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Variations in Hormonal Risk Factors for Breast Cancer in Marin County California

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Variations in Hormonal Risk Factors for Breast Cancer in Marin County, California

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Variations in Hormonal Risk Factors for Breast Cancer in Marin County California

Gabrielle Hall

Abstract

The purpose of this study was to examine the relationship between socio-economic status and established breast cancer risk factors related to endogenous and exogenous hormone exposures. This secondary analysis was based on a subset of data from a large epidemiological study of breast cancer, the Marin Women's Study, in Marin County California. Participants in the Marin Women's Study completed a 20 page self-administered questionnaire. Marin County California is an area with historically higher incidence of breast cancer. Previous efforts to explain the higher rates of breast cancer focused on the region's higher levels of socio-economic status. In a sample of 1,848 respondents, the following variables were examined in relation to education and income levels: age at menarche, age at menopause, total number of years menstruating, age at first pregnancy, number of pregnancies, total cumulative number of months breastfeeding, total number of years of oral contraceptive use, use of fertility medications, and the use of estrogen plus progestin hormone replacement therapy for greater than 5 years. Frequency distributions were calculated for each variable and median values were determined. The median education level obtained by participants was a Bachelor's Degree (34.8%). The median income level range was $150,000 to $299,999 (17.5%). Kendall's Tau-B and Cramer's V calculations showed the degree of correlation between education and income and the hormonal variables. The most significant associations between education, income, and endogenous hormones were not

very strong. The greatest correlation was a later age at first birth and increased levels of education (Tau-B = 0.238, $p < 0.001$), as well as increased levels of income (Tau-B = 0.159, $p < 0.001$). There were almost no associations of significance between education, income, and exogenous hormone exposure. The results from this study show that an increase in breast cancer rates in Marin County cannot be explained by an association between higher socio-economic status with higher levels of hormonal risk factors for the disease.

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Chapter I

Introduction

Worldwide, there are over 1,000,000 cases of breast cancer diagnosed annually (McPherson, Steel, and Dixon, 2000). The greatest incidence of new cases continues to be in North America (Parkin & Fernandez, 2006). In the United States, breast cancer is the most common type of cancer among women, excluding skin cancers (American Cancer Society, 2007). Approximately 180,000 new cases of invasive breast cancer were diagnosed in the United States last year (American Cancer Society, 2007). This means that the average American woman has a 12% chance of developing breast cancer over the course of her lifetime (Seer.cancer.gov, 2008).

On a more local level, during the period from 2000-2004 the incidence rate of breast cancer for all races in the State of California was 126.4 per 100,000 women; during the same period the rate for Marin County was 152.7 (Statecancerprofiles.cancer.gov, 2008). These data put Marin County near the top of the list for the highest rates of breast cancer globally.

Fortunately, there has been recent evidence to suggest that the rates in Marin County, as well as across the country, have been decreasing since the late 1990s. The initial decline that began in 1999 is thought to be due to a saturation of mammography screening (Jemal, Ward, and Thun, 2007). In 2003 there was an even greater decline following the 2002 release of the Women's Health Initiative Study (Ravdin, Cronin,

Howlander, Berg, Chlebowski, Feuer, et al., 2007). This study reported an increased risk of breast cancer and cardiovascular events for women using estrogen plus progestin hormone replacement therapy for greater than five years (Rossouw, Anderson, Prentice, LaCroix, Kooperberg, Stefanick, et al., 2002). As a result, many women stopped taking estrogen plus progestin hormone replacement therapy, and this decline in use is thought to have caused a similar decline in breast cancer rates (Colditz, 2007). The rapid and dramatic decrease in incidence points to the prominent role hormones may play in the development of certain breast cancers (Ravidn, et al., 2007).

Statement of the Problem

The incidence of many diseases is inversely proportional to socio-economic status. This is typically attributed to disparities in access to screening, treatment, and care. With breast cancer, women of lower socio-economic status do show decreased access to screening, an increased likelihood of presenting at a more advanced stage, and a decreased length of survival from breast cancer (Bigby & Holmes, 2005). However, as far back as the 1970s and 1980s, research has indicated that women of higher socio-economic status have higher rates of breast cancer. This has earned breast cancer the unlikely title of a "disease of affluence" (Rimpela & Pukkala, 1987). The use of socio-economic status to explain higher rates of breast cancer does little to help researchers, clinicians, and the general public better understand the etiology of the disease. The use of higher socio-economic status to explain increased rates of breast cancer in Marin County is questionable due to the variation in the prevalence of known hormonal breast cancer risk factors among women living in Marin with high socio-economic status.

Purpose of Study and Specific Aims

This study seeks to better understand the relationship between socio-economic status and established breast cancer reproductive and hormonal risk factors. The three aims below seek to examine the relationship between socio-economic status and established breast cancer reproductive and hormonal risk factors in a sample of 1,506 women in Marin County California, who had a mammogram between January 2007 and May 2008.

1) Describe the variations in socio-economic status as determined by education, household income, household size, home ownership, home value, and perceived social status;
2) Describe the variations in endogenous hormone exposures as related to education and income. Endogenous hormone factors include age at menarche, age at menopause, total number of years menstruating, age at first pregnancy, number of pregnancies, and total cumulative number of months breastfeeding.
3) Describe the variations in exogenous hormone exposures as related to education and income. Exogenous hormonal factors include total number of years of oral contraceptive use, use of fertility medications, and the use of estrogen plus progestin hormone replacement therapy for greater than 5 years.

Significance and Innovation

The research on whether or not higher socio-economic status is an independent risk factor for breast cancer has been problematic. While early research demonstrated that socio-economic status was an independent risk factor for breast cancer risk, others have hypothesized that it is a proxy for other variables, the most likely being reproductive

risk factors. One of the primary weaknesses with these studies is that they were unable to examine individual socio-economic status and had to rely on community data. This study aims to take a much closer look at a large cohort of women to assess their individual socio-economic status levels in relation to endogenous and exogenous hormone risk factors for breast cancer.

Many studies examining cancer rates use data gathered from cancer registries. Cancer registries are typically unable to collect useful data on socio-economic status. Researchers have hypothesized that this is probably due to the fact that information on individual income or education is rarely kept in medical records (Krieger, Quesenberry, Peng, Horn-Ross, Stewart, Brown, et al., 1999). As a result, most of the major studies evaluating socio-economic status and breast cancer risk have relied upon community rather than individual data (Liu, Deapen, and Bernstein, 1998). Historically, researchers have used census tracts or other geocoding methods to arrive at community figures. A likely result of an inability to obtain data on an individual level is that researchers have been unable to look at variations within a group of women with high socio-economic status. This study seeks to demonstrate that not all women with high levels of education and income share the same risk profile for breast cancer, just as women of low and high education and income do not.

Theoretical Framework

The framework for this research is the eco-social theory. It has its foundation in epidemiology but is strongly interdisciplinary. The fundamental question of the framework is 'who and what drive current and changing patterns of inequalities in health' (Krieger, 2001). The framework forces researchers to look for more complex patterns

that encompass a broader perspective than traditional biomedical models. This study uses the framework of the eco-social theory to understand the usefulness of higher socio-economic status as a possible explanation for increased breast cancer rates.

Chapter II

Review of Relevant Literature

Most of the recent literature regarding breast cancer incidence uses traditional models that seek to identify specific risk factors. Over time, a wide range of potential risk factors have been explored, with some remaining a concern for breast cancer while others have been shown to be unrelated. In addition to identifying specific risk factors, efforts have been made to quantify the degree of risk that each factor may confer. The key factors with the most relevance to determining a person's risk profile for breast cancer are gender, age, family history, genetics, reproductive history, hormonal use, prior history of hyperplasia in the breast, environmental factors including radiation exposure, and lifestyle factors such as alcohol intake and body mass (Singletary, 2003). Recent research has also found that increased breast density is positively associated with an increased risk for breast cancer (Martin & Boyd, 2008).

There are several aspects of a woman's reproductive history that can either increase or decrease her risk for breast cancer. Age at menarche, age of first pregnancy, the number of children a woman has, amount of time spent breastfeeding, and age at menopause, are all thought to play a role in breast cancer risk. Protective factors relating to reproductive history include: younger age at first birth (Hulka & Moorman, 2001), an increased number of children, and a longer time spent breastfeeding (Collaborative Group on Hormonal Factors in Breast Cancer, 2002). However, women who have their first

child after the age of 30 are actually at an increased risk as compared to women who do not have any children at all (Hulka & Moorman, 2001). Other reproductive factors that can increase breast cancer risk include early age at menarche, specifically below the age of 12, or reaching menopause at age 55 or older (Singletary, 2003). Most of the reproductive factors are thought to influence breast cancer risk because of the timing and degree of exposure to the endogenous hormones associated with physiological processes (Kelsey & Bernstein, 1996).

In addition to endogenous hormonal exposures through reproductive patterns, there are also a number of breast cancer risk factors related to exogenous hormone use. Data on the use of oral contraceptive pills and breast cancer risk have been conflicting. Some studies have shown that there is a small increased risk for those who are currently or have recently used oral contraceptives, however, this risk disappears 10 years after discontinuation (Collaborative Group on Hormonal Factors in Breast Cancer, 1996). The more significant risk factor, however, is the use of hormone replacement therapy and, in particular, the combination of estrogen plus progestin therapies for five or more years (Rossouw, et al., 2002). The timing of exogenous hormone use also appears to play a role in breast cancer, with increased risk occurring for women who use hormones before menopause (Shantakumar, Terry, Paykin, Teitelbaum, Britton, Moorman, et al., 2007).

In an effort to explain higher incidence rates of breast cancer found among women of higher socio-economic status, researchers have sought to draw connections to the previously mentioned established hormonal risk factors. With many of the endogenous and exogenous hormonal risk factors, researchers have theorized that the timing and amounts of exposure are likely to play a role in the development of certain

cancers and, in particular, breast cancer (Merrill, Fugal, Novilla, and Raphael, 2004). Many believe this is of particular concern for women of higher socio-economic status, because they are more likely to have delayed and/or reduced childbearing (Heck, Schoendorf, Ventura, and Kiely, 1997). This is an important connection as studies of socio-economic status and breast cancer rates are examined.

In the 1970s, researchers in Finland linked cancer registry data with census information to analyze several types of cancer and socio-economic status (Rimpela & Pukkala, 1987). Using occupation and education to determine socio-economic status, the results among women showed the most significant association occurred between high socio-economic status and breast cancer. The researchers attempted to explain this phenomenon by looking at changing reproductive patterns but were ultimately unable to demonstrate a link between socio-economic status, breast cancer, and changing reproductive patterns (Rimpela & Pukkala, 1987).

In a large epidemiologic study that followed a national cohort of women in the United States during the 1970s and again in the 1990s, Heck and Pamuk (1997) chose to look at breast cancer risk and its relation to education. The researchers felt that education was a better variable than others used in assessing socio-economic status because it is more likely to be constant over a person's lifetime. This could be especially important when examining diseases that have higher rates of incidence among older populations, such as breast cancer, because the elderly could more likely be on a lower fixed income. The authors found that increased education was indeed associated with a higher number of breast cancer cases. However, once other breast cancer risk factors, such as number of

births, age at first birth, and the use of exogenous hormones were considered, education ceased to be significant.

A study of Wisconsin women published in 2004 examined the role community socio-economic status played on breast cancer risk (Robert, Strombom, Trentham-Dietz, and Hampton). Unable to collect a significant number of individual level socio-economic status data, researchers relied on census data to create a composite socio-economic status figure. The indicators they chose to include were median family income, poverty and unemployment levels, and percentage of adults with a college education. The researchers found that simply living in an area of higher socio-economic status increased a woman's risk for breast cancer, even after controlling for other risk factors including individual reproductive patterns (Robert, et al., 2004).

Using an alternate methodology for estimating socio-economic status, in 1998 researchers examined socio-economic status and breast cancer incidence in Los Angeles County (Liu, Deapen, and Bernstein, 1998). The authors relied upon census-tract and cancer registry data to capture multiple dimensions of socio-economic status and breast cancer incidence trends over time. They concluded that an increased socio-economic status was associated with increased risk for breast cancer among non-Hispanic white women, which persisted even after controlling for other risk factors such as reproductive patterns and marital status (Liu, et al., 1998).

Krieger led a group that examined the incidence of various cancers in the San Francisco Bay Area from 1988 to 1992 (1999). The researchers were particularly interested in the role race and social class played in determining rates. Using geo-coding methods based on census tracts, the region was divided into three groups: areas of

working class poor, of working class non poor, and of professional. Based on this division, the authors found no variation in breast cancer incidence among non-Hispanic white women in the Bay Area (Krieger, Quesenberry, Peng, Horn-Ross, Stewart, Brown, et al., 1999).

Using incidence and mortality data collected from cancer registries as well as census data, researchers documented that between 1990 and 1999 breast cancer rates in Marin County increased at a rate six times faster than other areas of the country. Yet this dramatic rise was limited to women between the ages of 45 and 64 (Clarke, Glaser, West, Ereman, Erdmann, Barlow, and Wrensch, 2002). Researchers concluded that the high rates of breast cancer were attributable to Marin County's "unique and uniform sociodemographic characteristics, which correspond to a higher prevalence of women with known breast cancer risk factors" (Clarke, et al., 2002). Unfortunately, when the actual 2000 census figures were released, researchers were surprised to discover that there had been an error in the population projections for Marin County. There was a significant underestimation in the number of women aged 45 to 64 living in Marin. This meant that the initial calculations for the rates of breast cancer among this group of women, while still significant, were higher than they should have been (Phipps, Clarke, and Ereman, 2005).

In an effort to better understand the higher rates in Marin, a population-based case-control study was designed to interview over 500 women living in Marin County (Wrensch, Chew, Farren, Barlow, Belli, Clarke, et al., 2003). The researchers found that both groups were fairly similar in their exposures to both known and suspected breast cancer risk factors, including socio-economic status. Of particular interest was the

discovery that length of time living in Marin had no significance on breast cancer risk. This helped lay to rest concerns that the high rates of breast cancer in Marin could have been due to potential environmental exposures.

Using cancer registry data to analyze breast cancer incidence, in addition to several interview based studies to examine breast cancer risk factors, researchers in 2007 confirmed that the San Francisco Bay Area (SFBA) continues to have high rates of breast cancer as well as high rates of established risk factors (Keegan, Chang, John, Horn-Ross, Wrensch, Glaser, and Clarke). The authors found that since Surveillance, Epidemiology and End Results (SEER) began collecting data in 1973, incidence among non-Hispanic white women remained higher in the SFBA than other areas. While some argued that Marin County and SFBA rates were declining beginning in 1999, Keegan et al. (2007) confirmed that this was consistent with breast cancer trends elsewhere as well.

Chapter III

Methodology

This is a cross sectional study and a secondary analysis of data taken from a larger ongoing research project, the Marin Women's Study. The Marin Women's Study was initiated in 2006 as a response to Marin County's historically higher incidence rates of invasive breast cancer and higher rates of breast cancer risk factors. Using a 20-page, self-administered questionnaire, the study is designed to capture individual level data on a variety of factors that are possibly related to breast cancer. These factors include alcohol consumption, diet, exercise, environmental exposures, socio-economic status, exogenous hormone use, and reproductive history. The study also collects bio-specimens (saliva and/or blood), mammography data, and breast cancer case status to eventually

look at outcomes associated with individual and community behaviors. All study procedures and materials for the Marin Women's Study were approved by both the Marin General Hospital and Kaiser Permanente Internal Review Boards.

Eligibility criteria for the Marin Women's Study includes female residents of Marin County, age 18 or older, scheduled for a mammogram, and able to provide informed consent. Women scheduled for a mammogram at Novato Community Hospital, Marin General Hospital, and Kaiser Permanente facilities in Marin County are sent study materials prior to their appointments or they are handed materials at the time of their mammogram. In addition, Marin residents receiving mammograms outside of Marin County at the California Pacific Medical Center and the University of California San Francisco Medical Center, who have agreed to be contacted about research, are mailed study materials. All study materials are available in Spanish.

Initially, over 3,000 women completed the original version of the questionnaire. Based on response patterns and community feedback, the questionnaire was revised to increase the study's accuracy and validity. Due to slight variations in the two versions of the questionnaire, this analysis was completed using data solely from the newer, revised questionnaire.

Human Subject Issues

According to the UCSF Committee on Human Research, this study is considered a Category 4 exempt research project. The study falls in this category because it is using coded private data that was collected for another purpose. There was no contact with human subjects and no identifying personal health information was used. A self-certification form was completed.

Sample

Due to widespread publicity and community interest, the response rate for the Marin Women's Study has been high. By the summer of 2008 the Marin Women's Study had enrolled over 8,000 women, with a long-term goal of collecting data on up to 20,000 women. The current analysis uses data from 1,848 respondents whose questionnaires have been reviewed for completeness, entered into the study database, and de-identified. Further criteria were used in this analysis to limit respondents to include White, non-Hispanic women without a history of breast cancer and whose menstrual periods have permanently stopped. This ensures that the study sample only includes women who have completed their childbearing years, leading to a sample of 1,506. Due to randomly missing data, the N for each variable is slightly lower than 1,506.

Description of Questionnaire Data and Analyses for this Study

The following variables were used to describe the variations in socio-economic status: education (highest level obtained), household income (current gross annual income for the household), household size (number of people supported by household income), marital status (six categories from single to married), home value (self-estimation of market value), home ownership (four categories from no mortgage to renting), and self perception of social status currently and in high school (five categories from lower to upper class). The specific values possible for each variable are shown in Table 1. Descriptive statistics were used to examine the variables. Frequency distributions were calculated for each variable and median values determined. Data were missing from cases at random, leading to a different total number analyzed for each variable.

Due to a lack of a standardized formula, determining values for socio-economic status was the most significant challenge in analyzing the data. Typically income, education, and occupation are used in combination to assess socio-economic status. While occupation data were collected as part of the Marin Women's Study, the range of answers was large and difficult to quantify or rank. Traditionally, occupation data were seen as a reflection of social prestige. In modern times determining whether a person working, for example, in business marketing is of a higher status than someone in health care is no longer practical. In addition, many of the primary scales used to sort occupation data were created based on education and income levels.

This study determined socio-economic status based on education and income alone. Preliminary analyses depicted little correlation between increasing levels of income and education (Tau-B = 0.183, $p < 0.001$). As a result, the data were examined using education and income independently.

The following continuous variables were used to describe the variations in endogenous hormone exposure: current age (in years), age at menarche (year menstruation began), age at menopause (year menstruation ended, either naturally or as a result of surgery or other intervention), total number of years menstruating (age at menopause minus age at menarche), age at first live birth, total number of live births, and total number of months spent breastfeeding (sum of total months spent breastfeeding for each live birth). The minimum, maximum, mean, median, and standard deviation were calculated for each variable. Each variable was then divided into ordinal quintiles and analyzed with the education and income variables using cross tabulations and Kendall's Tau B. The p value for significance was set at alpha ≤ 0.05.

The following variables were used to describe the variations in exogenous hormonal changes: age first used oral contraceptive pills (in years), total number of years used oral contraceptive pills (sum of the number of years when birth control pills were used), age first used any type of hormone replacement therapy (in years), and the use of estrogen plus progestin (in years). The minimum, maximum, mean, median, and standard deviation were calculated for each variable. Cross tabulations were generated with the education and income variables. Cramer's V was used because there were both ordinal and categorical variables. The p value for significance was set at alpha ≤ 0.05.

Another possible exogenous hormonal exposure is fertility drug use. Unfortunately, only 22 women out of the 1,506 in the sample had ever reported using a fertility drug. In addition, there was a range of different types of fertility medications that the women took. As a result of these factors the data on fertility drug use were not examined.

Chapter IV

Results for Specific Aim 1

Table 1 describes variations in socio-economic status among respondents. Clearly the women who took part in the study have above-average income and education levels, even for Marin County. Over 90% of the sample population had some college education or greater. The median education level was a bachelors degree, with the next most frequent level a master degree. The median household income level range was $150,000 to $299,999, which is considerably higher than the $83,870 median income for Marin County (www.Census.gov, 2008). Perhaps reflecting the percentage of married respondents (58.3%), the majority of women (49.1%) reported that their current

household income supported 2 people. The median home value for respondents ranged between $750,000 and $1,000,000, with half (50.1%) paying a mortgage on their homes. Interestingly, using the self-perceived and self-reported social class levels, almost half of the women (47.1%) thought they were in the middle class in high school, yet a similar number (47.9%) reported being in the upper middle class currently.

To complete the data analysis, some of the responses were combined to create more equal distribution among groups. For education levels, the women with a professional degree or a doctoral degree were analyzed together, as well as the technical school, high school, and less than high school. For income levels, those with income levels below $49,999 were combined as well as those with incomes above $300,000. The variables regarding family size, home ownership, home value, and perceived social status both current and in high school, were not used to examine variations in hormone levels. They are included here only to provide a better picture of the sample's overall socio-economic characteristics but are not standard SES variables.

Table 1

Description of socio-economic status among respondents

Variables	Frequency	Percent	
Education			
Less than High School	13	0.9	
High School/GED	75	5.0	
Technical School	30	2.0	
Some College	262	17.4	
Associates Degree	116	7.7	
Bachelor's Degree	524	34.8	Median
Masters Degree	313	20.8	
Professional Degree	78	5.2	
Doctoral Degree	60	4.0	
Total	1471	97.7	
Missing	35	2.3	

Income			
<$24,999	49	3.3	
$25,000-$49,999	142	9.4	
$50,000-$74,999	208	13.8	
$75,000-$99,999	193	12.8	
$100,000-$149,000	316	21.0	
$150,000-$299,999	264	17.5	Median
$300,000-$499,999	81	5.4	
>$500,000	43	2.9	
Don't Know	21	1.4	
Decline to Answer	143	9.5	
Total	1460	96.9	
Missing	46	3.1	
Number of People Supported by a Specific Income			
1	427	28.4	
2	703	46.7	Median
3	164	10.9	
4	106	7.0	
5 or more	32	2.1	
Total	1432	95.1	
Missing	74	4.9	
Marital Status			
Married	878	58.3	Median
Living with Partner	76	5.0	
Widowed	150	10.0	
Divorced	258	17.1	
Separated	17	1.1	
Single, Never Married	113	7.5	
Total	1492	99.1	
Missing	14	0.9	
Home Value			
<$250,000	16	1.1	
$250,001-$500,000	63	4.2	
$500,001-$750,000	203	13.5	
$750,001-$1,000,000	356	23.6	Median
$1,000,001-$1,500,000	297	19.7	
$1,500,001-$2,000,000	134	8.9	

Don't Know	24	1.6	
Decline to Answer	58	3.9	
Total	1275	84.7	
Missing	231	15.3	
Home Ownership			
Own Home with no mortgage	486	32.3	
Paying Mortgage on Home	755	50.1	Median
Rent	155	10.3	
Other	40	2.7	
Total	1436	95.4	
Missing	70	4.6	
Current Social Status			
Lower	8	0.5	
Lower Middle	68	4.5	
Middle	600	39.8	
Upper Middle	722	47.9	Median
Upper	77	5.1	
Total	1475	97.9	
Missing	31	2.1	
Social Status in High School			
Lower	42	2.8	
Lower Middle	289	19.2	
Middle	709	47.1	Median
Upper Middle	391	26.0	
Upper	41	2.7	
Total	1472	97.7	
Missing	34	2.3	

Results for Specific Aims 2 and 3

Table 2 shows the distribution of endogenous and exogenous hormone exposure among participants. The range of current ages for the participants was from 35 to 100, with a mean of 62.9. The average age at menarche was 12.64 with a standard deviation of 1.43. The average age at menopause was 49.33 with a standard deviation of 5.86. The

mean value for the total number of years menstruating was 36.70 with a standard deviation of 5.99. The average number of live births was 1.56 with a standard deviation 1.32. These values reflect a fairly typical pattern for most women living in the United States. Where the respondents vary slightly outside of national norms, but not necessarily Bay Area norms, is the age at first birth with a mean of 27.31 years and a wide range of 14 to 45 years of age. The total number of months a woman breastfed over her lifetime varied considerably from 0 to 116 months, with the average being 12.03.

Table 2

Description of endogenous hormone exposure

Variables	N	Min	Max	Mean	Median	SD
Current Age	1481	35	100	62.86	61	8.78
Age at Menarche	1501	9	18	12.64	13	1.43
Age at Menopause	1427	20	65	49.32	50	5.86
Total Years Menstruating	1425	8	53	36.70	38	5.99
Age at First Birth	1035	14	45	27.31	26	5.72
Total Number of Live Births	1499	0	8	1.56	2	1.32
Total Number of Months Breastfeeding	1037	0	116	12.03	9	14.07

Table 3 examines the relationship between endogenous hormones and education levels. All variables except age at menarche show a correlation with increased education levels, however in most instances the correlation is quite weak. The variable with the greatest association is age at first birth ($r = 0.238$, $p < 0.001$). This shows that as education levels increased, so did the age at which women had their first child. There is

also a small negative correlation between increased education and the total number of live births, meaning that women of higher education had slightly fewer children. Of the 5 variables with some association with education, only one is protective for breast cancer: the total number of months spent breastfeeding. Four of the variables show an increase in breast cancer risk: later age at menopause, total years menstruating, later age at first birth, and number of live births.

Table 3

Relationship between endogenous hormones and education

Education	Kendall's Tau-B	P Value
Age at Menarche	0.027	0.185
Age at Menopause	0.081	< 0.001
Total Years Menstruating	0.089	< 0.001
Age at First Birth	0.238	< 0.001
Number of Live Births	-0.093	< 0.001
Total Months Breastfeeding	0.153	< 0.001

The relationship between endogenous hormones and income is shown in Table 4. The two variables that had the strongest association with education are the only two to show a significant, albeit weak, correlation with income. The age at first birth increased with increasing income levels (Tau-B = 0.159, $p < 0.001$); and number of months spent breastfeeding increased with greater income (Tau-B = 0.101, $p < 0.001$).

Table 4

Relationship between endogenous hormones and income

Income	Kendall's Tau-B	P Value
Age at Menarche	0.058	0.006
Age at Menopause	-0.014	0.545
Total Years Menstruating	-0.025	0.279
Age at First Birth	0.159	< 0.001
Number of Live Births	0.032	0.155
Total Months Breastfeeding	0.101	< 0.001

Table 5 depicts the distribution of exogenous hormone use among participants. A substantial portion of participants used oral contraceptives. The mean age of first use was 22.5 years (SD 5.39) with a wide range from 10 to 46 years of age. The average number of years oral contraceptives were used was 9.23 years (SD 7.56). For hormone replacement therapy of any type, the average age of first use was 50.6 (SD 7.04). The specific type of hormone replacement therapy that has been shown to increase breast cancer risk is estrogen + progestin. Women who took this type of HRT did so for a mean number of eight years (SD 5.98).

Table 5

Distribution of exogenous hormone use among participants

Variables	N	Min	Max	Mean	Median	SD
Age First Used Oral Contraceptives	1193	10	46	22.5	21	5.39
Total Number of Years Used Oral Contraceptives	1152	1	50	9.23	7	7.56
Age First Used HRT (any type)	959	14	82	50.6	50	7.04
Total Number of Years Used Estrogen + Progestin	493	1	41	8	7	5.98

Table 6 shows the correlations between education and exogenous hormone exposure. There is an extremely small association between increased education and an increased number of years using oral contraceptives (Cramer's V = 0.087, p = 0.015), as well as increased age at first use of hormone replacement therapy (Cramer's V = 0.095, p = 0.026). There is no association of significance between education and age at first use of oral contraceptive pills or between education and use of estrogen plus progestin hormone replacement therapy for five or more years (0.098, p = 0.463).

Table 6

Relationship between exogenous hormone exposure and education

Education	Cramer's V	P Value
Age First Used Oral Contraceptive Pills	0.073	0.170
Oral Contraceptives (Total Number of Years Used)	0.087	0.015
Age First Used Hormone Replacement Therapy (any type)	0.095	0.026
Hormone Replacement Therapy (5+ years of E+P use)	0.098	0.463

Table 7 depicts the relationships between income and exogenous hormone exposure. A small positive correlation can be found between increased age at first use of oral contraceptives and increased income (Cramer's V = 0.115, p = <0.001). There is also a minute relation between increased oral contraceptive use and increased income (Cramer's V = 0.086, p = 0.043). There are no associations of significance between income levels and the age at first use of hormone replacement therapy or use of estrogen plus progestin for five or more years.

Table 7

Relationship between exogenous hormone exposure and income

Income	Cramer's V	P Value
Age First Used Oral Contraceptive Pills	0.115	< 0.001
Oral Contraceptives (Total Number of Years Used)	0.086	0.043
Age First Used Hormone Replacement Therapy (any type)	0.089	0.152
Hormone Replacement Therapy (5+ years of E+P use)	0.095	0.562

Chapter V

Discussion

The results from this study show that an increase in breast cancer rates in Marin County cannot be explained by an association between higher socio-economic status with higher levels of hormonal risk factors for the disease. While some significant results were identified, the relationships were rather weak. For example, a significant but weak association was found between higher education levels and age at first birth, which could increase a woman's risk for breast cancer. The only other endogenous hormonal risk factor that had any correlation with higher levels of education was an increase in the number of months spent breastfeeding, which could decrease a woman's risk for breast cancer. Similar results were found between endogenous hormone exposures and income levels, but, again, the correlations were quite weak. There was also almost no relationship between exogenous hormone exposures and income or education.

Most of the previous research on socio-economic status and breast cancer has focused on incidence rates. In Marin County there are both higher levels of socio-economic status, as well as higher rates of breast cancer. It can be tempting to conclude that there is a possible correlation between the two. This study was not able to examine incidence rates, however, it did show that the links between hormonal risks factors and both education and income are minimal at best. If it was true that higher socio-economic status serving as a proxy for increased reproductive risk factors was an explanation for higher rates of breast cancer in Marin, then one might expect to see the risk factors concentrated among women with higher education and income. This study found that hormonal risk factors were more evenly distributed among post-menopausal, White, Non-Hispanic women, regardless of income or education levels.

While not an intended outcome, this study found that education is perhaps a better variable for determining socio-economic status. The researchers Heck and Pamuk (1997) felt that education was a better variable for assessing socio-economic status because it is less likely to fluctuate as much across the lifespan. This is of particular importance when looking at a disease that primarily occurs later in life, such as breast cancer. This study found that there was a small difference in the prevalence of breast cancer risk factors based on education, but not based on income. Also of interest in this population is the weak correlation between higher levels of education and income. This could prove important in future studies examining socio-economic status levels in Marin County.

The question remains, however, how useful is socio-economic status as a variable to explain patterns in breast cancer. To truly evaluate socio-economic status there needs to be a consistent method for calculating it. While this study was unusual in its ability to

look at individual level data, far too many studies continue to rely on community or census data. Novel methods of using factor analysis or composite measures should be generated and tested. In addition, it would be much easier to examine hypotheses on the role of socio-economic status and health if cancer registries and other surveillance organizations were able to capture data on an individual's education, income, and other relevant variables.

Limitations and Future Research

The primary limitation of this study is its inability to assess anything more significant than the prevalence of various risk factors in relation to education and income levels. Due to the nature of the study design, causation or rates of incidence cannot be determined. In the future a cohort study using the same participants could be completed to determine if income or education play a role in breast cancer outcomes. An analysis could follow in the vein of the eco-social framework to seek to better understand the patterns of disease distribution among women of Marin County.

This study did not look at variations in reproductive patterns based on age. It may be that the results would vary based on age cohorts. Similarly, younger women were not included in this analysis which could lead to an under or over estimation of the variation of risk. It is possible that younger women have alternate risk profiles based on increased awareness and education about breast cancer risk in Marin County. Future research could examine variations in socio-economic status and/or reproductive patterns among women of different generations.

There is the possibility of a recall bias within this analysis. This is especially likely for questions regarding age, dates, and lengths of time for such factors as hormone

use and breastfeeding. Potentially adding to this bias is the inclusion of only older women who are likely to have had more time elapse since such events. Fortunately the sample size is large enough to minimize such a bias in any one direction.

The study sample was limited to women accessing traditional Western medical care. While efforts were made to recruit women for the Marin Women's Study during free and low-cost mammography events, the larger study population may not have fully captured women with reduced access to health care in general. In addition, there are women in Marin who elect to undergo breast cancer screening at Thermography locations instead of using mammography. It is hard to estimate how excluding this group of women from the analysis would affect the results.

To be a true examination of the eco-social theory, future studies could look at a broader range of variables. It would be important to not only examine potential exposures and biological risk factors, but to also investigate how issues such as accountability, power, and knowledge interact to contribute to breast cancer risk in Marin County.

Conclusion

This study did not demonstrate a significant link between higher education or income levels and established reproductive and hormonal risk factors for breast cancer in white, non-Hispanic, post menopausal women in Marin County. If it is true that higher socio-economic status increases a woman's risk for breast cancer, there needs to be a better explanation for that hypothesis. This study also explored the lack of understanding about what constitutes socio-economic status as a variable, much less its connection to

breast cancer risk. More work needs to be done to examine how and when socio-economic status should be used as an explanation for patterns in breast cancer risk.

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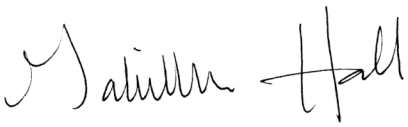

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