
<td>Cuban</td>
<td>1.19 (0.34-4.15)</td>
<td>0.78</td>
<td>0.91 (0.20-4.17)</td>
<td>0.91</td>
</tr>
<tr>
<td>Central/South American</td>
<td>1.16 (0.69-1.93)</td>
<td>0.58</td>
<td>1.24 (0.71-2.16)</td>
<td>0.46</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>0.95 (0.67-1.36)</td>
<td>0.79</td>
<td><strong>0.51 (0.32-0.81)</strong></td>
<td>0.004</td>
</tr>
<tr>
<td>Other Hispanic</td>
<td>1.21 (0.87-1.68)</td>
<td>0.26</td>
<td><strong>0.56 (0.35-0.90)</strong></td>
<td>0.02</td>
</tr>
</tbody>
</table>

<sup>a</sup> Compared to localized cancer  
<sup>b</sup> Adjusted for age, grade, histology, and marital status
APPENDIX C. ADDITIONAL TABLES AND FIGURES

Figure 1. Study Population Flowchart

Initial Sample Size: 242,193

Sample Size=197,022

Sample Size=196,395

Sample Size=194,839

Sample Size=150,589

Sample Size=150,567

Sample Size= 91,319

Sample Size= 58,484

Excluded: subsequent tumor repeats (N= 45,171)

Excluded: Spanish surname only (N=627)

Excluded: Missing census tract data (N=1,556)

Excluded: missing stage and in situ cancer diagnoses (N=44,247)

Excluded: Individuals younger than 18 years of age (N=22)

Restricted: Female breast cancer cases only

Restricted: Colorectal cases only
Figure 2. Age Distribution by Birthplace

Mean Age at Diagnosis

Age (years)

Birthplace

Missing
Foreign-born
Native-Born

Figure 3. Race Distribution by Birthplace

Race

Birthplace

Missing
Foreign-Born
Native-Born

Percent

Native-Born
Foreign-Born
Missing

Race

Other
Black
White

Figure 4. Ethnicity Distribution by Birthplace

Ethnicity

Birthplace

Missing
Foreign-Born
Native-Born

Percent

Native-Born
Foreign-Born
Missing

Hispanic
Non-Hispanic
APPENDIX D. RESEARCH ETHICS

IRB Exemption Approval

UNIVERSITY AT ALBANY
State University of New York

IRB 00000599
FWA 00004070
Notice of Approval
IRB Protocol Number: 14-X-127-01
Expiration Date: May 26, 2016

Title: Disparities in Breast and Colorectal Cancer Screening and Survival in New York State
Principal Investigator: Margaret Gates

Review Type: Exempt #4
Approved under Exempt Category:

<table>
<thead>
<tr>
<th>1. Research conducted in established, commonly accepted educational settings involving normal educational practices.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Research involving the use of educational tests, survey procedures, interview procedures or observation of public behavior.</td>
</tr>
<tr>
<td>3. Research involving the use of educational tests, interview procedures not exempt under Category 2 if subjects are appointed public officials or research conducted under federal statute requiring confidentiality to be maintained throughout the research and thereafter.</td>
</tr>
<tr>
<td>4. Research involving collection or study of existing data, documents, records, pathological specimens or diagnostic specimens.</td>
</tr>
<tr>
<td>5. Research and demonstration projects conducted by or subject to approval of federal Department or Agency needs and designed to study, evaluate, obtain public benefit or service programs.</td>
</tr>
<tr>
<td>6. Tests and food quality and evaluation/consumer acceptance studies</td>
</tr>
</tbody>
</table>

1. Provision of Approval: The exemption is valid until the expiration date above. If your research is expected to continue beyond this expiration date, you must submit a new protocol. You are required to maintain IRB approval for as long as the study remains active.

2. All recruitment materials and methods must be approved by the IRB (as part of the determination of exempt from IRB review) prior to being used.

3. Informed Consent: An adequate standard of informed consent has been met when required.

4. Principal Investigator Responsibilities: It is the responsibility of the PI to ensure that all investigators and staff associated with this study meet the training requirements for conducting research involving human subjects. Promptly report any changes in research activity to ORRC, keep accurate research records, and comply with all University at Albany Policies. Federal, state, and local laws, Declaration of Helsinki, and Helsinki Report.

5. Research Records: Accurate and detailed research records must be maintained. All research records (including all IRR correspondence) must be kept for a minimum of 3 years after the completion of the research. This research is subject to an audit under the terms of the IRB's Quality Improvement Program.

6. Modifications: All protocol modifications must be IRB approved prior to implementation. Modifications include but are not limited to study parameters, research instruments, protocol procedures, and/or addition of funding sources.

7. Faxed Research: If your research is funded or otherwise sponsored research, you must submit any changes to the grant to ORRC with the human subject study approval.

8. Study Closure: A study is considered to be open and active until all research has reached its completion date. If the investigator has submitted a closure form available on ORRC's website (www.albany.edu/researchcompliance/forms), until a closure form is received, the IRB oversight of the project will remain active. A closure notice will be sent to you, but it is your responsibility to ensure that you submit an updated protocol and receive approval in a timely manner.

9. Unanticipated or adverse events: All unanticipated or adverse events must be reported to the IRB within 5 days.

10. Other:


Office of Regulatory & Research Compliance
1905 Washington Ave, Albany, NY 12222
518-442-3855
518-442-3855
www.albany.edu/irb
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