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Socio-Economic and Demographic Predictors of Mammography and Pap Smear Screening in US Women

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SOCIO-ECONOMIC AND DEMOGRAPHIC PREDICTORS OF MAMMOGRAPHY AND PAP SMEAR SCREENING IN US WOMEN

by

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Dedication

To all the women I know who have suffered and persevered through cancer. Your strength and determination is truly inspirational.

To my wife, Sarah, and family who have been such an amazing source of support and encouragement as I've walked this journey.

To my friends and classmates who've who have helped me along this path and always motivated me to push myself and never settle for anything less than my best.

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ABSTRACT

In 2010, 240,000 women were diagnosed with breast cancer and 16,000 women were diagnosed with cervical cancer (www.seer.cancer.gov). In spite of technological advances and increases in education regarding cancer screening, healthcare costs are still on the rise and disagreement still exists between physicians who create guidelines and policy makers (Woloshin, 2000). This project examines cancer screening and examines socio-economic and demographic predictors for usage of preventative screening measures. This project also examines disparities in the current screening process. Data from the National Health Interview Survey (NHIS) from 1987 and 2010 were used to compare differences across time. The results indicate that utilization of mammograms and Pap smears overall has increased, but many disparities still exist amongst groups who actually receive the preventative screenings.

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Chapter 1 Introduction

In 2010 approximately 240,000 women were diagnosed with breast cancer and 43,000 died from the disease. In 2010 approximately 16,000 women were diagnosed with cervical cancer and 6,000 died from the disease (www.seer.cancer.gov). From 1987 to 2010 the incidence of breast cancer has increased while the mortality rate has stayed constant (www.seer.cancer.gov). Breast cancer is the most common cancer in women and the second leading cause of death in women, after lung cancer (Lerner, 2003). Cervical cancer is highly preventable and treatable with proper screening and medical care. Women's access to preventative screening is vital in detecting and reducing preventable deaths from cancer.

But it is also important to consider the cost of these screenings. Healthcare expenditures in America are increasing. In 1990 healthcare expenditures were $653 billion with per capita expenditures of $2525 (Clark, 1992). In 2010 expenditures on healthcare in America were over $2.9 trillion with a per capita rate of almost $9300 per person (World Bank). In 1965 healthcare expenditures were 5.9% of GDP and increased to 11.9% of GDP in 1990 (Vincenvino, 1991). In 2010 America spent 17.7% of GDP on healthcare. America spends more of its GDP on healthcare than any other industrialized nation in the world. The Netherlands spends 12.1%, France spends 11.7% and Austria spends 11.6% (World Bank). This increase in US spending can been attributed to several factors including a medical inflation rate greater than the base

CPI inflation rate in the medical care sector, increased usage of medical care, technological developments, and a growing elderly population (Clark, 1992). With rising healthcare costs, it is beneficial to examine who is receiving care and how those services are distributed to the women who need them.

In my thesis, I examine the 1987 National Health Interview Survey (NHIS) data to replicate a study by *Calle et al.* that was published in the *American Journal of Public Health*. I examine demographic and socio-economic predictors of utilization of preventative screening by women. Specifically these screenings are mammograms and Pap smears. I used the 1987 NHIS Cancer Control Supplement. The NHIS is a cross-sectional, annual, household interview survey of the civilian, non-institutionalized population of the United States, conducted by the National Center for Health Statistics. I then replicated the model with 2010 NHIS data to look for differences over that time period.

I employed two metrics of underuse for my dependent variables. The first was no prior preventative screening and the second was no screening in the past year. I examined eight demographic components for my independent variables as potential predictors of usage. They were age, race/ethnicity, income, education, marital status, type of urban area, region of the United States, and employment status. Results indicate that mammogram and Pap smear screenings increased between 1987 and 2010. However the many disparities that existed in 1987 still existed in 2010. Women with low income, lower levels of education, and who were minorities were much less likely to receive screening than women who were well above the poverty line, obtained education, and were not minorities.

This thesis is organized into 6 chapters. The first chapter provides an introduction to the topic, the reason for its relevance, the design of the study, and an overview of the results. Chapter 2 explores the background of screenings for breast and cervical cancer. A main goal is to show the sheer complexity and enormity of the subject matter as well a highlight that even to this day many experts disagree on recommendations and guidelines. The chapter then highlights other literature that is pertinent to the topic of interest. Chapter 3 provides the methods and description of variables and data used for the study. The fourth chapter provides the results of the study while the fifth chapter examines the results and discusses the implications. Chapter 6 concludes the thesis and provides policy recommendations.

Chapter 2 Background

The purpose of this chapter is to provide background on the changes in technology, education, policies and guidelines concerning mammography and Pap smear screening. It will highlight the controversies, the consensuses, the disagreements, and the complexity regarding the preventative healthcare measures. This chapter will also survey other literature and studies regarding disparities in treatment and screening, and the alternatives costs of other options.

2.1 Mammography

Shortly after Wilhelm von Roentgen discovered the X-ray in 1895, physicians began using the technology to visualize the inside of the body. On the whole, they used this early technology to identify fractures, which appeared as irregularities in the dense, white bone, and pulmonary tuberculosis, which appeared as a white mass inside a normally blackened lung area. It was nearly 20 years after the initial discovery of the x-ray that the German surgeon, Albert Salomon, reported on his attempts to visualize cancer through radiography of the breast. Yet little was done to pursue this technology and it was not until that mid-1960s that mammograms began to emerge as an accepted technology.

By the end of the 1970s, the technology had spread much more widely while simultaneously becoming the source of immense controversy. On one side, advocates of the technology energetically touted its ability to detect cancer at an earlier, smaller, and more curable stage. On the other side, critics asked whether the harm of the x-rays, the false positive diagnosis, and the detection and subsequent treatment of benign cancers actually caused more harm than benefit. As of 2014, despite publications of hundreds of studies and papers, this dispute persists.

For many years, those who study the history of technology (including medical technology) characterized innovation as the driving force for progress (Howell, 1996:228). In other words, the technologies alone, by producing advances in therapeutics or diagnostics, improved medicine's ability to care for patients. However, this idea has largely fallen out of favor. Since the 1960s, historians have tried to capture and emphasize the way in which various groups, societies, or even individuals have influenced the diffusion of medical technologies. Furthermore, these authors have argued that the information generated by such technologies is not necessarily objective but is constructed over time by influential actors (Pickstone, 1992); (Wailoo, 1997); (Stanton, 1999).

This does not imply that the quality of the information obtained has no influences on the proliferation and acceptance of the technology itself. Between 1930 and 1950, physicians who were interested in radiology, including Jacob Gershon-Cohen of Philadelphia, Raul Leborgne of Uruguay, and Stafford L Warren of Rochester, New York, were fierce proponents of mammography as an additional measure for detection and diagnosis of breast cancer. They devised several technical innovations, such as breast compression and double-emulsion film, which led to higher-quality images. However, the films were still hazy and dark and their new techniques were not easily reproduced by other researchers and clinicians (Gold et al., 1990).

However, improvements made by the radiologist Robert L. Egan toward the end of the 1950s had a dramatic impact on the spread of mammography. Egan used a high milliamperage-low voltage technique, a fine-grain intensifying screen, and industrial film, which generated mammographic images that were clearer and much easier to interpret (Egan, 1960). Furthermore, physicians across the country could also replicate his methods with similar results. Arguably Egan's largest contribution was the presentation of data that strongly suggested the value of mammography in diagnosing breast cancer. Between 1956 and 1959 Egan and his associates at M.D. Anderson Cancer Hospital took 1000 woman who did not have obvious cancer on physical examination and further examined them with mammograms. 245 breast cancers were ultimately confirmed by biopsy of which Egan had identified 238 by mammography. 19 of these cancers were in the women whose physical examination showed no cancer. One of the cancers was only eight millimeters in diameter when sectioned at biopsy (Egan, 1960).

Egan had made important technical improvements, but the highly positive response to his work shows the way in which social factors often influence the reception of medical technologies. For decades, physicians such as Gershon-Cohen, Leborgne, and Warren were widely overlooked as they claimed that mammography could be useful in the detection of breast cancers that were not discovered on examination. But by the early 1960s the perception of cancer among the public and professionals was drastically changing. The American Cancer Society (ACS), founded in 1913 as the American Society for the Control of Cancer, underwent a major reorganization and modernization effort after World War II. In an attempt to fight the fatalism that so often resulted from a diagnosis of cancer, ACS literature emphasized that breast and other cancers were highly curable if discovered early in their course (Patterson, 1987).

The campaigns and efforts of the ACS struck a positive chord with the American public. As tuberculosis and other infectious diseases declined as causes of mortality, non-communicable ailments had taken their place (Lerner, 1998). Cancer was the second leading cause of death in America, behind only heart disease, and breast cancer specifically was the leading cause of cancer deaths among women (Lerner, 2003).

Given the high mortality from breast cancer, society's general infatuation with the breast, and it easy accessibility on the exterior of the body, it followed somewhat naturally that the "war" on breast cancer began to accelerate. Mammography increasingly was touted as an essential weapon in this war. Part of this growing enthusiasm from mammography stemmed from its visual nature (Stafford, 1992). To borrow the common phrase, "seeing is believing" and this was certainly the case for mammography. It was written that mammography had a "certain magic appeal" (Egan, 1969). Others wrote that the patient "feels something special is being done for her" and that "the radiologist has become a potential savior of women—and their breast" (Strax, 1979).

But such anecdotal examples hardly constitutes proof of the value of mammography. After the 1960s researchers began to introduce more sophisticated statistical methodologies foremost of which was the randomized controlled trial (RCT), which rigorously tested a new modality against either placebo or the existing standard of care. This changing emphasis led Philip Strax to propose that Egan's mammographic technique undergo more rigorous formal evaluation. Strax had a personal connection to breast cancer: his wife had died from the disease.

Until the 1960s, doctors ordered mammograms to help the diagnostics of complex cases where physical examination was unclear or inconclusive. In such an instance, a positive result would typically lead to a surgeon performing a diagnostic biopsy while a negative mammogram would typically render such a procedure unnecessary. Strax did not challenge the value of mammography in these circumstances, but he firmly believed that the tool's greatest utility was to help diagnose breast cancer in women with seemingly normal physical exams. This methodology was congruent with ACS's efforts to decrease mortality rates for breast cancer by identifying malignancies at their earliest stage. In short, what Strax proposed was a trial that examined mammography as a screening tool.

Beginning in 1963, Strax, along with Sam Shapiro, the Director of Research and Statistics for a medical insurance program, and surgeon Louis Venet, randomized 62,000 women aged 40-64 into one of two groups. The intervention group received an annual clinical breast examination and screening for four years while the control group received its usual care, which included breast screening in some instances but not in others.

The researchers published their findings in 1971. Physicians had clearly discovered earlier-stage breast cancers among women in the intervention group although it was difficult to ascertain the contribution of mammography versus clinical examination. Nearly 70% had negative underarm lymph nodes, which greatly increased the likelihood that the cancer was localized to the breast. Conversely, the control group had only about 45% with localized cancers. The most significant finding of the study, however, was that the death rate from breast cancer of women in the intervention group was 40% lower than those in the control group (Shapiro et al., 1971). This study invigorated the field and generated much excitement for the American Cancer Society because for the first time a study revealed that mammography screening could lower the mortality rate from this dreaded disease.

Armed with this and other data, the ACS partnered with the National Cancer Institute (NCI), and inaugurated the Breast Cancer Detection Demonstration Project (BCDDP), which would screen over 250,000 women with mammography in 1972. The BCDDP emanated from the Cancer Control Act, which President Nixon signed into law at the end of 1971. The act signaled a major acceleration in America's war on breast and other cancers. The major beneficiary from the legislation was the NCI, which received $334 million each year to sponsor studies designed to find a cure for cancer. But in the case of breast cancer the ACS was in charge (Patterson, 1987).

Initially, the ACS had only planned to pilot the program in 8 to 12 clinics across the country. But given the success in terms of momentum and funding from the War on Cancer Act there was demand for more clinics. In September of 1972, NCI director approved a $6 million dollar annual contribution to support 29 detection centers across the country. The new goal for the BCDDP was to enroll 270,000 women, ages 35-74 beginning in 1973. Special efforts were made to include minority women and those who were poor and underrepresented in previous studies (Greenberg, 1976).

Early news from the BCDDP was very positive. In October 1974, based on data from 42,000 women, the NCI reported that 77% of detected breast cancers contained no positive underarm lymph nodes. This news was exactly what women wanted to hear: they were empowered and there was something they could do in the face of this terrifying disease. Screening mammography started to play two important cultural roles for American women. First, receiving the screening allowed women to take personal responsibility for their health (something that many of the public health campaigns had long encouraged). Second, having a mammogram became seen as a way to improve one's odds against breast cancer, and thus fit well with the risk-averse response of Americans to the threat of disease (Lerner, 1998).

Soon, however, controversy arose and much disagreement still exists today. A chief critic of the BCDDP was John Bailar, a doctor who pursued advanced training in biostatistics and epidemiology rather than becoming a practicing clinician. Bailar started a line of critique that has continued to have dramatic influence on debates over mammography. Bailar feared that routine mammography was likely to detect many slow-growing lesions that were unlikely to ever materialize into threatening breast cancers. These included ductal and lobular carcinoma in situ, which were cancer-like cells that collected but never actually invaded the breast tissue. Bailar further argued that the risks of mammograms "may be greater than are commonly understood." He noted experimental and clinical evidence that ionizing radiation can cause breast cancer (Bailar, 1976). In short, just because a mammogram detected an abnormality, which was subsequently treated, Bailar argued, did not in and of itself prove the value of the series of tests and interventions.

Over the next several decades in an effort to resolve the increasingly contentious debates many conferences, meetings, and symposiums were held to reach consensus among influential organizations including the ACS, NCI, National Institutes of Health (NIH), and the U.S. Preventive Services Task Force (USPSTF).

In spite of many technological advances to include, film-screen mammography, which lowers the amount of radiation used to safer levels, or digital mammography which allows for enhancement and zooming on the image itself, or the use of breast Magnetic resonance imaging (MRI) which can help increase accuracy and the discovery of the BRCA gene the schism between professionals remains. In 1980, the ACS broke ranks with the NCI and proposed that women between 35 and 39 receive a baseline screening mammogram. In 1983 they recommended that women 40 to 49 receive mammograms every one to two years. In 1997, the NCI reiterated that there was no need for women in their 40s to receive annual mammograms. However, that same year the ACS changed its recommendation and advised women in their 40s to receive mammograms every year. The American College of Radiology soon followed suit (Lerner 2001). In 2009 the USPSTF issued guidelines saying that women should only start at the age of 50 and should be checked every other year.

This detailed historical perspective on the evolution of technology, education and guidelines is helpful in understanding the sheer complexity and enormity and ambiguity of the issue.

2.2 Pap Smear

The history of the Pap smear test is far less contentious and complicated than that of the mammogram, albeit not without its share of controversy as well. Aurel Babeş is largely credited with pioneering this field. In the early 1900s Babeş' proposed that a cytological diagnosis of noninvasive cervical carcinoma was possible many years before this concept was generally accepted (Tasca et al., 2002). Babeş' work was the basis for much of the work done by Dr. George N. Papanicolaou after whom the test is named. In fact it is believed that Papanicolaou used much of Babeş' work without citing it and this was the reason that Papanicolaou never won a Nobel Prize (Carmichael, 1973).

Dr. Papanicolaou first proposed that cancer cells found in a vaginal smear could be indicative of the early stages of this disease in a study presented at the 1928 meeting of the Third Race Betterment Conference, a gathering of eugenicists. In 1941 he published a paper entitled “The Diagnostic Value of Vaginal Smears in Carcinoma of the Uterus” which became a landmark for Pap smear screening (Papanicolaou, 1941). In taking a Pap smear, a speculum is used to open the vaginal canal and allow the collection of cells from the outer opening of the cervix of the uterus and the endocervix. The cells are examined under a microscope to look for abnormalities. The test aims to detect potentially pre-cancerous changes which are called cervical intraepithelial neoplasia (CIN) or cervical dysplasia (Papanicolaou, 1941).

While physicians accepted the test, it was not widely publicized or utilized. In a New York Time article in 1961, 40% of women reported that they had never heard of a Pap smear (Schmeck, 1961). However, the ACS championed the Pap smear test in the 1960s and its popularity and use increased significantly over the next two decades.

In the 1970s, German researcher Harald zur Hausen pursued the idea that the human papilloma virus (HPV) was responsible for cervical cancer. Eventually, he singled out HPV 16 and 18, the strains responsible for about 70%-80% of cervical cancers worldwide (cancer.org). His discoveries paved the way for the development of vaccines that can prevent infection with these strains of HPV. Two vaccines (Cervarix and Gardasil) protect against cervical cancers in women (cdc.gov).

These changes in technology have affected the policy guidelines for Pap smear screening. In 1980, the ACS first changed its recommendation from yearly to once every three years for women with at least two negative tests. In 2003 the US Preventative Services Taskforce recommended that screenings start at the age of 21 and continue every 3 to 5 years until the age of 65 (USPSTF, 2003).

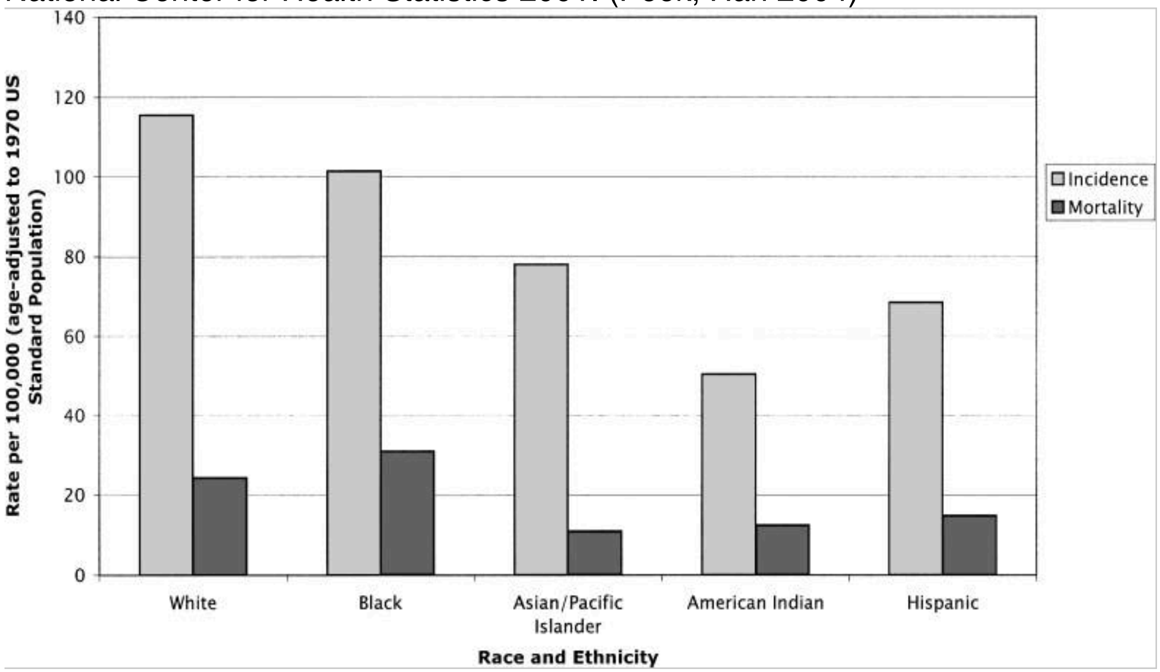
With the histories of the mammogram and Pap smear established it has been shown that popularity of these measures has increased over the past century. But to gain a fuller perspective, it is vital to understand how these preventative healthcare measures are being utilized across society. The next section includes a literature review on studies in this area.

2.3 Literature Review

Many studies have shown that there are disparities in the utilization of healthcare. Peek and Han (2004) examined disparities in mammography screening. They found that The United States has improved its use of screening mammography over the past decade, with increased rates observed in every demographic group. Disparities in screening mammography are decreasing among medically underserved populations but still persist among racial/ethnic minorities and low-income women.

Vulnerable populations such as racial/ethnic minorities, the elderly, and the poor continue to bear a disproportionate burden of breast cancer mortality. For example, despite an overall lower incidence of disease compared to white women, African-American women suffer higher breast cancer mortality owing to a higher proportion of advanced breast cancer stage as shown in Figure 1below. A similar pattern of excess late-stage disease was observed in some groups of Hispanic, Native-American, Asian, and low-income women, particularly those who are immigrants or less acculturated, presumably due to less access to screening.

Figure 1. Breast cancer incidence and mortality by race and ethnicity age 40 and over—United States, 1992 to 1998. Data sources: American Cancer Society Surveillance Research 2001, National Cancer Institute SEER Program 2001, National Center for Health Statistics 2001. (Peek, Han 2004)



Peek and Han also noted that recent data from the 2000 NHIS does show some residual differential use of mammography, with 67.6% of African-American women reporting mammograms within the prior 2 years compared to 71.2% of white women (Swan, 2000). Additionally, disparities among African Americans are still documented in Medicare and fee-for-service insurance plans, indicating some heterogeneity within this population. Hispanic women have narrowed their screening disparity over the past decade from 9.7% to 4.7%, with 67.0% of Hispanic women reporting having had a mammogram within the prior 2 years.10 Not all Hispanic subpopulations have such a high rate of mammography; one recent study reported mammography use among Mexican women to be 10% to

15% lower than that in non-Hispanic whites (Gilliland, Rosenberg, Hunt, et al., 2000).

After examining the disparities in their paper, Peek and Han explored some possible barriers to utilization of mammograms. Receipt of breast cancer screening is contingent upon gaining adequate access to the health care system they noted. Access factors, such as insurance status, income, and usual source of care, are the largest contributors to racial/ethnic screening differences in mammography rates (Fiscella, Franks, Doescher, 2002). Women without a usual source of care were half as likely to report having had a mammogram, and low-income women reported cost as a significant barrier to obtaining a mammogram. According to their study, despite the availability of free mammograms to the uninsured, women without insurance remain one of the most under screened groups, indicating that expanding insurance coverage to this population may be a more effective strategy than targeted mammography interventions.

Disparities do not just exist in regard to mammogram utilization. Harvard Medical School's Elizabeth Garner examined disparities in screening, treatment, and survival of cervical cancer (2003). She noted that cervical cancer has been preventable since the introduction of the Pap smear in 1941. In developed countries, Pap smear programs have reduced cervical cancer deaths by 70% (Devesa et al., 1987). Microscopic examination of cells from the cervix can identify the progression of precancerous changes. Development of cervical cancer in the majority of women occurs over many years, so these precancerous changes can be observed, followed, and treated.

Dr. Garner showed that in the United States, benefits of early detection have not been shared by all segments of the population. Racial and socioeconomic disparities exist in cervical cancer incidence and mortality rates. Low income and minority women tend to be diagnosed at later stages and have higher mortality rates. Patients with stage I disease at diagnosis have a 90% 5-year survival rate, whereas corresponding survival rates for stage II and III diseases are less than 50% and 10%, respectively (Perez, 1992)

She highlights disparities that in 1993, African-American women were twice as likely as Caucasian women to be diagnosed with cervical cancer and were two to three times more likely to die from their disease (Miller et at., 1996). More recent American Cancer Society data indicate that African-American women continue to have higher cervical cancer incidence and mortality rates. During the 1940s to 1980s, the incidence of cervical cancer in African Americans declined with increased Pap smear screening; however, cervical cancer still accounts for approximately 25% of cancer deaths in African-American women from certain urban populations (Thoms et al., 1995).

Access to quality healthcare service, According to Dr. Garner, is often compromised among minority, rural, and other underserved populations. These populations have barriers to well-organized, quality Pap smear screening services, and often present with late-stage disease. Surprisingly, African

Americans in some areas of the United States have higher screening Pap smear rates (Makuc et al., 1989) but are still diagnosed in later stages of disease and have higher mortality than Caucasians. One possible explanation for this is inadequate systems for follow-up of abnormal Pap smears. Reliability of Pap smear interpretation in many laboratories is another factor. One study reported that New York City pathology labs were so overwhelmed with large volumes of work in the 1980s that some Pap smears were not read at all (Fahs et al., 1992).

Overall, the literature suggests that there are both positive and negative trends regarding the use of mammograms and Pap smears. In general, there seems to be an increased awareness and utilization these measures. However, many disparities still exist in the utilization of preventative healthcare. Minorities, less educated, and poor women tend to have relatively low usage percentages of mammograms and Pap smears and high mortality rates.

Chapter 3 Methods and Data Description

The objective of this study is to examine how women utilized mammography and Pap smear screening in 1987 and how the data has changed almost 25 years later in 2010. Using this data based on demographic and socio-economic predictors I analyze ways to possibly better utilize the money that is spent on healthcare in a more cost-efficient manner.

To examine the 1987 data I replicated a study by *Calle et al.* that was published in the *American Journal of Public Health*. In order to replicate the results, I used the 1987 National Health Interview Survey (NHIS) Cancer Control Supplement. The NHIS is a cross-sectional, annual, household interview survey of the civilian, non-institutionalized population of the United States, conducted by the National Center for Health Statistics (Schoenborn, 1987). The NHIS survey design oversamples Hispanics and African Americans to improve the precision of those estimates. For the study, 12,868 women over the age of 18 completed the cancer control supplement.

The analysis was based on 12,252 who were at least 18 years old and had no prior history of cancer. One exception that was not omitted was non-melanoma skin cancer due to its prevalence and relative harmlessness.

For the *dependent variables*, the authors of this paper used two measures of underuse of mammography and Pap smears—1) never having been screened and 2) not having been screened in that past year. Female participants age 18 years and older and 40 years and older were asked a series of questions to determine when their most recent Pap smear and mammogram occurred respectively. I constructed a dichotomous variable to indicate whether a woman reported no previous screening or no screening in the previous year.

There were a total of eight *independent variables* that were examined as possible predictors of underuse—1) age (18 to 39, 40 to 64, 65+ for Pap smear; 40 to 49, 50 to 64, 65+ for mammography); 2) race/ethnicity (White, Black, Hispanic, other); 3) income (below poverty level, poverty level to 200% of poverty level, 200% to 300% of poverty level, greater than 300% of poverty level); 4) education (fewer than 12 years, 12 years, more than 12 years); 5) marital status (married, widowed, divorced, never married); 6) type of urban area (central city, other metropolitan statistical area, nonmetropolitan statistical area); 7) region (Northeast, Midwest, South, West); and 8) employment (in the labor force, not in the labor force). For race/ethnicity, Hispanic was an exclusive category. Therefore any woman who is considered white or black for this study is exclusively white or black. I calculated the income variable based off the 1987 poverty guidelines and family income (taking into consideration the size of the household).

I calculated crude odds ratios (ORs), adjusted ORs, and 95% confidence intervals using simple and multiple logistic regressions in STATA version 12.0 accounting for the survey design and weighting. I did not test for statistical significance of interactions, but rather evaluated the two-way interactions by examining the differences in ORs. Any variable that was a significant predictor of usage in the multiple logistic regression was used to make profiles high-risk women. I calculated the frequencies of usage of each profile and then sorted them lowest usage to the highest usage to determine the profiles of the highest-risk profiles for underuse of these screening technologies.

Chapter 4 Results

4.1 Mammogram Screening

Table 1 shows the univariate and multivariate distribution of mammogram usages. Over 60% of all women over the age of 40 reported that they had never had a mammogram. Over 85% had not had a mammogram within the past year. Low income was the strongest predictor of underuse of mammography (crude OR=3.2; 95% CI=1.7, 2.7). 77% of those below the poverty line never had a mammogram as opposed to just 50% in the wealthiest income bracket. I did find a minor error in the original study. The original tables can be found in Appendix 1. They made a transposition mistake and instead of 871 people who were below the poverty line, the authors put 817 people. This also affected their crude and adjusted ORs. However, the point still stands that income below the poverty line was the most significant predictor of underuse of this preventative healthcare.

TABLE 1—Characteristics of Mammography Use in Women Aged 40 and Older, by Frequencies and Odds Ratios, National Health Interview Survey, 1987													
		Never Had a Mammogram						No Mammogram in Past Year					
	n (total)	n (not screened)	%	Crude OR	Adjusted OR	95% CI		n (not screened in past year)	%	Crude OR	Adjusted OR	95% CI	
Age, y													
40-49	1723	993	57.6%	1.0	1.0	...		1451	84.2%	1.0	1.0	...	
50-64	2107	1194	56.7%	1.0	0.9	0.8	1.1	1765.0	83.8%	0.9	0.9	0.7	1.1
65+	2523	1739	68.9%	1.6	1.3	1.1	1.5	2284.0	90.5%	1.7	1.4	1.1	1.8
Race/ethnicity													
White	5076	3060	60.3%	1.0	1.0	...		4360	85.9%	1.0	1.0	...	
Black	862	581	67.4%	1.3	1.0	0.8	1.2	765.0	88.7%	1.4	1.1	0.8	1.4
Hispanic	328	222	67.7%	1.5	1.4	1.1	1.9	294.0	89.6%	1.7	1.6	0.9	2.7
Other	87	63	72.4%	2.1	2.3	1.0	5.1	81.0	93.1%	3.1	3.4	1.1	10.3
Income													
<PL	871	672	77.2%	3.2	2.1	1.7	2.7	819.0	94.0%	3.3	1.9	1.3	2.9
200% PL	1332	946	71.0%	2.2	1.7	1.4	2.0	1207.0	90.6%	2.2	1.6	1.2	2.0
300% PL	980	630	64.3%	1.6	1.5	1.2	1.8	861.0	87.9%	1.5	1.4	1.1	1.8
>300% PL	2222	1111	50.0%	1.0	1.0	...		1773	79.8%	1.0	1.0	...	
Education													
<12	2166	1589	73.4%	2.8	2.0	1.7	2.5	1992.0	92.0%	2.9	2.1	1.6	2.7
12	2443	1457	59.6%	1.4	1.3	1.1	1.5	2002.0	81.9%	1.3	1.2	1.0	1.5
>12	1716	868	50.6%	1.0	1.0	...		1403	81.8%	1.0	1.0	...	
Marital Status													
Married	2984	1716	57.5%	1.0	1.0	...		2502	83.8%	1.0	1.0	...	
Widowed	1959	1346	68.7%	1.5	1.0	0.9	1.2	1769.0	90.3%	1.8	1.2	0.9	1.5
Divorced	1005	601	59.8%	1.1	1.0	0.8	1.2	869.0	86.5%	1.3	1.2	0.9	1.5
Never Married	396	259	65.4%	1.4	1.2	1.0	1.6	352.0	88.9%	1.7	1.5	1.0	2.1
Urban Area													
Central City	2209	1365	61.8%	1.1	1.0	0.8	1.2	1915.0	86.7%	1.2	1.0	0.8	1.3
Other MSA	2488	1424	57.2%	1.0	1.0	...		2093	84.1%	1.0	1.0	...	
Non-MSA	1656	1137	68.7%	1.5	1.3	1.1	1.6	1492.0	90.1%	1.8	1.6	1.3	2.1
Region													
Northeast	1421	873	61.4%	1.1	1.1	0.9	1.4	1232.0	86.7%	1.2	1.2	1.0	1.5
Midwest	1555	931	59.9%	1.0	1.0	...		1336	85.9%	1.0	1.0	...	
South	2225	1482	66.6%	1.3	1.2	1.0	1.4	1958.0	88.0%	1.2	1.1	0.8	1.4
West	1152	640	55.6%	0.9	0.9	0.8	1.1	974.0	84.5%	0.9	1.0	0.7	1.3
In labor force													
Yes	2718	1560	57.4%	1.0	1.0	...		2291	84.3%	1.0	1.0	...	
No	3635	2366	65.1%	1.3	0.9	0.8	1.1	3209.0	88.3%	1.3	0.9	0.7	1.1
Total	6353	3,926	61.8%					5500	86.6%				

In the multivariate analysis, five characteristics that included race, Metropolitan Statistical Area, income, age, and education were significantly associated underuse. Other race (adjusted OR=2.3; 95% CI=1.0, 5.0) being below the poverty line (adjusted OR=2.1; 95% CI=1.7, 2.7) and women with less than 12 years of education (adjusted OR=2.0; 95% CI=1.7, 2.5) were at the highest risk for not utilizing mammograms. With increasing age, decreasing income, less education, and a race of Hispanic or other, there was a increasing gradient for the highest risk of underuse. In both the multivariate and univariate analysis, the levels of risk for each demographic predictor were similar between never having had a mammogram and not having had one within the past year.

I conducted a pairwise analysis on 102 profiles with these characteristics to examine which had the most significant effect on underuse. The results are in Table 2.

Table 2—High-Rish Profiles of Women Who Had Never Had a Mammogram Based on All Pairwise Combinations of Significant Predictors

	Profile		n	n never screened	% Not Screened
1.	<PL, non-MSA		276	223	80.8%
2.	200% PL, non-MSA		411	328	79.8%
3.	<PL, 65+		490	388	79.2%
4.	<PL, <12 y		603	477	79.1%
5.	<12 y, non-MSA		654	516	78.9%
6.	<PL, White		543	426	78.5%
7.	Hisp, 65+		81	62	76.5%
8.	<PL, not CC		208	159	76.4%
9.	<PL, Black		246	187	76.0%
10.	300% PL, <12 y		266	202	75.9%
11.	65+, <12 y		1200	911	75.9%
12.	65+, non-MSA		732	551	75.3%
13.	<PL, CC		387	290	74.9%
14.	200% PL, <12 y		664	497	74.8%
15.	<PL, 50-64		226	169	74.8%
16.	40-49, <12 y		318	235	73.9%
17.	200% PL, Black		214	155	72.4%

Note MSA = metro statistical area;

The women at the highest risk are those who are below the poverty line and live in a rural area. Over 80% of the women in this category had never had a mammogram. In all of the top 17 combinations, over 72% of the women on each category had never had a mammogram. Being below the poverty line again showed to be significant as it was a factor in many of the underserved combinations.

A further analysis of all 3-way profiles is listed in Table 3. Because these profiles are more narrowly defined, the numbers of women in each category are significantly smaller than the two-way combinations. However, the proportion of women who had never ben screened is higher. The most underserved profile was women who were at 200% of the poverty level, age 40-49 and lived in rural areas. Almost 85% of them had never had a mammogram.

Table 3—High-Rish Profiles of Women Who Had Never Had a Mammogram Based on All Pairwise Combinations of Significant Predictors

	Profile		n	n never screened	% Not Screened
1.	200% PL, 40-49, non-MSA		53	45	84.9%
2.	<PL, 50-64, non-MSA		198	168	84.8%
3.	200% PL, 40-49, <12y		72	61	84.7%
4.	200% PL, Black, 40-49		80	67	83.8%
5.	<PL, <12y, non-MSA		214	177	82.7%
6.	<PL, 65+, non-MSA		354	290	81.9%
7.	<PL, White, non-MSA		157	128	81.5%
8.	<PL. White, < 12y		377	306	81.2%
9.	200% PL <12y, non-MSA		212	172	81.1%
10.	<PL, White, 65+		37	30	81.1%
11.	<PL, 65+, <12y		52	42	80.8%
12.	Hisp, 65+, <12y		357	288	80.7%
13.	200% PL, Black, non-MSA		81	65	80.2%
14.	Black, 65+, >12y		121	97	80.2%
15.	Hisp, 40-49, <12y		173	135	78.0%
16.	<PL, 50-64, not CC		43	33	76.7%
17.	300% PL, 65+, <12y		34	26	76.5%
18.	Hisp, <12y, not CC		41	31	75.6%
19.	<PL, White, CC		42	31	73.8%

Note MSA = metro statistical area;

4.2 Pap Smear Screening

In many ways the results for Pap smear screening were similar to those of the mammogram data. In the univariate analysis, income below the poverty line (crude OR=3.2), less than 12 years of education (crude OR=2.7), other race (crude OR=7.0), and having never been married (crude OR=6.7) were some of the most significant predictors of underuse. Overall, nearly 9% of all women over the age of 18 reported never having had a Pap smear. As can be seen in Table 4 screening levels were significantly different between never having had a Pap smear and not having had one within the last year.

TABLE 4—Characteristics of Pap Smear Use in Women Aged 18 and Older, by Frequencies and Odds Ratios, National Health Interview Survey, 1987

		Never Had a Pap Smear						No Pap Smear in Past Year					
	n (total)	n (not screened)	%	Crude OR	Adjusted OR	95% CI		n (not screened in past year)	%	Crude OR	Adjusted OR	95% CI	
Age, y													
18-39	5899	430	7.3%	1.0	1.0	...		2911	49.3%	1.0	1.0	...	
40-64	3830	175	4.6%	0.5	0.9	0.7	1.2	2600.0	67.9%	2.1	2.1	1.9	2.3
65+	2523	449	17.8%	1.9	2.5	1.9	3.2	2123.0	84.1%	4.9	3.6	3.0	4.3
Race/ethnicity													
White	9288	657	7.1%	1.0	1.0	...		5815	62.6%	1.0	1.0	...	
Black	1862	160	8.6%	1.3	0.8	0.6	1.0	1095.0	58.8%	0.8	0.8	0.7	0.9
Hispanic	835	154	18.4%	3.4	3.2	2.3	4.5	538.0	64.4%	1.1	1.2	1.0	1.4
Other	267	83	31.1%	7.0	9.3	5.6	15.5	186.0	69.7%	1.3	1.6	0.9	2.8
Income													
<PL	1979	339	17.1%	3.2	1.4	1.1	1.9	1292.0	65.3%	1.4	1.1	1.0	1.3
200% PL	2396	248	10.4%	1.7	1.1	0.9	1.4	1659.0	69.2%	1.6	1.3	1.1	1.5
300% PL	2170	122	5.6%	1.0	0.9	0.7	1.1	1321.0	60.9%	1.1	1.2	1.0	1.3
>300% PL	4274	193	4.5%	1.0	1.0	...		2342	54.8%	1.0	1.0	...	
Education													
<12	3019	488	16.2%	2.7	2.3	1.8	3.0	2301.0	76.2%	2.7	1.8	1.6	2.1
12	4854	299	6.2%	1.0	1.2	0.9	1.6	2970.0	61.2%	1.4	1.2	1.1	1.4
>12	4342	261	6.0%	1.0	1.0	...		2331	53.7%	1.0	1.0	...	
Marital Status													
Married	6113	272	4.4%	1.0	1.0	...		3567	58.4%	1.0	1.0	...	
Widowed	2004	328	16.4%	4.1	1.8	1.4	2.3	1669.0	83.3%	3.4	1.4	1.2	1.7
Divorced	1918	65	3.4%	0.8	0.7	0.5	1.1	1164.0	60.7%	1.1	1.1	1.0	1.2
Never Married	2200	386	17.5%	6.7	8.2	6.3	10.6	1223.0	55.6%	1.0	1.5	1.2	1.7
Urban Area													
Central City	4476	444	9.9%	1.5	1.0	0.8	1.3	2743.0	61.3%	1.0	1.0	0.9	1.1
Other MSA	4870	341	7.0%	1.0	1.0	...		2967	60.9%	1.0	1.0	...	
Non-MSA	2906	269	9.3%	1.1	1.0	0.8	1.2	1924.0	66.2%	1.2	1.1	0.9	1.2
Region													
Northeast	2535	281	11.1%	1.5	1.3	1.0	1.6	1624.0	64.1%	1.1	1.1	0.9	1.3
Midwest	3041	244	8.0%	1.0	1.0	...		1863	61.3%	1.0	1.0	...	
South	4263	353	8.3%	1.0	0.9	0.7	1.2	2681.0	62.9%	1.0	1.0	0.9	1.1
West	2413	176	7.3%	1.1	0.8	0.6	1.0	1466.0	60.8%	1.0	1.0	0.9	1.2
In labor force													
Yes	7047	396	5.6%	1.0	1.0	...		3923	55.7%	1.0	1.0	...	
No	5205	658	12.6%	1.9	1.4	1.1	1.8	3711.0	71.3%	1.9	1.1	1.0	1.3
Total	12252	1,054	8.6%					7634	62.3%				

As with the mammography study, I conducted multivariate logistic regressions and found that other race (adjusted OR=9.3; 95% CI 5.6, 15.6), and never-married marital status (adjusted OR=8.2; 95% CI 6.3, 10.6) were the strongest predictors of never having had a Pap smear. Furthermore, age over 65, Hispanic ethnicity, and education less than 12 years were also strong independent predictors.

Again I conducted a pairwise combination of the significant predictors of usage. The two-way profiles were strongly influenced by the strongest predictors. Roughly 32% of Hispanics who were not married or over 65 years old had never had a Pap smear. This can be seen in Table 5. In examining the table, several characteristics (Hispanic, not being married, income below the poverty line, and less than 12 years of education) are in many of the profiles.

Table 5—High-Rish Profiles of Women Who Had Never Had a Pap Smear Based on All Pairwise Combinations of Significant Predictors					
	Profile		n	n never screened	% Not Screened
1.	Hisp, 65+		81	26	32.1%
2.	Hisp, NM		168	53	31.5%
3.	<PL, 65+		490	149	30.4%
4.	Hisp, <12y		360	104	28.9%
5.	Black, 65+		275	79	28.7%
6.	Hisp, widow		82	21	25.6%
7.	65+, NM		145	37	25.5%
8.	<PL, Hisp		207	52	25.1%
9.	<12y, NM		358	86	24.0%
10.	65+, <12y		1200	288	24.0%
11.	<12y, widow		978	223	22.8%
12	200% PL, Hisp		193	44	22.8%
13.	<PL, NM		656	135	20.6%
14.	200% PL, NM		352	68	19.3%
15.	12y, NM		744	142	19.1%
16.	White, NM		1398	261	18.7%
17.	18-39, NM		1804	318	17.6%
18.	300% PL, NM		313	53	16.9%
19.	<PL,widow		549	89	16.2%
20.	>300% PL, NM		685	95	13.9%
Note MSA = metro statistical area;					

Many of these trends held true for the three-way profiles in Table 6. In all of the combinations at least 23% of the women had never had a Pap smear. The highest risk category were women below the poverty line who were over 65 and Hispanic. As with Table 5, demographics such as Hispanic ethnicity, not being married, income below the poverty line, and less than 12 years of education were significantly associated with underuse of Pap smear screening.

Table 6—High-Rish Profiles of Women Who Had Never Had a Pap Smear Based on All Three-Way Combinations of Significant Predictors					
	Profile		n	n never screened	% Not Screened
1.	<PL, Hisp, 65+		25	14	56.0%
2.	Hisp, 65+, <12y		53	23	43.4%
3.	200% PL, Hisp, NM		37	16	43.2%
4.	<PL, Hisp, widow		26	11	42.3%
5.	Hisp, <12y, NM		62	24	38.7%
6.	300% PL, <12y, NM		29	11	37.9%
7.	<PL, Black, 65+		103	39	37.9%
8.	Hisp, <12y, widow		54	20	37.0%
9.	<PL, 65+, married		50	18	36.0%
10.	65+, <12y, NM		54	19	35.2%
11.	200% PL, < 12y, NM		74	24	32.4%
12.	White, <12y, NM		127	41	32.3%
13.	Hisp, 18-39, NM		147	47	32.0%
14.	200% PL, Hisp, <12y		97	31	32.0%
15.	Hisp, 12y, NM		44	14	31.8%
16.	Black, 65+, 12 y		45	14	31.1%
17.	<PL, Hisp, married		73	22	30.1%
18.	Hisp, 40-64, <12y		116	34	29.3%
19.	<PL, White, NM		313	91	29.1%
20.	>300% PL, Hisp, NM		39	9	23.1%
Note MSA = metro statistical area;					

Model Applied to 2010 NHIS Data

After replicating the original study, I then used that model and applied the most recent Cancer Control Supplement for the NHIS, which was in 2010. I extensively searched the codebooks not only to find the same variables, but also to find variables that encompassed some of the same assumptions as those that were used in the 1987 data. For example, there were many race variables in the 2010 codebook, but I chose the one with similar categories to the 1987 data. However, I was not able to find a corresponding for the variable in the 2010 data for the Metropolitan Statistical Area (MSA) from the 1987 data. I searched all the codebooks for “metro, urban, city, population, rural, msa, area, and geographic”. I was not able to find anything that matched. While this probably changed the results some, the general results seemed logical for the 2010 dataset.

Table 7 shows the univariate and multivariate distribution of mammogram usages. Only 9% of all women over the age of 40 reported that they had never had a mammogram. 55% had not had a mammogram within the past year. Low income was the strongest predictor of underuse of mammography (crude OR=2.9; 95% CI=1.5, 2.4). 17% of those below the poverty line never had a mammogram as opposed to just 7% in the wealthiest income bracket.

In the multivariate analysis, four characteristics that included race, marital status, income, and education were significantly associated with underuse. Other race (adjusted OR=1.9; 95% CI=1.4, 2.6) being below the poverty line (adjusted OR=1.9; 95% CI=1.5, 2.4) and women with less than 12 years of education (adjusted OR=2.2; 95% CI=1.7, 2.8) were at the highest risk for not utilizing mammograms.

TABLE 7—Characteristics of Mammography Use in Women Aged 40 and Older, by Frequencies and Odds Ratios, National Health Interview Survey, 2010													
		Never Had a Mammogram						No Mammogram in Past Year					
	n (total)	n (not screened)	%	Crude OR	Adjusted OR	95% CI		n (not screened in past year)	%	Crude OR	Adjusted OR	95% CI	
Age, y													
40-49	2619	472	18.0%	1.0	1.0	...		1531	58.5%	1.0	1.0	...	
50-64	3701	235	6.3%	0.3	0.3	0.3	0.4	1854	50.1%	0.7	0.7	0.6	0.8
65+	3311	251	7.6%	0.4	0.3	0.2	0.4	1903	57.5%	0.9	0.7	0.6	0.9
	9631												
Race/ethnicity													
White	5962	484	8.1%	1.0	1.0	...		3170	53.2%	1.0	1.0	...	
Black	1617	174	10.8%	1.3	0.9	0.7	1.1	908	56.2%	1.1	0.8	0.7	1.0
Hispanic	1414	199	14.1%	1.8	1.1	0.9	1.4	828	58.6%	1.2	0.9	0.7	1.1
Other	638	101	15.8%	2.0	1.9	1.4	2.6	382	59.9%	1.2	1.2	0.9	1.4
	9631												
Income													
<PL	1402	242	17.3%	2.9	1.9	1.5	2.4	929	66.3%	2.2	1.7	1.4	2.0
200% PL	1635	213	13.0%	2.2	1.7	1.4	2.2	1027	62.8%	2.0	1.7	1.5	2.0
300% PL	1454	140	9.6%	1.5	1.3	1.0	1.7	828	56.9%	1.5	1.4	1.2	1.6
>300% PL	3716	248	6.7%	1.0	1.0	...		1636	44.0%	1.0	1.0	...	
	8207												
Education													
<12	1739	281	16.2%	2.4	2.2	1.7	2.8	1135	65.3%	2.0	1.6	1.4	1.9
12	2753	294	10.7%	1.4	1.4	1.1	1.7	1579	57.4%	1.3	1.2	1.1	1.4
>12	5080	375	7.4%	1.0	1.0	...		2530	49.8%	1.0	1.0	...	
	9572												
Marital Status													
Married	4137	347	8.4%	1.0	1.0	...		2046	49.5%	1.0	1.0	...	
Widowed	1969	176	8.9%	1.2	1.7	1.3	2.1	1208	61.4%	1.6	1.4	1.2	1.6
Divorced	2224	237	10.7%	1.5	1.4	1.1	1.7	1271	57.1%	1.4	1.3	1.1	1.5
Never Married	1281	198	15.5%	2.0	1.7	1.3	2.1	748	58.4%	1.5	1.4	1.2	1.7
	9611												
Region													
Northeast	1703	157	9.2%	0.7	0.7	0.6	1.0	914	53.7%	0.9	0.9	0.8	1.1
Midwest	2134	210	9.8%	1.0	1.0	...		1138	53.3%	1.0	1.0	...	
South	3498	349	10.0%	0.9	0.8	0.7	1.1	1937	55.4%	1.0	1.0	0.9	1.2
West	2296	242	10.5%	0.9	0.9	0.6	1.1	1299	56.6%	1.1	1.1	0.9	1.3
	9631												
In labor force													
Yes	4840	519	10.7%	1.0	1.0	...		2542	52.5%	1.0	1.0	...	
No	4787	438	9.1%	0.9	1.0	0.8	1.2	2743	57.3%	1.2	1.1	0.9	1.2
Total	9631	958	9.9%					5288	54.9%				

The results for Pap smear screening were similar to those of the mammogram data. The results can be seen in Table 8. In the univariate analysis, income below the poverty line (crude OR=2.8), less than 12 years of education (crude OR=2.6), other race (crude OR=4.1), and having never been married (crude OR=5.1) were some of the most significant predictors of underuse. Overall, almost 7% of all women over the age of 18 reported never having had a Pap smear while 56% of women over 18 reported not having a Pap smear in the past year. As can be seen in Table 4 screening levels were significantly different between never having had a Pap smear and not having had one within the last year.

TABLE 8—Characteristics of Pap Smear Use in Women Aged 18 and Older, by Frequencies and Odds Ratios, National Health Interview Survey, 2010

		Never Had a Pap Smear						No Pap Smear in Past Year					
	n (total)	n (not screened)	%	Crude OR	Adjusted OR	95% CI		n (not screened in past year)	%	Crude OR	Adjusted OR	95% CI	
Age, y													
18-39	5540	589	10.6%	1.0	1.0	...		2565	46.3%	1.0	1.0	...	
40-64	6320	206	3.3%	0.2	0.3	0.3	0.4	3297	52.2%	1.2	1.3	1.2	1.4
65+	3311	210	6.3%	0.4	0.5	0.3	0.6	2603	78.6%	3.8	2.9	2.5	3.5
Race/ethnicity													
White	8566	368	4.3%	1.0	1.0	...		4819	56.3%	1.0	1.0	...	
Black	2666	141	5.3%	2.5	0.8	0.6	1.1	1416	53.1%	0.9	0.8	0.7	0.9
Hispanic	2853	292	10.2%	3.4	1.5	1.2	2.0	1554	54.5%	1.0	0.9	0.8	1.0
Other	1086	204	18.8%	4.1	4.4	3.4	5.7	676	62.2%	1.3	1.4	1.2	1.7
Income													
<PL	2886	330	11.4%	2.8	1.2	1.0	1.6	1742	60.4%	1.6	1.4	1.2	1.6
200% PL	2744	222	8.1%	1.9	1.2	0.9	1.5	1685	61.4%	1.6	1.4	1.2	1.5
300% PL	2265	144	6.4%	1.7	1.4	1.1	1.9	1316	58.1%	1.4	1.3	1.1	1.5
>300% PL	5402	188	3.5%	1.0	1.0	...		2475	45.8%	1.0	1.0	...	
Education													
<12	2583	299	11.6%	2.6	2.4	1.8	3.1	1742	67.4%	2.4	1.8	1.5	2.0
12	3954	250	6.3%	1.3	1.4	1.1	1.7	2445	61.8%	1.7	1.5	1.3	1.6
>12	8561	445	5.2%	1.0	1.0	...		4221	49.3%	1.0	1.0	...	
Marital Status													
Married	6231	267	4.3%	1.0	1.0	...		3157	50.7%	1.0	1.0	...	
Widowed	1992	137	6.9%	2.2	2.0	1.5	2.8	1576	79.1%	3.7	1.6	1.4	1.9
Divorced	2795	89	3.2%	0.8	1.0	0.7	1.4	1579	56.5%	1.3	1.2	1.0	1.3
Never Married	4122	512	12.4%	5.1	4.2	3.4	5.2	2133	51.7%	1.1	1.3	1.2	1.5
Region													
Northeast	2464	210	8.5%	1.6	1.6	1.2	2.1	1378	55.9%	1.0	1.0	0.9	1.1
Midwest	3365	185	5.5%	1.0	1.0	...		1858	55.2%	1.0	1.0	...	
South	5597	304	5.4%	1.0	0.9	0.7	1.2	3088	55.2%	1.1	1.0	0.9	1.2
West	3745	306	8.2%	1.7	1.3	1.0	1.8	2141	57.2%	1.0	1.2	1.0	1.3
In labor force													
Yes	8899	487	5.5%	1.0	1.0	...		4260	47.9%	1.0	1.0	...	
No	6266	518	8.3%	1.5	1.8	1.5	2.2	4200	67.0%	2.1	1.3	1.2	1.5
Total	15171	1,005	6.6%					8465	55.8%				

Again I conducted multivariate logistic regressions and found that other race (adjusted OR=4.4; 95% CI 3.4, 5.7), and never-married marital status (adjusted OR=4.2; 95% CI 3.4, 5.2) were the strongest predictors of never having had a Pap smear. Furthermore, Hispanic ethnicity, and education less than 12 years were also strong independent predictors. As with the data from 1987, I studied the pairwise and three-way interactions between the significant predictors. These tables can be found in Appendix 2. Overwhelmingly, the results were extremely similar to the 1987 data where demographics such as Hispanic ethnicity, not being married, income below the poverty line, and less than 12 years of education were significantly associated with risk for underuse of mammography and Pap smear screening

Chapter 5 Discussion and Implications

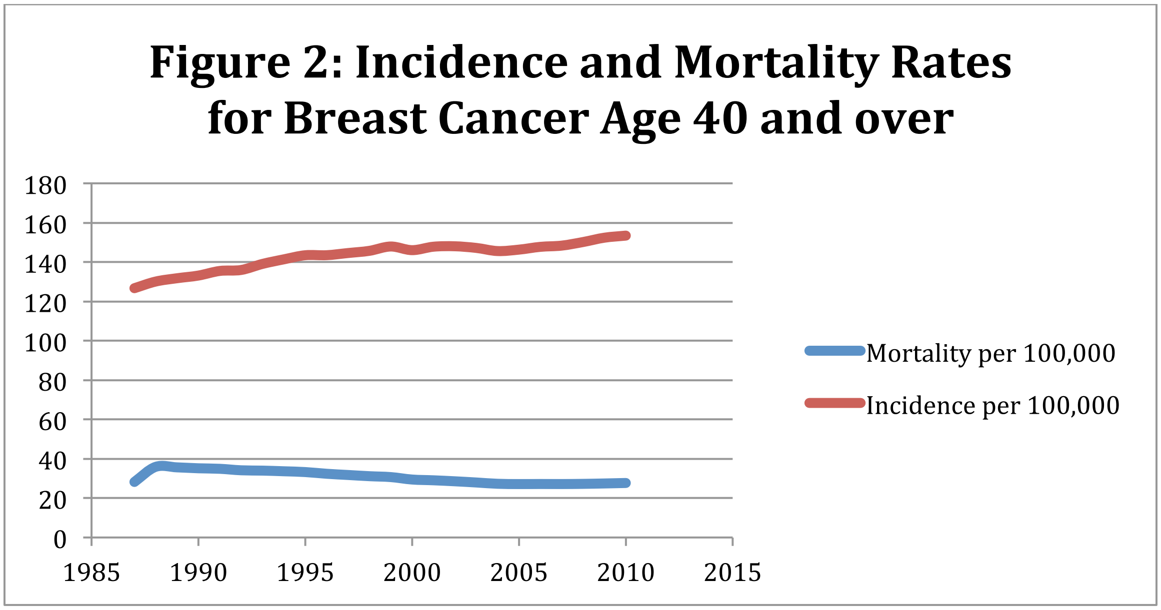
This study identifies many differences across basic demographic characteristics. It shows the importance of each characteristic regarding mammograms screening and Pap smear screening. Income is a significant predictor of mammography use. And while there is a greater incidence of breast cancer among higher socioeconomic classes, there is evidence to suggest that women of lower socioeconomic statuses are less likely to be diagnosed with early-stage disease and are more likely to die of the disease (Farley, 1989)

The most striking result from analyzing the 2010 data is that over the past 25 years, preventative healthcare usage has dramatically increased. The numbers for never having had a mammogram dropped from around 60% in 1987 to nearly 10% in 2010. Similarly, the numbers dropped for not being screened in that past year from over 85% in 1987 to 55% in 2010. The numbers were not as drastically different for Pap smears, but they decreased as well.

The largest discrepancies between the original study and my replication were with the Income variable. The income variable was difficult in that income was reported in either $1000 or $5000 increments which did not match exactly to the poverty lines for 1987. I contacted the authors to request their data so as to match their assumptions, but the only person to get back to me (who is also the only author still alive or working in the field) said that the study was so long ago he does not have the code nor does he remember their assumptions. Thus I did my best to make logical assumptions but I could never match their results exactly.

Another conclusion that can be drawn from the data is that the same predictors that were significant for preventative healthcare in 1987 (low income, little education, Hispanic ethnicity and non black or white races, and being widowed or never married) were for the most part still the most significant predictors in 2010. Again, the underuse numbers have significantly dropped, but the same groups of women that were most likely to be underserved in 1987 are also likely to be underserved and have the lowest screening rate in 2010.

Figure 2 shows a possible outcome of such trends. Over the past 25 years the breast cancer incidence per 100,000 females has steadily risen from 126 to 153. The mortality rate per 100,000 females dropped initially from about 1988 to 2003. However, over the last 10 years the mortality rate has remained constant at about 27 deaths per 100,000.



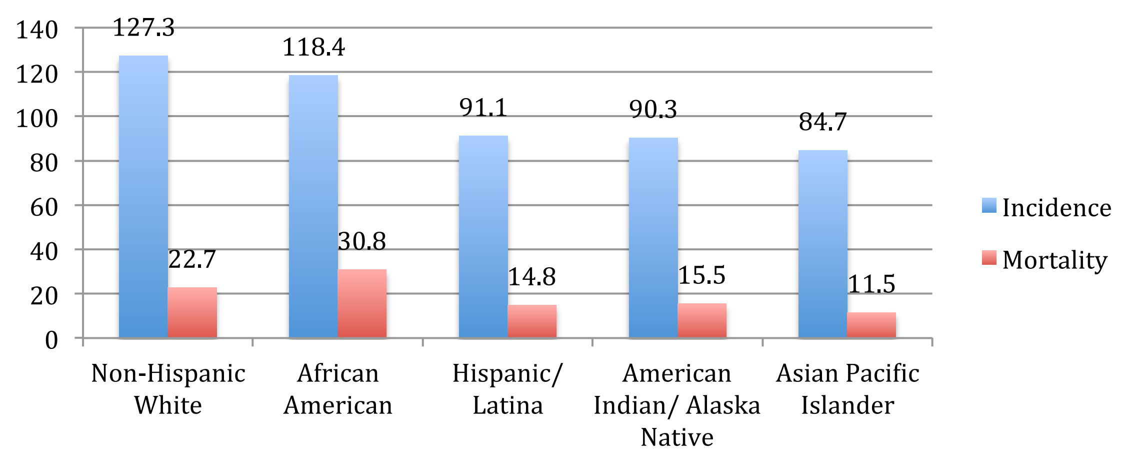
Source: Institute for Health Metrics and Evaluation, March 2014, http://www.healthdata.org/results/topics

In examining these trends, it is important to note that there are some limitations of mammography. The first limitation is false positive results. This occurs when the physician decides the mammogram is abnormal and needs additional follow-up. This can cause anxiety and stress in addition to costly and time consuming testing to rule out cancer. The second limitation is over diagnosis and over treatment. Screening mammograms can find cases of ductal carcinoma in situ (DCIS), which would never have caused symptoms or threatens a woman's life. This often leads to costly exams and procedures and exposes women to many of the painful cancer treatment options. Lastly, with each mammogram, small doses of x-rays penetrate the tissue. Repeated doses of the x-rays have the potential to actually cause cancer.

A plausible explanation for this plateau in the mortality rate for breast cancer seen in Figure 2 is exactly the disparities highlighted earlier in my analysis. It could be that women in the lower risk categories for underuse of mammograms (those who are white, with high incomes, or have high education levels) are being over-screened while those in high-risk categories (Hispanics, those below the poverty line, or with little education) are being under-screened. Thus while aggregate levels of screenings are increasing, they might not necessarily be reaching those who would benefit the most.

Indeed a study sponsored by the ACS highlights one aspect of this disparity. In Figure 3 numbers are given for incidence and mortality for breast cancer and are divided by race.   White women have the highest incidence rate for breast cancer. However black women are nearly 30% more likely to die of breast cancer than white women. As shown in my analysis, black women are not getting screened as often as white woman and thus their greater mortality rate is likely due to detection of the cancer in a late stage.

Figure 3. Female Breast Cancer Incidence and Mortality Rates per 100,000 by Race and Ethnicity Age 40 and Over, US, 2006-2010



Sources: Incidence: Copeland et al. Mortality: Howlader et al.

It seems that we as a society are not efficiently spending our healthcare dollars. Rather than recommending that every women be screened with a mammogram every year starting at age 40, it would seem more prudent to target those individuals in the highest risk categories for underuse of these screenings. The financial implications are enormous. In a recent study published in the *Annals of Internal Medicine* it was noted that if all women started getting screenings every year at the age of 40 as the ACS recommends, it would cost nearly $10 billion a year. That's in comparison to the US Preventive Services Task Force's recommendation that women receive mammograms every other year starting at age 50 which would only cost $2 Billion a year (O'Donoghue et at., 2014). This is a contentious issue but with such large financial implications it warrants a healthy debate in our culture.

Regarding Pap smear testing, it has already been noted that low income and minority women are usually diagnosed at later stages and have higher mortality rates. This also follows from my analysis of the demographic and socio-economic predictors of underuse of preventative healthcare measures. But cost limitations constantly challenge healthcare institutions in underserved communities where relatively expensive cytology-based cervical cancer screening programs have been difficult to sustain (Garner, 2003).

One possible solution was introduced in 2006. It is the HPV vaccine. Cervarix and Gardasil are currently the only two vaccines on the market, but have been shown to prevent up to 70-80% of cervical cancers (cdc.gov). This offers a solution to combat the disparities highlighted earlier. A study published in the *Journal of Evaluation in Clinical Practices* in 2010 examined the cost effectiveness of the HPV vaccine compared to regular Pap smear screening. They found that Triennial Pap smears over the expected life of a woman cost $379.6 whereas the vaccination cost $344.1 over the expected life (Chen, Meng Kan, et al., 2011). This conclusion lends vaccines as a viable option for targeted intervention for high-risk profiles of women.

For optimal results, the vaccine should be given to prepubescent teens before they are sexually active in three doses over six months. If given to those with high-risk profiles of underuse of screening measures (minorities, those at or below the poverty line, and those with little education) it could prevent 70-80% of the cervical cancers. With the already established higher mortality rates for those in this high-risk profile, the vaccine could help prevent future expensive treatments, procedures, and drugs to fight the cancer. The vaccines are still relatively new to the market, but do offer potential for better efficiency in healthcare expenditures.

Chapter 6 Conclusion and Policy Recommendations

This thesis has examined an important yet complex subject. The history of preventative healthcare measures is long, dynamic, and still controversial today. This study determined that there are disparities in usage of mammograms and Pap smears based on demographic and socio-economic predictors. Overall, certain trends emerged in both the 1987 data and 2010 NHIS data.

Over the past 25 years women on the whole have been using preventative healthcare screenings such as mammograms and Pap smears much more. For mammograms, the numbers for women overall never having had a mammogram dropped from around 60% in 1987 to nearly 10% in 2010. Similarly, the numbers dropped for not being screened in that past year from over 85% in 1987 to 55% in 2010. The patterns were similar for Pap smears as well.

However, a troubling pattern also emerged when comparing the datasets over time. Many of the exact same demographic and socio-economic predictors of women who had high-risk profiles for mammography or Pap smear underuse in 1987 were significant in 2010. The same patterns and gradients existed. As income decreased, screening usage also decreased. Women who were at or below the poverty line were much more likely to not have had a mammogram or Pap smear in both the 1987 dataset and 2010 data sets. As education decreased so too did the expected screening utilization. Women with less than 12 years education had much higher chances of underutilizing preventative screenings.

With healthcare costs on the rise it is important to examine expenditures to ensure cost efficiency is maximized. Using the information and disparities researched in this thesis, it seems as though we are over-screening certain demographics while still under-screening others. Those who are most likely to utilize screening (the educated, wealthy, or non-minority woman) seem to be over-screened as can be seen by the high incidence rate. While those who are least likely to receive care (less educated, poor, or minority women) are being under screened as evidenced by a high mortality rate. Policies that include women receiving mammograms every two years starting at the age of fifty and the widespread implementation of HPV vaccinations could decrease healthcare expenditures while not decreasing the quality of healthcare.

But to overcome these disparities highlighted, it will be necessary to target the barriers that can contribute to women in high-risk categories underutilizing preventative screening. It is vital to address the financial and health access barriers that high-risk women have. It is important to look at their knowledge, cultural beliefs, attitudes, acculturation, language, and literacy to understand what is causing the disparity.

There are many areas for future research on this topic. A limitation of the current study is that it did not include insurance as a predictor of screening use. This was done to match the original model. For future research, it would be beneficial to include insurance coverage as an independent variable. Another variable to consider is family history of cancer. Because many cancers can be related to genetics, it would also be useful to understand how family history affects those who are receiving screening. One topic would be to examine the different methods for breast and cervical screening as technology is progressing. Specifically, it would be beneficial to look at the respective costs and efficacy of each screening measure to be able to compare them for future use. This along with current research would allow a further understanding of how to provide the best healthcare to women in a cost-efficient manner.

Appendix A

Original tables from *Calle et at.* study

TABLE 1—Characteristics of Mammography Use in Women Aged 40 and Older, by Frequencies and Odds Ratios, National Health Interview Survey, 1987

		Never Had a Mammogram						No Mammogram in Past Year					
	n (total)	n (not screened)	%	Crude OR	Adjusted OR	95% CI		n (not screened in past year)	%	Crude OR	Adjusted OR	95% CI	
Age, y													
40-49	1723	984	57.1%	1.0	1.0	...		1456	84.5%	1.0	1.0	...	
50-64	2107	1195	56.7%	1.0	0.9	0.8	1.1	1761	83.6%	0.9	0.9	0.7	1.1
65+	2523	1716	68.0%	1.6	1.3	1.1	1.6	2281	90.4%	1.7	1.4	1.1	1.7
Race/ethnicity													
White	5076	3000	59.1%	1.0	1.0	...		4330	85.3%	1.0	1.0	...	
Black	862	561	65.1%	1.3	1.0	0.8	1.2	765	88.8%	1.0	1.0	0.8	1.4
Hispanic	328	226	68.9%	1.5	1.4	1.1	1.9	297	90.6%	1.7	1.6	0.9	2.9
Other	87	65	74.9%	2.1	2.3	1.3	4.1	82	94.7%	3.1	3.4	1.3	9.0
Income													
<PL	817	636	77.9%	3.5	2.3	1.8	2.9	768	94.0%	3.9	2.3	1.5	3.5
200% PL	1332	943	70.8%	2.4	1.8	1.5	2.1	1213	91.1%	2.5	1.8	1.4	2.3
300% PL	980	630	64.3%	1.8	1.6	1.3	1.9	861	87.9%	1.8	1.6	1.2	2.0
>300% PL	2222	1115	50.2%	1.0	1.0	...		1780	80.1%	1.0	1.0	...	
Education													
<12	2166	1590	73.4%	2.8	2.0	1.6	2.4	2004	92.5%	2.9	1.9	1.5	2.2
12	2443	1422	58.2%	1.4	1.3	1.1	1.5	2064	84.5%	1.3	1.2	1.0	1.5
>12	1716	851	49.6%	1.0	1.0	...		1393	81.2%	1.0	1.0	...	
Marital Status													
Married	2984	1725	57.8%	1.0	1.0	...		2510	84.1%	1.0	1.0	...	
Widowed	1959	1330	67.9%	1.5	1.0	0.8	1.2	1779	90.8%	1.8	1.1	0.9	1.4
Divorced	1005	604	60.1%	1.1	1.0	0.8	1.2	876	87.2%	1.3	1.1	0.9	1.4
Never Married	396	261	65.8%	1.4	1.2	0.9	1.6	356	90.0%	1.7	1.4	1.0	2.0
Urban Area													
Central City	2209	1325	60.0%	1.1	1.0	0.8	1.2	1898	85.9%	1.1	1.0	0.8	1.2
Other MSA	2488	1423	57.2%	1.0	1.0	...		2087	83.9%	1.0	1.0	...	
Non-MSA	1656	1114	67.3%	1.5	1.3	1.1	1.6	1497	90.4%	1.8	1.6	1.3	2.0
Region													
Northeast	1421	871	61.3%	1.1	1.1	0.9	1.4	1238	87.1%	1.2	1.2	0.9	1.4
Midwest	1555	914	58.8%	1.0	1.0	...		1328	85.4%	1.0	1.0	...	
South	2225	1431	64.3%	1.3	1.2	0.9	1.4	1938	87.1%	1.2	1.1	0.8	1.4
West	1152	635	55.1%	0.9	0.9	0.8	1.1	968	84.0%	0.9	1.0	0.7	1.3
In labor force													
Yes	2718	1544	56.8%	1.0	1.0	...		2291	84.3%	1.0	1.0	...	
No	3635	2319	63.8%	1.3	0.9	0.8	1.1	3188	87.7%	1.3	0.9	0.7	1.1
Total	6353	3850	60.6%					5470	86.1%				

Table 2—High-Rish Profiles of Women Who Had Never Had a Mammogram Based on All Pairwise Combinations of Significant Predictors

	Profile		n	n not screened	% Not Screened
1.	<PL, non-MSA		270	222	82.3%
2.	<PL, 65+		485	390	80.4%
3.	<PL, White		543	435	80.1%
4.	<PL, <12 y		595	476	80.0%
5.	200% PL, non-MSA		408	325	79.6%
6.	<12 y, non-MSA		645	507	78.6%
7.	<PL, not CC		203	157	77.5%
8.	300% PL, <12 y		257	196	76.3%
9.	<PL, 50-64		220	167	75.8%
10.	200% PL, <12 y		648	489	75.5%
11.	65+, <12 y		1183	893	75.5%
12.	200% PL, Black		214	161	75.0%
13.	Hisp, 65+		81	61	74.9%
14.	65+, non-MSA		728	545	74.9%
15.	40-49, <12 y		311	232	74.5%
16.	<PL, CC		384	286	74.4%
17.	<PL, Black		246	182	74.0%

Note. MSA = metro statistical area;

Table 3—High-Rish Profiles of Women Who Had Never Had a Mammogram Based on All Three-Way Combinations of Significant Predictors					
	Profile		n	n not screened	% Not Screened
1.	200% PL, 40-49, non-MSA		71	61	85.6%
2.	<Pt, 50-64, non-MSA		77	65	84.8%
3.	200% PL, 40-49, <12y		76	64	84.6%
4.	200% PL, Black, 40-49		52	44	84.4%
5.	<PL, <12y, non-MSA		193	163	84.4%
6.	<PL, 65+, non-MSA		155	130	84.1%
7.	<PL, White, non-MSA		212	177	83.4%
8.	<PL. White, < 12y		354	293	82.8%
9.	200% PL <12y, non-MSA		211	174	82.6%
10.	<PL, White, 65+		357	295	82.5%
11.	<PL, 65+, <12y		373	305	81.9%
12.	Hisp, 65+, <12y		53	43	81.9%
13.	200% PL, Black, non-MSA		37	30	81.5%
14.	Black, 65+, >12y		34	28	81.5%
15.	Hisp, 40-49, <12y		43	35	81.2%
16.	<PL, 50-64, not CC		40	32	80.8%
17.	300% PL, 65+, <12y		118	95	80.8%
18.	Hisp, <12y, not CC		41	33	80.2%
19.	<PL, White, CC		173	138	80.0%
Note MSA = metro statistical area;					

TABLE 4—Characteristics of Pap Smear Use in Women Aged 18 and Older, by Frequencies and Odds Ratios, National Health Interview Survey, 1987														
		Never Had a Pap Smear						No Pap Smear in Past Year						
	n (total)	n (not screened)	%	Crude OR	Adjusted OR	95% CI		n (not screened in past year)	%	Crude OR	Adjusted OR	95% CI		
Age, y													
18-39	5899	555	9.4%	1.0	1.0	…		2985	50.6%	1.0	1.0	…	
40-64	3830	188	4.9%	0.5	1.0	0.7	1.3	2604	68.0%	2.1	2.1	1.9	2.4
65+	2523	421	16.7%	1.9	2.5	1.9	3.3	2104	83.4%	4.9	3.6	3.0	4.3
Race/ethnicity													
White	9288	659	7.1%	1.0	1.0	…		5768	62.1%	1.0	1.0	…	
Black	1862	169	9.1%	1.3	0.8	0.6	1.0	1073	57.6%	0.8	0.7	0.6	0.9
Hispanic	835	170	20.3%	3.4	3.2	2.3	4.5	544	65.1%	1.1	1.1	0.9	1.4
Other	267	93	34.9%	7.0	9.1	5.7	14.6	183	68.6%	1.3	1.6	0.9	2.8
Income													
<PL	1977	376	19.0%	3.8	1.6	1.2	2.2	1305	66.0%	1.6	1.2	1.1	1.4
200% PL	2398	269	11.2%	2.1	1.3	1.0	1.6	1652	68.9%	1.8	1.4	1.2	1.6
300% PL	2170	143	6.6%	1.2	1.0	0.7	1.3	1339	61.7%	1.3	1.3	1.1	1.4
>300% PL	4274	248	5.8%	1.0	1.0	…		2287	53.5%	1.0	1.0	…	
Education													
<12	3019	504	16.7%	2.7	2.3	1.7	2.9	2300	76.2%	2.8	1.8	1.5	2.1
12	4854	330	6.8%	1.0	1.2	0.9	1.6	2976	61.3%	1.4	1.2	1.1	1.4
>12	4342	304	7.0%	1.0	1.0	…		2323	53.5%	1.0	1.0	…	
Marital Status													
Married	6113	281	4.6%	1.0	1.0	…		3613	59.1%	1.0	1.0	…	
Widowed	2004	333	16.6%	4.2	1.7	1.4	2.2	1665	83.1%	3.4	1.4	1.2	1.7
Divorced	1918	73	3.8%	0.8	0.7	0.5	1.0	1180	61.5%	1.1	1.1	1.0	1.2
Never Married	2200	541	24.6%	6.8	8.4	6.5	10.8	1296	58.9%	1.0	1.4	1.2	1.7
Urban Area													
Central City	4476	510	11.4%	1.5	0.9	0.7	1.2	2748	61.4%	1.0	1.0	0.9	1.1
Other MSA	4870	385	7.9%	1.0	1.0	…		2971	61.0%	1.0	1.0	…	
Non-MSA	2906	238	8.2%	1.0	0.9	0.7	1.1	1892	65.1%	1.2	1.1	0.9	1.2
Region													
Northeast	2535	297	11.7%	1.5	1.2	0.9	1.6	1627	64.2%	1.1	1.1	0.9	1.2
Midwest	3041	249	8.2%	1.0	1.0	…		1855	61.0%	1.0	1.0	…	
South	4263	354	8.3%	1.0	0.9	0.7	1.2	2639	61.9%	1.0	1.0	0.9	1.1
West	2413	215	8.9%	1.1	0.8	0.6	1.0	1474	61.1%	1.0	1.0	0.9	1.2
In labor force													
Yes	7047	486	6.9%	1.0	1.0	…		3960	56.2%	1.0	1.0	…	
No	5205	645	12.4%	1.9	1.3	1.0	1.7	3670	70.5%	1.9	1.1	1.0	1.2
Total	12252	1115	9.1%					7596	62.0%				

Table 5—High-Rish Profiles of Women Who Had Never Had a Pap Smear Based on All Pairwise Combinations of Significant Predictors

	Profile		n	n not screened	% Not Screened
1.	Hisp, NM		168	66	39.0%
2.	Hisp, <12y		360	117	32.4%
3.	<12y, NM		351	111	31.7%
4.	<PL, 65+		465	143	30.7%
5.	Black, 65+		275	80	29.2%
6.	<PL, Hisp		206	59	28.4%
7.	65+, NM		144	41	28.4%
8.	Hisp, 65+		81	23	28.3%
9.	200% PL, NM		338	94	27.7%
10.	<PL,widow		475	125	26.3%
11.	12y, NM		724	190	26.2%
12.	White, NM		1398	354	25.3%
13.	200% PL, Hisp		194	48	24.9%
14.	18-39, NM		1741	432	24.8%
15.	300% PL, NM		308	73	23.6%
16.	<PL, NM		632	149	23.5%
17.	Hisp, widow		82	19	23.4%
18.	>300% PL, NM		668	151	22.6%
19.	<12y, widow		960	213	22.2%
20.	65+, <12y		1183	258	21.8%

Note MSA = metro statistical area;

Table 6—High-Rish Profiles of Women Who Had Never Had a Pap Smear Based on All Three-Way Combinations of Significant Predictors					
	Profile		n	n not screened	% Not Screened
1.	<PL, Hisp, 65+		25	13	50.8%
2.	200% PL, Hisp, NM		37	18	47.9%
3.	Hisp, <12y, NM		62	29	46.3%
4.	300% PL, <12y, NM		29	12	42.5%
5.	200% PL, < 12y, NM		71	30	41.6%
6.	65+, <12y, NM		53	22	40.7%
7.	Hisp, 65+, <12y		53	21	40.4%
8.	Hisp, 18-39, NM		147	59	40.1%
9.	<PL, Black, 65+		103	41	39.4%
10.	White, <12y, NM		127	50	39.0%
11.	>300% PL, Hisp, NM		39	15	37.3%
12.	<PL, 65+, married		49	18	37.2%
13.	Hisp, 12y, NM		44	16	37.2%
14.	200% PL, Hisp, <12y		98	36	36.6%
15.	Hisp, 40-64, <12y		116	40	34.7%
16.	Black, 65+, 12 y		45	16	34.7%
17.	Hisp, <12y, widow		54	19	34.5%
18.	<PL, Hisp, widow		26	9	34.3%
19.	<PL, Hisp, married		72	25	34.1%
20.	<PL, White, NM		313	106	34.0%
Note MSA = metro statistical area;					

Appendix B

High-risk profiles of women in 2010 who had not had a mammogram or Pap smear based on pairwise and three-way combinations of significant predictors

Table 9—High-Rish Profiles of Women Who Had Never Had a Mammogram Based on All Pairwise Combinations of Significant Predictors, 2010

	Profile		n	n never screened	% Not Screened
1.	<PL, Hispanic		372	104	28.0%
2.	<PL, Other race		489	136	27.8%
3.	<PL, Black		473	129	27.3%
4.	Hisp, 65+		599	162	27.0%
5.	<PL, <12 y		639	171	26.8%
6.	65+, Black		424	113	26.7%
7.	<PL, 50-64		156	41	26.3%
8.	<PL, 65+		302	78	25.9%
9.	40-49, 200% PL		283	71	25.1%
10.	200% PL, <12 y		412	100	24.3%
11.	200% PL, Black		389	93	24.0%
12.	<12 y, Hispanic		640	148	23.2%
13.	200% PL, Other race		432	100	23.1%
14.	40-49, <12 y		525	115	21.9%
15.	<PL, White		478	96	20.0%
16.	300% PL, <12 y		429	83	19.3%
17.	65+, <12 y		389	69	17.8%

Note MSA = metro statistical area;

Table 10—High-Rish Profiles of Women Who Had Never Had a Mammogram Based on All Three-Way Combinations of Significant Predictors, 2010					
	Profile		n	n never screened	% Not Screened
1.	Hisp, 65+, <12y		75	41	54.7%
2.	200% PL, Black, 40-49		92	48	52.2%
3.	Hisp, 40-49, <12y		50	26	52.0%
4.	<PL, White, Div		95	49	51.6%
5.	200% PL, 40-49, Nev Mar		230	118	51.3%
6.	200% PL <12y, Nev Mar		154	78	50.6%
7.	<PL, White, Nev Mar		94	47	50.0%
8.	300% PL, 65+, <12y		213	105	49.3%
9.	<PL, <12y, Nev Mar		323	158	48.9%
10.	200% PL, 40-49, <12y		275	134	48.7%
11.	<PL, White, 65+		187	89	47.6%
12.	<PL. White, < 12y		89	42	47.2%
13.	<PL, 65+, Nev Mar		77	36	46.8%
14.	<PL, 50-64, Div		52	24	46.2%
15.	<PL, 65+, <12y		48	22	45.8%
16.	Black, 65+, >12y		42	19	45.2%
17.	Hisp, <12y, Div		134	58	43.3%
18.	200% PL, Black, Nev Mar		145	61	42.1%
19.	<Pt, 50-64, Nev Mar		69	29	42.0%

Table 11—High-Rish Profiles of Women Who Had Never Had a Pap Smear Based on All Pairwise Combinations of Significant Predictors, 2010

	Profile		n	n never screened	% Not Screened
1.	Other, 65+		132	35	26.5%
2.	Hisp, <12y		145	38	26.2%
3.	Black, 65+		328	84	25.6%
4.	Hisp, widow		230	54	23.5%
5.	Other, NM		129	30	23.3%
6.	18-39, NM		439	96	21.9%
7.	Hisp, NM		146	29	19.9%
8.	Other, <12y		207	40	19.3%
9.	200% PL, NM		143	27	18.9%
10.	<PL, 65+		306	55	18.0%
11.	200% PL, Hisp		323	56	17.3%
12	<12y, NM		148	24	16.2%
13.	<PL,widow		544	88	16.2%
14.	<12y, widow		236	35	14.8%
15.	65+, NM		267	37	13.9%
16.	<PL, NM		490	67	13.7%
17.	12y, NM		386	47	12.2%
18.	>300% PL, NM		248	28	11.3%
19.	<PL, Hisp		124	14	11.3%
20.	65+, <12y		309	27	8.7%

Note MSA = metro statistical area;

Table 12—High-Rish Profiles of Women Who Had Never Had a Pap Smear Based on All Three Way Combinations of Significant Predictors, 2010					
	Profile		n	n never screened	% Not Screened
1.	Hisp, 12y, NM		57	22	38.6%
2.	<PL, 65+, married		36	13	36.1%
3.	<PL, White, NM		54	19	35.2%
4.	Hisp, 40-64, <12y		39	12	30.8%
5.	200% PL, Hisp, <12y		101	31	30.7%
6.	65+, <12y, NM		56	17	30.4%
7.	200% PL, < 12y, NM		88	25	28.4%
8.	White, <12y, NM		139	39	28.1%
9.	Hisp, <12y, NM		76	21	27.6%
10.	Hisp, 18-39, NM		121	33	27.3%
11.	300% PL, <12y, NM		44	12	27.3%
12.	<PL, Hisp, married		85	23	27.1%
13.	<PL, Hisp, widow		96	25	26.0%
14.	<PL, Black, 65+		104	25	24.0%
15.	>300% PL, Hisp, NM		64	15	23.4%
16.	200% PL, Hisp, NM		128	29	22.7%
17.	Hisp, 65+, <12y		116	26	22.4%
18.	Black, 65+, 12 y		94	21	22.3%
19.	<PL, Hisp, 65+		72	16	22.2%
20.	Hisp, <12y, widow		91	20	22.0%
Note MSA = metro statistical area;					

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