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Socioeconomic Disparities in Breast Cancer Screening among US Women: Trends from 2000 to 2005

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Objectives : This study describes trends in the socioeconomic disparities in breast cancer screening among US women aged 40 or over, from 2000 to 2005. We assessed 1) the disparities in each socioeconomic dimension; 2) the changes in screening mammography rates over time according to income, education, and race; and 3) the sizes and trends of the disparities over time.

Methods : Using data from the Behavioral Risk Factor Surveillance System (BRFSS) from 2000 to 2005, we calculated the age-adjusted screening rate according to relative household income, education level, health insurance, and race. Odds ratios and the relative inequality index (RII) were also calculated, controlling for age.

Results : Women in their 40s and those with lower relative incomes were less likely to undergo screening mammography. The disparity based on relative income was greater than that based on education or race (the RII among low-income women across the survey years was 3.00 to 3.48). The overall participation rate and absolute differences among socioeconomic groups changed little or decreased slightly across the survey years. However, the degree of each socioeconomic disparity and the relative inequality among socioeconomic positions remained quite consistent.

Conclusions : These findings suggest that the trend of the disparity in breast cancer screening varied by socioeconomic dimension. Continued differences in breast cancer screening rates related to income level should be considered in future efforts to decrease the disparities in breast cancer among socioeconomic groups. More focused interventions, as well as the monitoring of trends in cancer screening participation by income and education, are needed in different social settings.

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Key words : Socioeconomic disparity, Cancer screening, Trend, Breast cancer

INTRODUCTION

Breast cancer is the most commonly diagnosed cancer among women in the United States and the second most common cause of cancer deaths in women, after lung cancer [1]. In 2004, the breast cancer mortality rate in the United States was 22.0 per 100,000 person-years, which is four times higher than the rate of 5.4 in Korea [2]. The American Cancer Society estimates that 40,000 US women die from breast cancer every year and that one in eight (about 12%) is affected by breast cancer during her lifetime [3]

The risk for breast cancer increases with age, but several other factors are also associated with an increased incidence of breast cancer; these include family history, obesity, benign breast disease, early menarche, late menopause, not bearing children, and late childbearing [4]. However, there is no clearly defined risk factor that can be modified in intervention or prevention. Therefore, breast cancer screening is critical especially considering that screening mammography can decrease breast cancer mortality rates by 20 to 30% in general [5].

Cancer-related organizations such as the American Medical Association, the American College of Obstetricians and Gynecologists (ACOG), and the American Cancer Society recommend that women age 40 and older have a mammogram every year. The breast cancer screening rate has been increasing steadily since the 1990s but fell slightly between 1999 and 2002 [6]. This drop in the screening rate raised the concern that breast cancer occurrence and mortality rates might increase. Moreover, despite the overall increase in the screening rate, disparities based on socioeconomic position still exist in breast cancer screening [7-10]. The US "Healthy People 2010" program aims to attain a 70% breast cancer screening rate by 2010, regardless of race or social class such as minorities, the poor, new immigrants, the uninsured, and women over 70 years of age [6]. Understanding the strong association between socioeconomic position and the breast cancer screening rate in the US may provide insight into improving the screening rate in Korea.

Several studies in other countries have revealed disparities between population subgroups at each phase of breast cancer: prevention, occurrence, screening, diagnosis, and treatment. The trend in the disparities between groups based on race, age, education, or income varies greatly [10,11], continually challenging researchers to explain the basis of

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these changes in disparity. For example, differences in the incidence and mortality of breast cancer among income groups have generally remained the same, whereas racial disparities, especially between black and white women, have decreased or even reversed [12]. A recent study indicated that the breast cancer screening rate is higher in black women than in white women. However, screening rates among non-black minority women and women of lower socioeconomic status are still low, and the morbidity and death rates have not been reduced [13,14].

To consider the role of socioeconomic position in breast cancer disparity comprehensively, a study must define and monitor the characteristics of groups that have fewer screenings. However, most previous studies have observed the differences among social classes cross-sectionally [11,15-18]. Only a few have systematically observed the trends in disparities by time period according to socioeconomic differences [19], although several studies have examined the interaction between dimensions such as social class, income, education, race, and region [10]. Harper and Lynch [19] measured state trends for education inequalities in smoking, binge alcohol consumption, physical inactivity, obesity, and seatbelt use [19], but cancer screening was not included in their study. Another study showed the national trends in mammography use by income and race for the period 1987-1994 [18]. Continued monitoring of population-based trends and variations in breast cancer screening use by socioeconomic position is needed.

In Korea, breast cancer rates have recently begun to rise sharply, and the incidence is expected to continue to increase. The breast cancer incidence among Seoul residents increased 58.3% between 1993 and 2002 [20]. In addition, over the past 2 years, the breast cancer screening rate for women aged 40 and older was 30.8%, far below the 60% goal of Health Plan 2010. In both Korea and the United States, improving the breast cancer screening rate is an important objective for the national cancer screening projects: "Health Plan 2010" in Korea and "Healthy People 2010" in the US. Moreover, a thorough grasp of the impact that socioeconomic position has on screening behavior can help to reduce the burden of breast cancer by increasing effective cancer screening. The inequality level of a society is reflected in the differential patterns of the use of prevention services and the occurrences of disease, treatment, and death. Confirming the difference in breast cancer screening rates by socioeconomic position will help to plan effective intervention to cope with the ever-increasing occurrence of breast cancer. In addition, examining the trends in the difference in breast cancer screening rate by socioeconomic position in countries like the US, which already has a high burden of breast cancer, will suggest practical implications for understanding and intervening in the increasing rates of breast cancer in Korea.

In this study, we assessed the difference in the breast cancer screening rate according to women's socioeconomic position and reviewed trends in breast cancer screening disparities by socioeconomic position, using the 'Behavioral Risk Factor Surveillance System' (BRFSS) from 2000 to 2005. We examined the changes in breast cancer screening rates and existing disparities by observing differences in education, income, and racial demographics over the 5-year period.

METHODS

I. Data Sources

BRFSS data from 2000 to 2005 were used for this study. The BRFSS is a US national survey, conducted by the Centers for Disease Control(CDC) in cooperation with each state government. The subjects are civilian, non-institutionalized adults aged 18 or older, and it's purpose is to monitor risk factors related to health behaviors. The survey is performed on representative samples in each state, using a multistage cluster design that includes selected households as primary probability sampling units and households randomly selected from the telephone directory. One adult in each selected household was interviewed by telephone. A total of 184,450 to 356,112 people responded to the survey in each state from 2000 to 2005, with a median response rate of 76.7% [21].

The BRFSS questionnaire consists of standardized basic core questions (e.g., health behaviors and health perceptions) that are applicable to every state. Breast cancer-related questions are included in the women's health service section, which is conducted differently each year and in each state. In the years 2001, 2003, and 2005, the survey was conducted in 13 states only, which resulted in a total number of samples was about 30% of that in the other years. More detailed information about BRFSS is available at the CDC website [21].

For this study, we limited our analyses to women 40 years of age and older. The study population of this study consisted of 69,090 women in 2000; 80,996 in 2001; 100,374 in 2002; 111,055 in 2003; 131,660 in 2004; and 161,693 in 2005. Women younger than 40 years old were excluded because '40 or older' is the recommend criterion for mammography. Samples that were missing any key variables such as income, education, or race were excluded from the analysis.

II. Measures

The outcome measure was mammogram screening within the past 2 years. Respondents who "ever had a mammogram within past 2 years" were selected. Education, household income, and race were used to determine socioeconomic position. Education was classified into four categories: less than high school, high school graduate, some college, and college graduate or higher. Income was evaluated as relative income based on the annual household's income. For relative income, we substituted the value the respondent provided with the median value in the category, and then divided it into quintiles.

Table 1. Demographic characteristics of study population (women aged over 40 years, from 2000 to 2005)

Weighted percent (%)	Initial year 2000 (N=69,090)					Final year 2005 (N=161,693)				
		Race		Relative income			Race		Relative income	
	Total (N, %)	Black	White	Low	High	Total (N, %)	Black	White	Low	High
Age										
40-49	23,133 (33.13)	36.41	31.12	21.69	51.34	42,646 (32.11)	37.28	29.74	23.81	48.52
50-59	17,407 (25.14)	27.33	24.47	18.70	33.99	44,763 (27.48)	27.37	27.54	20.37	36.35
60-69	12,609 (18.96)	18.36	19.47	23.38	9.34	33,369 (17.83)	17.15	18.26	19.96	10.87
70+	15,941 (22.75)	17.87	24.93	36.21	5.32	40,915 (22.56)	18.18	24.43	35.83	4.24
Mean age(±SE)	58.01±0.08	56.38±0.27	58.84±0.08	62.90±0.20	51.03±0.16	58.14±0.06	56.48±0.21	58.93±0.06	62.60±0.16	51.26±0.09
Race/Ethnicity										
White	55,968 (77.30)			63.27	88.17	130,875 (74.78)			58.11	85.20
Black	5,145 (9.56)			15.17	3.65	12,464 (9.23)			16.07	4.85
Other	7,977 (13.12)			21.55	8.16	18,354 (15.97)			25.81	9.94
Annual household income										
<15,000	9,938 (14.95)	23.77	11.36			21,208 (13.62)	22.99	10.06		
15,000-49,999	30,311 (53.10)	59.89	52.71			66,861 (46.35)	53.07	45.00		
≥ 50,000	15,832 (31.93)	16.32	35.91			45,343 (40.02)	23.93	44.92		
Education										
None or some high school	9,875 (14.70)	22.64	10.61	34.55	0.92	18,579 (12.46)	18.01	7.97	31.69	0.97
High school graduate	23,201 (34.01)	35.06	35.55	40.34	14.88	53,589 (32.10)	33.88	33.24	40.04	14.22
Attended college or tech school (1-3 yr of college)	18,374 (26.79)	24.64	27.77	18.80	27.64	42,940 (26.35)	24.85	27.84	20.31	24.89
College degree or higher	17,415 (24.51)	17.63	26.05	6.29	56.54	46,101 (29.07)	23.24	30.93	7.94	59.59
Health Insurance										
Insured	63,138 (91.50)	85.94	93.83	82.60	98.37	120,875 (89.95)	84.68	92.81	79.21	97.98
Uninsured	5,909 (8.36)	13.77	6.07	17.33	1.59	12,412 (9.92)	14.97	7.02	20.48	1.96
Employment										
Employed for wages	29,729 (42.41)	47.33	41.66	22.50	61.73	64,215 (41.64)	45.00	41.71	19.64	62.84
Self-employed	4,609 (6.02)	3.40	6.41	3.23	10.61	10,674 (6.50)	4.31	6.68	3.74	10.15
Not in labor force	34,624 (51.56)	49.26	51.92	74.26	27.65	86,319 (51.85)	50.68	51.60	76.60	27.00
Marital status										
Married	35,784 (60.58)	36.44	63.55	29.28	91.32	83,810 (62.29)	37.91	65.21	29.48	89.62
Divorced, separated, widowed	28,761 (34.09)	50.28	32.32	63.06	6.54	66,662 (32.17)	46.30	30.56	61.70	7.69
Never married	4,269 (5.31)	13.27	4.12	7.65	2.12	10,509 (5.53)	15.78	4.22	8.81	2.67
Household size										
Mean(±SD)	2.44±0.008	2.63±0.03	2.33±0.008	2.11±0.02	2.92±0.02	2.49±0.006	2.53±0.02	2.39±0.006		
Self-reported health status										
Good or better	53,916 (78.56)	70.24	81.73	57.65	94.97	124,551 (77.77)	69.06	81.48	53.49	94.26
Fair or poor	14,983 (21.43)	29.75	18.26	42.34	5.02	36,475 (22.22)	30.93	18.51	46.51	5.73

Note: Unweighted N , % for total, Weighted percent (%) for other cells. All; p<0.001

The highest quintile group was categorized as the high-income bracket, and the lowest quintile group was the low-income bracket; quintiles 2, 3, and 4 were then designated as the middle-income bracket. We could not analyze occupational disparities because the BRFSS does not ask about occupation. Race is classified as white, black, and others. Self-reported health status was defined as the healthy group based on the answers 'Excellent' and 'Good' and the unhealthy group based on the answers 'Fair' and 'Poor'.

III. Statistical Analysis

We present the general demographic characteristics and the socioeconomic distribution of the study population from 2000 to 2005. For the breast cancer screening rate by year, we present the age-adjusted screening rates and standard error for assessing an absolute measure of disparity, taking the population for 2000 as the standard population. As a relative measure of disparity, we calculated the odds ratios and 95% confidence intervals, and the relative inequality index (RII) by socioeconomic position. We also analyzed the yearly change in the screening rate.

The RII is a relative measure of disparity that was developed to reflect socioeconomic groups of different sizes [22-25]. It is used to calculate the relative position of each socioeconomic position within a segment of the population, also considering what proportion it is of the whole. The relative socioeconomic position of each group ranged from 0 to 1. For example, in 2000, 32% of the women were in the highest income level; this group was assigned the proportion of the population above its midpoint, i.e., 0.16. The second group comprised 53% of the women, so its relative position was assigned a value of 0.32+0.53/2=0.585, which is the proportion of the population above the midpoint of this group. Using Poisson regression, we calculated the odds ratios and 95% confidence intervals of these indicators of socioeconomic position. The odds ratios represent the relative rate of screening when comparing two extremes of income level. We also calculated the RII p-trend by year for income and education.

SAS (v9.1) and SAS-callable SUDAAN were used to account for the multistage complex survey design of the BRFSS [26,27].

RESULTS

Table 1 shows the general characteristics of the study population. The distributions of the

Table 2. Age-adjusted proportion of participation in the breast cancer screening (weighted %)

	2000 (N=69,090)	2001 (N=80,996)	2002 (N=100,374)	2003 (N=111,055)	2004 (N=131,660)	2005 (N=161,693)
Age						
40-49	70.93	70.91	69.86	68.72	66.43	68.17
50-59	81.93	82.11	81.01	81.08	79.33	79.19
60-69	82.04	81.08	81.08	82.48	80.58	80.58
70+	75.86	72.96	76.27	73.20	75.72	74.79
Relative Income						
Low	68.25	64.95	66.95	66.93	65.38	66.00
Middle	78.04	77.59	77.66	76.56	75.17	75.00
High	84.25	85.12	83.06	83.04	81.34	80.98
Race						
White	77.26	76.71	77.14	75.44	75.32	74.94
Black	78.29	78.63	78.02	78.01	75.62	75.92
Education						
Less than high school	67.19	65.38	66.52	66.62	65.58	66.44
High school	75.96	76.27	75.23	74.07	73.39	73.37
Some college	78.74	76.77	77.86	76.00	74.78	74.37
College or higher	82.08	81.76	81.20	81.65	79.57	80.38
Health insurance						
Insured	79.30	78.68	78.90	77.86	77.26	77.58
Uninsured	50.92	50.27	52.74	53.05	49.82	48.50
Employment						
Employed	77.59	77.75	77.53	76.51	75.34	76.18
Self-employed	71.72	72.35	71.21	73.93	69.14	68.15
Not in labor force	76.97	75.41	75.88	74.88	74.57	74.56
Marital status						
Married	79.28	78.98	78.68	77.51	76.82	77.34
Divorced, separated, widowed	73.62	72.23	73.11	72.45	71.22	71.14
Never married	71.23	68.82	68.93	70.95	68.34	67.82
Household size						
Single HH	75.13	73.73	75.49	74.71	74.24	73.79
Number of HH $\geq$ 2		76.89	76.48	75.72	74.57	75.17
Health status						
Good or better	77.76	77.72	77.33	76.60	75.91	75.92
Fair or poor	74.05	72.78	72.60	71.86	69.62	71.19
Total	76.68	76.19	76.26	75.49	74.49	74.88

demographic characteristics for the beginning (2000) and ending (2005) years are presented. The change in distribution of each demographic across all 6 years was examined. In 2000, 14.9% of the study population was in the low-income group, with an annual household income of $15,000 or under; 31.9% was in the high-income group, with an annual household income over $50,000. The percentage in the high-income group increased slightly each year; in 2005, 40.0% of the sample was in the high-income group, while the proportion in the low-income group remained the same at 13.6% and the proportion in the middle-income group fell from 53.1 to 46.3%. With respect to the education level, the proportion of those with a college degree or more increased from 24.5 to 29.0%. There was no significant change in employment, marital status, or health status throughout the study period.

The distributions of general characteristics between races differed significantly. Black women were more likely to have 'less than high school' education, large proportions were divorced or widowed, and reported poor health. The pattern of a shrinking middle income group was similar among both races, although white women showed a slightly greater degree of change. Overall, white women were more likely to have a higher education level, to be married, and to report good health, compared with black women. They showed lower rate of employment, higher rate of 'not in labor force', but still had a higher rate of being insured. The differences in general characteristics also varied significantly by income level. Those in the low-income group were more likely to be aged 60 or over and to be black, unemployed, and divorced or widowed, with the lowest level of education and poor health.

Table 2 shows the crude rate of mammography by year. In 2000, the percentage of women aged 40 or over who reported having had a mammogram within the past 2 years was 76.6%. In 2005, it was 74.8%, reflecting a slight decrease ($p<0.001$). In 2000, the screening rate for women in the lowest relative income group was 68.2%, compared with 84.3% for women in the highest income group. In 2005, the rates decreased for both groups: to 66.0% in the lowest income group and to 80.9% in the highest income group. The drop was greater in the highest income group. Several characteristics were observed for those who had the lower screening rates: they tended to be less educated, unmarried, live alone, and report poor health status. By contrast, those with higher screening rates were more likely to be employed or self-employed, married, and live in multi-people households. Insured women also had higher screening rates, with the range of 79.3-78.8% compared with 51.2-54.4% for uninsured people. These parameters were consistent from 2000 to 2005, and the yearly changes in income level, education level, and health status were significant.

As Table 3 shows, the breast cancer screening rate differed by education level, income level, race, and insurance status. The screening rate was slightly lower in white women (77%) than in black women (78%), a finding that was significant across all survey years. The difference in screening rate by income level was also apparent throughout the survey years with statistical significance. In addition, across all years, the RII for income level was greater than the RII for education level. Odds ratio for getting mammogram among the relative income groups also consistently had a highest range of difference -from 2.64 to 3.69-among highest and lowest level within each socioeconomic positions. The disparities among education level were smaller than that by income level, with range of 2.2-2.5. Racial disparity showed the least difference, with the odds ratio of screening among black women ranged from 0.84-0.93, compared with white

Table 3. Age-adjusted participation rate* according to socioeconomic position, age adjusted odds ratio (95% confidence intervals) and Relative Inequality Index(RII) in breast cancer screening among US women age 40+, 2000-2005

Weighted percent (%)	2000 (N=69,090)		2001 (N=80,996)		2002 (N=100,374)	
	Participation rate (%) ± SE	Odds Ratio† (95% C.I.)	Participation rate (%)	Odds Ratio† (95% C.I.)	Participation rate (%)	Odds Ratio† (95% C.I.)
Race						
White	77.19 ± 0.29	0.93 (0.84, 1.04)	76.58±0.50	0.87 (0.74, 1.03)	76.97±0.24	0.93 (0.84, 1.03)
Black	78.21±0.92	1.00	78.99±1.36	1.00	78.29±0.87	1.00
Income						
High	85.82±0.95	3.08 (2.70, 3.51)	87.39±1.57	3.69 (2.97, 4.58)	84.14±0.81	3.01 (2.69, 3.36)
Middle	78.45±0.38	1.85 (1.70, 2.01)	77.91±0.65	2.04 (1.78, 2.33)	78.08±0.34	1.90 (1.77, 2.05)
Low	66.62±0.79	1.00	63.81±1.31	1.00	65.50±0.73	1.00
RII		3.71 (3.46, 3.98)		4.07 (3.57, 4.65)		3.68 (3.47, 3.90)
Education						
Less than high school	66.20±1.02	1.00	65.01±1.73	1.00	65.53±1.03	1.00
High school	75.54±0.47	1.61 (1.46, 1.77)	75.92±0.75	1.74 (1.49, 2.03)	74.86±0.41	1.57 (1.43, 1.73)
Some college	79.13±0.49	1.98 (1.79, 2.19)	77.02±0.87	1.85 (1.57, 2.18)	78.15±0.44	1.89 (1.71, 2.09)
College or higher	82.79±0.51	2.52 (2.26, 2.81)	82.07±0.87	2.52 (2.12, 3.01)	81.54±0.49	2.38 (2.14, 2.64)
RII		1.36 (1.33, 1.38)		2.58 (2.29, 2.91)		2.56 (2.43, 2.71)
Health insurance						
Insured	79.31±0.27	3.82 (3.44, 4.24)	78.65±0.45	3.94 (3.36, 4.62)	78.83±0.26	3.38 (3.10, 3.69)
Uninsured	51.21±1.57	1.00	53.68±2.22	1.00	54.38±1.36	1.00

* Calculated by direct age standardization (5 year interval) using the 2000 BRFSS population as the standard
† Adjusted for age

Table 3. Age-adjusted participation rate* according to socioeconomic position, age adjusted odds ratio (95% confidence intervals) and Relative Inequality Index(RII) in breast cancer screening among US women age 40+, 2000-2005 (Continued)

	2003 (N=111,055)		2004 (N=131,660)		2005 (N=161,693)		P for trend across year
	Participation rate (%)	Odds Ratio† (95% C.I.)	Participation rate (%)	Odds Ratio† (95% C.I.)	Participation rate (%)	Odds Ratio† (95% C.I.)	
Race †							0.0363
White	75.46±0.38	0.84 (0.73, 0.97)	75.04±0.24	0.94(0.87, 1.03)	74.75±0.44	0.91 (0.79, 1.05)	
Black	75.24±0.43	1.00	76.03±0.79	1.00	76.64±1.23	1.00	
Income†							0.0121
High	83.77±1.20	2.95 (2.52, 3.45)	82.16±0.70	2.86 (2.61, 3.14)	82.46±1.04	2.64 (2.26, 3.07)	
Middle	76.83±0.55	1.77 (1.59, 1.96)	75.51±0.33	1.76 (1.65, 1.88)	75.14±0.60	1.66 (1.49, 1.84)	
Low	65.60±0.96	1.00	64.03±0.66	1.00	65.06±1.02	1.00	
RII(p for trend=0.0177)		3.69 (3.30, 4.12)		3.61 (3.43, 3.79)		3.57 (3.21, 3.97)	0.1983
Education†							0.0177
Less than high school	65.68±1.32	1.00	64.85±0.94	1.00	65.01±1.46	1.00	
High school	73.59±0.66	1.47 (1.30, 1.67)	72.87±0.40	1.49 (1.37, 1.62)	72.93±0.69	1.47 (1.29, 1.68)	
Some college	76.23±0.75	1.70 (1.49, 1.95)	75.07±0.44	1.67 (1.52, 1.82)	74.56±0.80	1.60 (1.39, 1.84)	
College or higher	82.55±0.67	2.50 (2.17, 2.88)	80.07±0.41	2.26 (2.06, 2.47)	81.01±0.69	2.33 (2.01, 2.70)	
RII(p for trend=0.0649)		2.51 (2.26, 2.78)		2.46 (2.35, 2.58)		2.43 (2.20, 2.69)	0.011
Health insurance†							0.0542
Insured	77.82±0.39	3.21 (2.82, 3.67)	77.11±0.23	3.32 (3.06, 3.61)	77.42±0.41	3.73 (3.25, 4.27)	
Uninsured	53.40±2.07	1.00	52.05±1.29	1.00	51.41±1.96	1.00	

* Calculated by direct age standardization (5 year interval) using the 2000 BRFSS population as the standard
† Adjusted for age, † p for SEP difference <.0001

women as a reference.

The RIIs calculated for income and education level differed significantly by year and by socioeconomic position indicators. The RII for income level was highest (4.07) in 2001 and then fell slightly in 2004 and 2005, to 3.61 and 3.57, respectively. The RII for education level was highest in 2001 at 2.58 but remained relatively consistent over the years. We verified the p-value of the interaction between years and indicators in the analysis, and also checked the significance of the change in the yearly trends for the screening rate by socioeconomic status. The interactions of race, education, and income with year were all significant (p=0.0363, 0.0177, and 0.0121, respectively).

Figure 1 shows the trends for the disparities in the breast cancer screening rate based on income, race, and education. The disparity based on income was calculated as the absolute difference between the rate in the lowest income group and that in the highest income group. The racial disparity in rates was calculated by subtracting the rate among black women from the rate among whites. In 2000, the difference in the screening rate between women at the two income levels was 19.2%. In 2001, it increased to 23.6%; after 2002, it remained in the range 17-18%, decreasing slightly to 17.4% in 2005. The size of the racial disparity was in the range of 0.2-1.9%. It had negative values for the years when the screening rate among black women was higher than that among white women. The size of income disparity and educational disparity were similar. The largest disparity was that based on income levels for all of the survey years, and racial disparity was smallest in its absolute size.

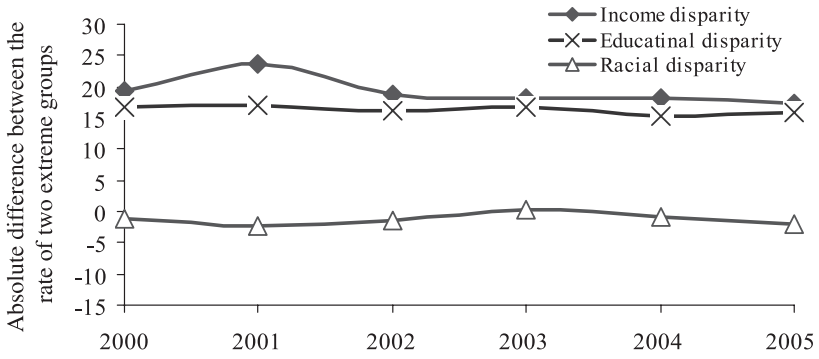

Figure 1. Trend in socioeconomic disparity in the use of breast cancer screening services in the past 2 years among women age 40 or over, 2000~2005.

Note: Disparity calculated as the absolute difference in the participation rates between the highest and lowest position in each index

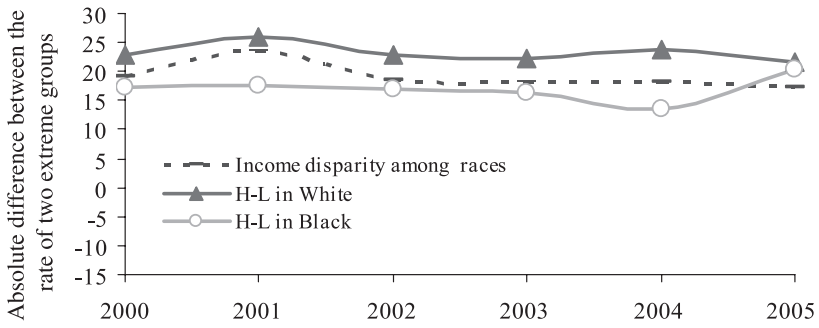

Figure 2. Trends in income disparity within racial groups, 2000~2005.

Note: L-H in White denotes the absolute difference in the participation rate between the highest and lowest income in White women; L-H in Black denotes the the absolute difference in the participation rate between the highest and lowest income in black women

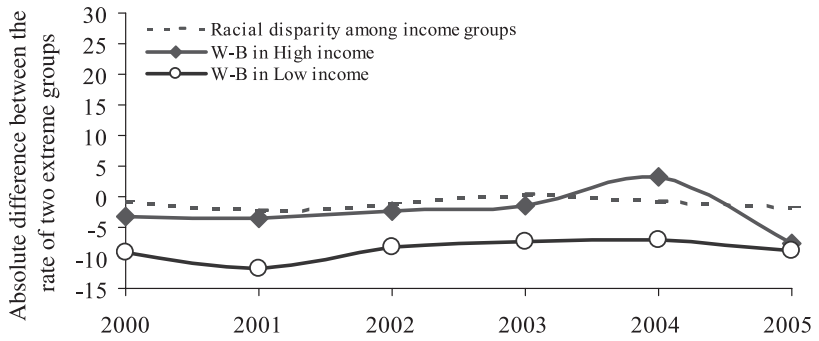

Figure 3. Trends in racial disparity within relative income groups, 2000~2005.

Note: W-B in Low imcome denotes the absolute difference in the participation rate between white and black women at a low income level; W-B in High income denotes the absolute difference in the participation rate between white and black women at a highest income level.

The trends in the screening rate by race and by income level within race are shown in Figure. 2, and the disparity based on income within race is shown in Figure. 3. Across the survey years, the income disparity was greater in white women than in black women, and the racial disparity was larger in the lower income group than in the higher income group.

DISCUSSION

In this study, we confirmed differences in the breast cancer screening rate based on women's socioeconomic positions; we also reviewed trends in the breast cancer screening disparity based on relative income level, education level, and race. The study period was 2000 to 2005, and we used data from the Behavioral Risk Factor Surveillance System.

Between 2000 and 2005, the rate of mammography use decreased slightly for all women 40 and older ($p<0.001$). The decreases were consistent across all socioeconomic groups. The three groups of women least likely to report having had a recent mammogram were those in their 40s, those in the lowest relative income group, and those without insurance. The disparity in the rate of recent mammography based on income level did not decrease but remained greater than that based on race or education level; in fact, it consistently remained 10-15% higher than the difference in the rate between white and black women. The racial disparity did not change significantly over time. The educational disparity decreased over time and might have been affected by a sharp increase in the number of poorly educated women who had recently had a mammogram.

In previous studies of breast cancer screening rates, high income, high education level, current employment, and central city residence were all positively associated with the use of mammography [28]. Even when women had a usual source of care with high accessibility to primary health care, the screening rate differed among socioeconomic positions [29]. The trend toward women with a lower socioeconomic position receiving less screening is a long-observed result, and it remained the same after adjusting for race or insurance status. Studies have suggested potential explanations associated with a lower screening rate in lower socioeconomic position [29]. People in lower social classes rarely have insurance; and they have low accessibility to health facilities and can usually access only lower-level medical treatments; they may have

a low level of education and lack knowledge on cancer prevention and precautions [30,31]. The literature on the cancer screening rate according to socioeconomic position in both the US and Korea reveals that the differences based on education level are more consistent than those based on income level [30-34] . In this study, however, the differences in screening rates based on income level appeared to be more consistent than those based on education level. One explanation might be that we used relative income, not absolute income.

This study found that black women were more likely than white women to report recent mammography use, which corresponds to the findings of other recent studies. In contrast to the increased disparity in the breast cancer mortality rate between black and white women, recent reports show that the racial difference in the breast cancer screening rate in the US has decreased or even reversed, owing to an increase in the rate among black women [5]. Some mixed findings have been reported. For example, one study asserts that the screening rate in black women is as low as ever [10], and another contends that researchers can eliminate or even reverse the disparity based on race by adjusting for socioeconomic differences [32]. In a different report, the screening rate in low-income black women was higher than that in low-income white women after adjusting for access to medical treatment and geographical factors [35]. Therefore, whether racial disparity in breast cancer screening has increased or decreased is controversial.

Over the past decade, programs promoting mammograms might have helped to increase the screening rate among low-income black women. The National Breast and Cervical Cancer Early Detection Program, based in community clinics in counties that are home to many low-income black women, has targeted African-American women [33]. Its report indicates that various efforts to increase mammogram rates among these women have begun to have a positive impact on the racial difference in the screening rate.

Changes in health care delivery, such as eliminating out-of pocket expenses to health and maintenance organization subscribers, providing consistent contact with primary care, and reimbursing 80% of the cost of biennial screening mammography for Medicare beneficiaries since 1991, might have helped to increase the rate of mammography until the end of the 1990s [34,36]. However, many women with insurance still do not take advantage of their mammography benefits. More recently, an overall drop in the breast cancer screening rate was reported, and the reason for the decrement is not yet clear. The rate could be affected by many factors, including the unmet health care needs of an aging population, the shortage of mammography specialists, the increasing number of uninsured people, and the declining access to primary health care. In addition, the rate may be affected by personal characteristics, including patient knowledge, behavior, and literacy level, as well as the cultural beliefs, language, and assimilation process of recent immigrants. Moreover, despite eliminating the racial disparity in the screening rate, the income disparity did not decline. A recent study [37] suggested that differences in the rate of physician recommendation for mammography could help explain the income disparity in the screening rate and concluded that socioeconomic position, but not race/ethnicity, was related to obtaining a physician recommendation.

We stratified the screening rate difference based on income by race and found that the income disparity among white women was larger than that among black women. The screening rate difference based on race within a relative income level was also consistent for both the low- and high-income groups, but the magnitude of the racial disparity was greater within lower income groups. It will be important to define the vulnerable population and apply interventions that are most appropriate for the target population. In addition, more focused interventions are needed in the US to reverse the inequalities based on income and education than that based on race.

Several researchers have tried to determine the reasons for the disparities in the rates of breast cancer diagnosis, treatment, and death. One study [29] compared the breast cancer screening rate between women in Quebec, Canada, who are covered by national health insurance, and women in the US, where 10.3% of the population is not insured. The researchers found that the differences in the screening rate based on income were very similar between the two groups, even after adjusting for medical insurance. Although, economic factors may not influence the screening rate directly. For example, women with higher income are likely to have greater knowledge of the benefits of screening, or different attitude toward the benefits and risks of screening and are generally more active users of health care services, compared with lower-income women [5,32,34].

A comparative study of the breast cancer screening rates in four Western countries examined the relative disparity between the highest and lowest socioeconomic groups [38]. The disparity was 1.32 in 1994 and 1.29 in 2003 in Canada; 1.08 in 2002-2003 in England; 1.06 in 2001-2003 in New Zealand; and 1.01 (83/82) in 1997 and 1.04 (85/82) in 2003 in the US. The socioeconomic position was measured using a deprivation index for New Zealand and England and using individual income for the US and Canada. We confirmed that an inequality in breast cancer screening based on income level continues to exist worldwide, despite differences in the medical systems and the standards for inequality. Some European countries are beginning to introduce interventions focused on improving health behaviors and increasing the accessibility to health care, in order to

increase the screening rates among people of lower socioeconomic status. In Korea, the comprehensive Health Plan 2010 specifies a cancer management plan as one of its core projects. It aims to increase the current treatment rate of five major cancers (40.3%) to 60% by 2010. As we have learned from examples in Europe and the US, adequate interventions should be made to reduce the inequalities based on socioeconomic position, in addition to efforts to improve the overall screening rate.

This study has several limitations based on the BRFSS data that we used. First, we could not determine occupational disparities in breast cancer screening because the BRFSS does not include data on occupation. Second, the BRFSS asks about the respondent's experience with mammography, which includes mammography for all breast-related clinical symptoms, and the reported mammography may not have been related to the early detection of cancer; therefore, the breast cancer screening rate might have been overestimated. Third, the BRFSS is a telephone interview, therefore it is impossible to survey those people who have only a mobile phone or who do not have a home telephone; this may affect the generalizability of the survey, as it might not represent the entire US female population. Fourth, for the years 2001, 2003, and 2005, the questionnaire module related to women's health including mammography, was conducted in some but not all states, which reduced the number of responses to about 30% of the total. Furthermore, the uneven geographical distribution might have provided limited representation of the entire US population.

Despite decreasing racial disparity in the screening rate, the disparity based on income and education did not decline during the period from 2000 through 2005. It remained fairly consistent, and low-income women were more vulnerable to racial disparity while white women had a larger income disparity than black women. One possible reason for this finding is that although US efforts to make screening more accessible have focused on this income gap, the benefits of intervention have not yet been realized. The efforts to increase mammography among low income women in the US need to be investigated further. Simultaneously, in order to increase the appropriate use of mammography among women from diverse social and cultural settings, we should consider the many factors, especially income and education, which continue to influence women's decisions to have a mammogram.

REFERENCE

1. Centers for Disease Control and Prevention Division of Cancer Prevention and Control. *United States Cancer Statistics: 1999-2004 Cancer Incidence and Mortality Data.* Atlanta, GA: US Department of Health and Human Service, CDC, National Cancer Institute. 2005. [cited 2008 April 5]. Available from; URL:http://apps.nccd.cdc.gov/uscs.
2. OECD. *Health at a Glance 2007: OECD Indicators.* Paris: OECD; 2007. [cited 2008 April 5]; Available from: http://fiordiliji.sourceoecd.org/pdf/health 2007/8120070s1-25.pdf.
3. American Cancer Society. *What Are the Key Statistics for Breast Cancer?* Atlanta, GA: American Cancer Society; c2008. Available from: URL:http://www.cancer.org/docroot/CRI/content/CRI_2_4_1X_What_are_the_key_statistics_for_breast_cancer_5.asp.
4. Elmore JG, Armstrong K, Lehman CD, Fletcher SW. Screening for breast cancer. *JAMA* 2005; 293(10): 1245-1256.
5. Smigal C, Jemal A, Ward E, Cokkinides V, Smith R, Howe HL, et al. Trends in breast cancer by race and ethnicity: Update 2006. *CA Cancer J Clin* 2006; 56(3): 168-183.
6. Feldstein AC, Vogt TM, Aickin M, Hu WR. Mammography screening rates decline: A person-time approach to evaluation. *Prev Med* 2006; 43(3): 178-182.
7. Burns RB, McCarthy EP, Freund KM, Marwill SL, Shwartz M, Ash A, et al. Black women receive less mammography even with similar use of primary care. *Ann Intern Med* 1996; 125(3): 173-182.
8. Makuc DM, Breen N, Freid V. Low income, race, and the use of mammography. *Health Serv Res* 1999; 34(1 Pt 2): 229-239.
9. Schootman M, Jeffe DB, Reschke AH, Aft RL. Disparities related to socioeconomic status and access to medical care remain in the United States among women who never had a mammogram. *Cancer Causes Control* 2003; 14(5): 419-425.
10. Bigby J, Holmes MD. Disparities across the breast cancer continuum. *Cancer Causes Control* 2005; 16(1): 35-44.
11. Peek ME, Han JH. Disparities in screening mammography. Current status, interventions and implications. *J Gen Intern Med* 2004; 19(2): 184-194.
12. Farria DM, Schmidt ME, Monsees BS, Smith RA, Hildebolt C, Yoffie R, et al. Professional and economic factors affecting access to mammography: A crisis today, or tomorrow? Results from a national survey. *Cancer* 2005; 104(3): 491-498.
13. Coughlin SS, Uhler RJ. Breast and cervical cancer screening practices among Asian and Pacific Islander Women in the United States, 1994-1997. *Cancer Epidemiol Biomarkers Prev* 2000; 9(6): 597-603.
14. Ward E, Jemal A, Cokkinides V, Singh GK, Cardinez C, Ghafoor A, et al. Cancer disparities by race/ethnicity and socioeconomic status. *CA Cancer J Clin* 2004; 54(2): 78-93.
15. Blustein J. Medicare coverage, supplemental insurance, and the use of mammography by older women. *N Engl J Med* 1995; 332(17): 1138-1143.
16. Hedegaard HB, Davidson AJ, Wright RA. Factors associated with screening mammography in low-income women. *Am J Prev Med* 1996; 12(1): 51-56.
17. Blackman DK, Bennett EM, Miller DS. Trends in self-reported use of mammograms (1989-1997) and Papanicolaou tests (1991-1997)-Behavioral Risk Factor Surveillance System. *MMWR CDC Surveill Summ* 1999; 48(6): 1-22.
18. Makuc DM, Breen N, Freid V. Low income, race, and the use of mammography. *Health Serv Res* 1999; 34(1 Pt 2): 229-239.
19. Harper S, Lynch J. Trends in socioeconomic inequalities in adult health behaviors among U.S. states, 1990-2004. *Public Health Rep* 2007; 122(2): 177-189.
20. Shin MH, Oh HK, Ahn YO. Ten year trend of cancer incidence in Seoul, Korea: 1993-2002. *J Prev Med Public Health* 2008; 41(2): 92-99. (Korean)
21. Centers for Disease Control and Prevention. *Behavioral Risk Factor Surveillance System: About the BRFSS-Overview.* Atlanta: Centers for Disease Control and Prevention; 2006.

[cited 2008 Mar 28]. Available from: URL: http://www.cdc.gov/brfss/about.htm.
22. Davey Smith G, Hart C, Hole D, MacKinnon P, Gillis C, Watt G, et al. Education and occupational social class: which is the more important indicator of mortality risk? *J Epidemiol Community Health* 1998; 52(3): 153-160.
23. Kunst AE, Mackenbach JP. The size of mortality differences associated with educational level in nine industrialized countries. *Am J Public Health* 1994; 84(6): 932-937.
24. Mackenbach JP, Kunst AE. Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Soc Sci Med* 1997; 44(6): 757-771.
25. Sergeant JC, Firth D. Relative index of inequality: Definition, estimation, and inference. *Biostatistics* 2006; 7(2): 213-224.
26. Research Triangle Institute. *SUDAAN User's Manual, Release 9.0.* Research Triangle Park, NC: Research Triangle Institute; 2001.
27. Shah BV, Barnwell BG, Bieler GS. *SUDAAN Software for Analysis of Correlated Data, Release 9.* User's Manual. Research Triangle Park, NC: Research Triangle Institute; 2004.
28. Snider J, Beauvais J, Levy I, Villeneuve P, Pennock J. Trends in mammography and Pap smear utilization in Canada. *Chronic Dis Can* 1996; 17(3-4): 108-117.
29. Katz SJ, Zemencuk JK, Hofer TP. Breast cancer screening in the United States and Canada, 1994: Socioeconomic gradients persist. *Am J Public Health* 2000; 90(5): 799-803.
30. Kwak MS, Park EC, Bang JY, Sung NY, Lee JY, Choi KS. Factors associated with cancer screening participation, Korea. *J Prev Med Public Health* 2005; 38(4): 473-481. (Korean)
31. Jang SN, Cho SI, Hwang SS, Jung-Choi K, Im SY, Lee JA, et al. Trend of socioeconomic inequality in participation in cervical cancer screening among Korean women. *J Prev Med Public Health* 2007; 40(6): 505-511. (Korean)
32. Smith-Bindman R, Miglioretti DL, Lurie N, Abraham L, Barbash RB, Strzelczyk J, et al. Does utilization of screening mammography explain racial and ethnic differences in breast cancer? *Ann Int Med* 2006; 144(8): 541-553.
33. Henson RM, Wyatt SW, Lee NC. The national breast and cervical cancer early detection program: A comprehensive public health response to two major health issues for women. *J Public Health Manag Pract* 1996; 2(2): 36-47.
34. Bush RA, Langer RD. The effects of insurance coverage and ethnicity on mammography utilization in a postmenopausal population. *West J Med* 1998; 168(4): 236-240.
35. Berry DA, Cronin KA, Plevritis S, Fryback DG, Clarke L, Zelen M, et al. Effect of screening and adjuvant therapy on mortality from breast cancer. *Obstet Gynecol Surv* 2006; 61(3): 179-180.
36. Wojcik BE, Spinks MK, Stein CR. Effects of screening mammography on the comparative survival rates of African American, white, and Hispanic beneficiaries of a comprehensive health care system. *Breast J* 2003; 9(3): 175-183.
37. O'Malley MS, Earp JA, Hawley ST, Schell MJ, Mathews HF, Mitchell J. The association of race/ethnicity, socioeconomic status, and physician recommendation for mammography: who gets the message about breast cancer screening? *Am J Public Health* 2001; 91(1): 49-54.
38. Hussey P, Anderson G, Berthelot JM, Feek C, Kelley E, Osborn R, et al. Trends in socioeconomic disparities in health care quality in four countries. *Int J Qual Health Care* 2008; 20(1): 53.