Socioeconomic Disparities across Ethnicities: An Application to Cervical Cancer Screening

Brendan Walsh[1,3], Ciaran O'Neill[2,3]

[1] Division of Health Services Research and Management, School of Health Sciences, City University London, London, UK

[2] Discipline of Economics, Cairnes School of Business and Economics, National University of Ireland, Galway, Galway, Ireland

[3] Economics of Cancer Research Group (www.economicofcancer.com)

Abstract

Objectives: Our aim is to investigate socioeconomic disparities in cervical cancer screening utilization among and between ethnic groups in the United States.

Study Design and Methods: Data on 27,238 women aged 21 to 64 are obtained from the 2007 – 2011 years of the Medical Expenditure Panel Survey. Data on cervical cancer screening utilization in the preceding 12 months and 3 years and a range of socio-demographic characteristics is included. Analyses are undertaken for all women and across racial/ethnic grouping (White, Black, Hispanic, and Other). Concentration indices are used to measure the socioeconomic gradient across ethnic groups. Probit regression analyses are used to examine variations in utilization related to socioeconomic factors across ethnic groups controlling for a range of pertinent characteristics.

Results: Annual utilization rates are high in the US (60%) and greatest among Black women (66%). Disparities as measured by concentration indices were large in the US and are largest for White women (CI=0.179) relative to Black (CI=0.103) and Hispanic (CI=0.081) women. Screening differences across income, education and insurance status are also greater amongst White women.

Conclusions: Annual utilization – too frequent utilization – of cervical cancer screening is high in the US with large socioeconomic disparities also evident. Those from lower socioeconomic or uninsured groups who are most likely to have, and to die from cervical cancer, are least likely to screen. Disparities differ across ethnic groups and are greatest amongst White women. Incorporating organized screening may serve to improve both the systems efficiency and address disparities between and within groups.

Keywords: Cervical Cancer Screening, Disparities, Concentration Index

Introduction

In the United States (US) age-standardized mortality rates for cervical cancer fell from 5.6 deaths per 100,000 women in 1975 to 2.3 per 100,000 in 2010.[1] Screening was instrumental in this reduction in mortality. Differences in mortality rates across socioeconomic groups[2,3] and racial/ethnic groups[4,5] have also been linked to differences in screening utilization across these groups. Age-standardized cervical cancer mortality rates among non-Hispanic Black (termed Black from hereon) and Hispanic women were 4.2 per 100,000 individuals and 2.9 per 100,000 individuals respectively compared to 2.2 per 100,000 individuals among non-Hispanic White (termed White from hereon) women.[1] While disparities across ethnic groups in cervical cancer treatment may explain some of the differences in mortality[6], lower screening rates among non-White women in the past may also explain these mortality differences.

Examining screening disparities between groups can aid in understanding the nature of barriers to screening and in developing appropriate policy responses. Despite the fact that evidence shows that cervical screening utilization differs between ethnic groups *and* socioeconomic groups in the US,[7-10] there is a dearth of research examining how socioeconomic disparities may differ across ethnicities. There is evidence that higher income and private health insurance are predictors of screening for White and Hispanic women, but they play a small (insignificant) role for Black women.[7] Income and education disparities have also been shown to be greater among White women relative to other groups.[11] However, more detailed analyses of these relationships are not pursued in these studies, in part perhaps because of limitations in the data used with respect to a fuller range of socio-demographic variables. Similarly, no attempt is made to quantify or compare socioeconomic disparities between groups to inform discussion of relationships. If differences in socioeconomic

disparities between ethnicities exist, this would add to our understanding and prompt more effectively tailored policy instruments. In this paper, we augment an analysis using regression techniques with an examination of the socioeconomic gradient in cervical cancer screening using concentration indices to shed further light on the issue of disparities.

Methods

Data

Data from the 2007 – 2011 years of the Medical Expenditure Panel Survey (MEPS) are used in the analysis. MEPS is a nationally representative survey of respondents' health, health care usage and a range of socio-demographic characteristics. Years 2007 – 2011 are chosen in order to increase the number of observations available. Years prior to 2007 are not included as they do not incorporate the same explanatory variable relating to total household income, and 2011 corresponds to the most recent year available. In the MEPS survey design, individuals are included in two consecutive waves of the survey. To prevent double counting in our pooled sample, only individuals in their second wave are included.

Within MEPS, women are asked if they screened for cervical cancer *i)* in the past year, *ii)* within the past 2 years, *iii)* within the past 3 years, *iv)* within the past 5 years, *v)* more than 5 years, *vi)* never screened. Using this variable, screening in the preceding 12 months and 3 years are analyzed amongst women aged 21 to 64 producing 27,238 observations. 12,282 were categorized as White, 5,451 as Black, 7,248 as Hispanic and 2,257 as Other ethnicities (including Asian and native American women, native Hawaiian/Pacific islander and multiple races). This age-group is recommended for screening by the American Cancer Society (ACS) and US Preventive Services Task Force (USPSTF).[12,13] Survey weights based upon the probability of being sampled in the survey are used to facilitate the robust extrapolation of

results to the overall population. We examine utilization at 12 months and 3 years to ascertain the stability of observed relationships at different intervals. Furthermore, while the USPSTF and ACS recommend screening using Pap tests every three years for women aged 21 to 64, annual screening is commonplace in the US.[14] Under the Affordable Care Act 26 States mandate annual screening for privately insured women.[15]

Concentration Indices

Socioeconomic disparities are calculated using concentration indices (CI). The CI allows us to measure the extent to which screening utilization in different income groups reflects their proportionate representation in the population. CIs are one of the foremost methods for calculating and comparing socioeconomic disparities,[16] including for cervical cancer screening[17,18] and other forms of screening.[19]

A continuous measure of socioeconomic status allows for the most precise calculation of CIs.[20] The total household income variable (FAMINC) in MEPS provides the measure of socioeconomic status in our analysis. Using this variable offers greater comparability among women in paid employment and those who are home makers for instance. Income is further equivalised to allow for more meaningful comparisons between women with different size households where disposable income might vary.[i] The OECD equivalence scale (square root of the number of people in the household) is chosen. It is this equivalised income variable which is thus used to rank women from the poorest to the richest in the sample.

The CI calculates a disparity estimate between -1 (screening disproportionately higher among poor) and +1 (screening disproportionately higher among rich), with 0 representing an equal

[i] In our sample family size for White, Black, Hispanic and Other is 2.76, 2.98, 3.91 and 3.33 members per household respectively.

distribution of screening across the ranking variable. The CI can be expressed as twice the covariance between screening (y) and income (R) divided by the mean of screening ($\bar{y}$):

$$CI = \frac{2cov(yR)}{\bar{y}}$$

For binary variables (whether woman screened in preceding 12 months or 3 years) the CI above is no longer bounded between -1 and +1. Therefore, it is further divided by 1 minus $\bar{y}$ to allow for the inequality to be measured between -1 and +1. This is known as the Wagstaff correction.[21] The CI used our analysis is thus expressed as:

$$CI = \frac{2cov(yR)}{\bar{y}} \Big/ 1 - \bar{y}.$$

Regression Analyses

Probit regression analyses were also undertaken allowing for adjusted socioeconomic disparities to be calculated, controlling for other potential confounders, and allowing for differences across education, marital status and health insurance status to be measured. Results are presented as marginal effects with standard errors clustered at the region level.[ii] Explanatory variables included were: educational attainment (Degree or higher, high school degree, and less than high school); marital status (married/cohabiting or not), age (5 year age-groups), geographic regions (Northeast, Midwest, South, and West) and ethnicity (White, Black, Hispanic, and Other). While the insurance plan of the woman was available, for ease of comparison health insurance status is included as any private insurance, only public insurance, and uninsured. While continuous equivalised household income is used to

[ii] While Odds Ratios allow for greater ease of interpretation, they cannot accurately be compared across models or across groups within a model.[22, 23] Therefore marginal effects are calculated in this study.

calculate the CIs, to allow for ease of interpretation of income it is partitioned into quintiles in the regression.

Results

Table 1 presents the descriptive statistics for the study sample. Whites constitute 45.09% of the sample, 20.01% are Black, 26.61% are Hispanic and 8.29% are Other. 32.49% had at least a Degree, 52.6% were married or cohabiting, 61.11% had private health insurance and 21% were uninsured.

Table 1: Descriptive Statistics

	Mean	Observations
Overall	**100%**	**27,238**
Ethnicity		
White	45.09%	12,282
Black	20.01%	5,451
Hispanic	26.61%	7,248
Other	8.29%	2,257
Income Quintile		
Income 1 (Lowest)	22.77%	6,203
Income 2	19.82%	5,399
Income 3	19.30%	5,257
Income 4	19.46%	5,300
Income 5 (Highest)	18.65%	5,079
Education		
Degree or higher	32.49%	8,852
High school	45.30%	12,340
Less than high school	22.20%	6,048
Marital Status		
Married/Cohabitating	52.60%	14,326
Unmarried	47.40%	12,912
Insurance Status		
Private Insurance	61.11%	16,644
Public Insurance	17.89%	4,874
Uninsured	21.00%	5,720
Age Group		
Age 21-24	10.76%	2,930
Age 25-29	11.35%	3,091
Age 30-34	11.73%	3,196
Age 35-39	11.70%	3,187
Age 40-44	11.78%	3,208
Age 45-49	12.12%	3,300
Age 50-54	11.61%	3,163
Age 55-59	10.46%	2,848
Age 60-65	8.50%	2,315
Region		
Northeast	15.16%	4,130
Midwest	19.98%	5,443
South	38.69%	10,538
West	26.17%	7,127

Table 2 presents utilization rates for cervical cancer screening in the preceding 12 months and 3 years with results partitioned across ethnicities. In the 12 month period, utilization in the US was 59.59%. Black women had higher utilization (66.05%) than Whites (60.05%) and Hispanics (57.97%). Utilization was higher amongst those in the highest income quintile compared to those in the poorest income quintile (67.93% versus 53.28%). Although an income gradient exists for each groups, the differential between the richest and poorest women was larger for Whites (68.12% versus 49.54%) than for Blacks (75.12% versus 61.73%) and Hispanics (70.14% versus 54.56%). Disparities are also greater for White women across to education and insurance status. Lower educated Blacks (58.14%) and Hispanics (54.12%) had greater 12 month utilization than similar Whites (43.55%). Blacks with private health insurance (71.36%) had higher utilization than Whites (64.66%) and Hispanics (63.71%) with private health insurance. Uninsured White women had far lower utilization (34.14%) than uninsured Black (43.52%) and Hispanic (47.51%) women. Screening utilization across Regions also differed across ethnicities though utilization for each group is greatest in the Northeast.

Overall utilization in the preceding 3 years in the US is 85.51%. Utilization is greater for Black (89.95%) than Hispanic (85.84%) and White (85.26%) women. While White, Black and Hispanic women in the richest group have similar utilization, the poorest Black (88%) and Hispanic (84.35%) have higher utilization than the poorest White (76.92%) women. Once more, lower educated Black (85.98%) and Hispanic(84.20%) women and uninsured Black (78.87%) and Hispanic (78.30%) women have greater utilization than similar White women (71.50% no high school degree, 66.77% uninsured). Marital status for Hispanic and Other ethnic women increases utilization by 11.7 and 14.74 percentage points respectively, though marital status is not as important for Black and White women.

Table2: Percentage Utilization of Cervical Cancer Screening in the US (Partitioned by Ethnicity) in the Preceding 12 months

Observations	US N=27,238	White N=12,282	Black N=5,451	Hispanic N=7,248	Other N=2,257	US N=27,238	White N=12,282	Black N=5,451	Hispanic N=7,248	Other N=2,257
Overall	59.95%	60.05%	66.05%	57.97%	52.16%	85.51%	85.26%	89.95%	85.84%	79.13%
Income Quintile										
Income 1(Lowest)	53.28	49.54	61.73	54.56	46.19	81.03	76.92	88.00	84.35	75.83
Income 2	51.56	48.15	62.25	55.35	40.19	80.15	77.95	86.61	83.93	69.31
Income 3	57.54	56.24	67.84	57.96	48.84	84.42	83.10	91.90	85.84	79.02
Income 4	62.69	63.26	69.32	58.27	54.01	87.56	87.99	91.68	86.95	77.92
Income 5 (Highest)	67.93	68.12	73.12	70.14	60.44	90.08	90.15	93.54	91.24	85.60
Education										
Degree or higher	66.96	67.59	72.25	63.60	58.82	90.69	90.98	93.91	90.55	84.85
High school degree	56.70	55.51	64.83	58.22	46.01	82.93	82.04	88.84	84.76	73.60
No high school degree	49.48	43.35	58.14	54.12	42.62	78.36	71.50	85.98	84.20	71.76
Marital Status										
Married/Cohabitating	62.22	62.29	69.00	61.52	56.29	88.27	87.55	93.29	90.91	85.15
Unmarried	57.02	56.58	64.65	53.53	46.18	81.95	81.72	88.36	79.53	70.41
Insurance Status										
Private Insurance	64.63	64.66	71.36	63.71	55.87	88.89	88.78	92.89	90.00	82.61
Public Insurance	57.32	50.56	68.16	61.23	51.19	82.68	76.55	90.13	88.17	80.82
Uninsured	39.51	34.14	43.52	47.51	32.33	71.51	66.77	78.87	78.30	58.10
Age Group										
Age 21-24	58.57	61.68	73.58	61.17	57.32	91.40	84.53	86.13	71.23	57.99
Age 25-29	67.61	69.47	68.11	48.76	40.68	80.26	92.94	94.37	88.27	81.10
Age 30-34	67.11	67.65	72.90	64.59	59.90	93.42	92.90	96.59	94.20	90.32
Age 35-39	63.14	64.40	69.93	58.83	53.36	90.20	90.23	93.42	90.09	85.36
Age 40-44	61.91	60.62	72.32	62.52	53.57	88.29	88.07	94.19	87.92	80.56
Age 45-49	58.11	57.54	64.85	56.89	54.27	84.95	83.33	90.47	87.21	86.70
Age 50-54	55.93	55.36	58.99	57.63	53.60	82.36	82.16	86.50	82.93	75.27
Age 55-59	54.79	55.32	55.64	54.74	46.53	79.97	78.67	83.23	85.65	80.57
Age 60-65	51.29	51.92	51.53	48.83	45.19	77.54	77.56	80.38	79.40	68.86
Region										
Northeast	63.73	63.79	68.89	63.32	56.35	88.91	87.75	91.59	88.22	85.88
Midwest	60.01	59.60	66.95	60.65	51.52	85.00	84.39	91.92	87.44	77.80
South	59.88	60.31	65.75	52.94	51.21	85.21	85.00	89.12	83.63	76.60
West	57.04	56.65	60.86	60.12	50.95	84.46	84.52	88.52	86.70	77.92

Figure 1 presents CIs for screening in the preceding 12 months and 3 years partitioned by ethnic group. In the US, and across all groups, pro-rich patterns (screening disproportionately higher among rich) exist. In the US, CI=0.144*** and CI=0.174*** are observed at 12 months and 3 years respectively. There are marked differences across ethnic groups. The largest disparities are observed amongst White women for the 12 month (CI=0.179***) and 3 year (CI=0.224***) periods. However, significant disparities exist for Blacks (CI=0.103*** 12 months; CI=0.151*** 3 years), Hispanics (CI=0.081*** 12 months; CI=0.079*** 3 years) and Other (CI=0.159*** 12 months; CI=0.178*** 3 years).

Figure 1: Concentration Indices for Cervical Cancer Screening in Previous 12 months and 3 Years. 95% Confidence Intervals

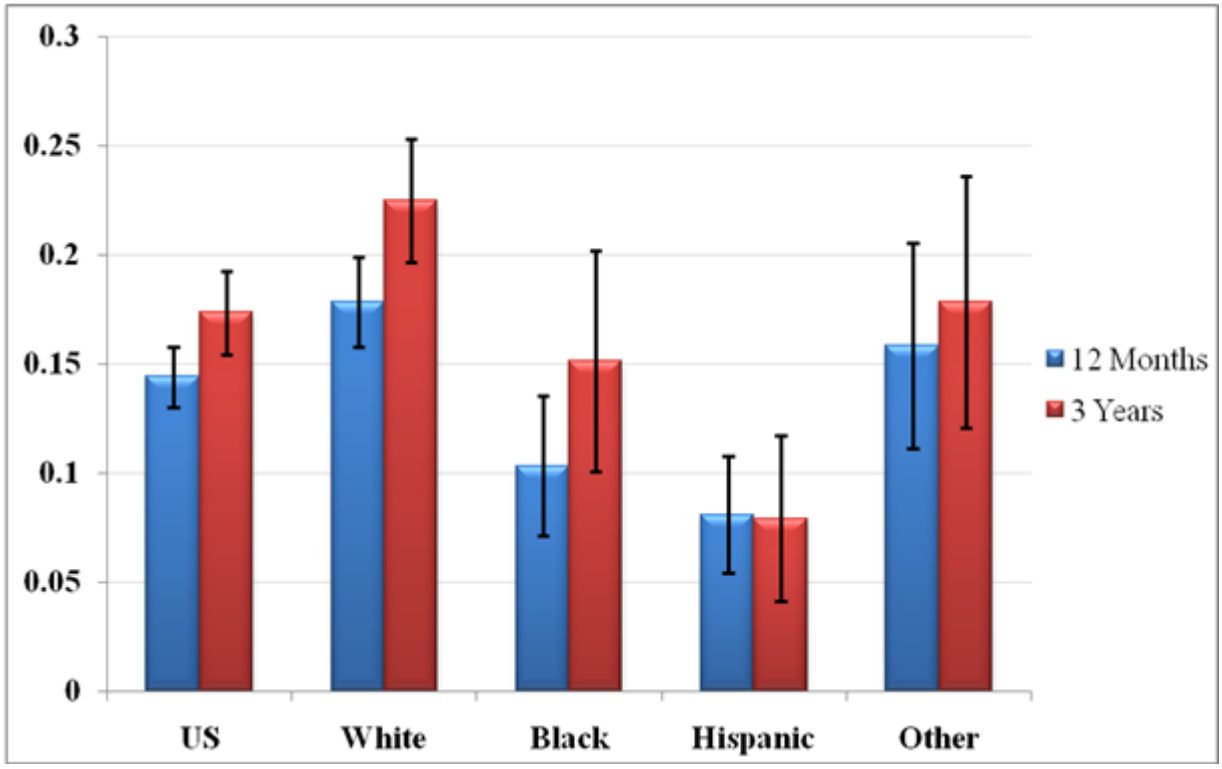

Table 2, illustrates the marginal effects following a probit regression of cervical cancer screening in the US. Utilization for Black and Hispanic women is 10.4 and 5.6 percentage

points higher compared to White women, *ceteris paribus*, and is lower for Other ethnicity (ME= -0.088***). Income disparities are greatest for Whites confirming the results of the CIs and women with lowest income have a ME= -0.087*** compared to the richest White women. In the US, compared to those with a degree, lower utilization is seen for the lowest education group (ME= -0.100***) with differences greatest for White women (ME= -0.149***). Being married is correlated strongly with screening for Hispanic women (ME= 0.067***). However the largest disparities are observed across insurance status. In the US sample, uninsured women's probability of screening is far lower than women with private insurance (ME= -0.221***) with the difference between across insurance status greatest for White (ME= -0.255***) and Black (ME= -0.253***) women, double that of Hispanic women (ME= -0.136***). No difference in the probability is seen between private and public health insurance for Hispanic women, though differences are observed with the White and Black groups. For White and Black women living in the West reduces the probability of screening by the greatest amount (ME= -0.62***; ME= -0.092***) while for Hispanic women the lowest utilization is in the South (ME= -0.88***).

Within the 3 year period some differences with the 12 month results are observed. Blacks (ME= 0.069***) and Hispanics (ME= 0.042***) have a greater probability of screening compared to Whites with Other ethnicity again the least likely to screen. While income disparities exist in the US as a whole and for White women, little or no income disparities in screening utilization are observed for Black and Hispanic women and for women from Other ethnicities for the 3 year period. However, significant disparities are still observed across education with the lowest educated group having a lower probability of screening in the US (ME= -0.079***), amongst Whites (ME= -0.123***) and Blacks (ME= -0.046) but not amongst Hispanics. The largest disparities are observed across insurance status with these

disparities once more greatest for Whites (ME= -0.172*** no high school degree) relative to Blacks (ME= -0.117*** no high school degree) and Hispanics (ME= -0.108*** no high school degree). Interestingly while White women with public insurance have a 6 percentage point lower probability of screening compared to private insurance, no differences across private and public insurance are observed for the other ethnic groups. Screening was highest in the Northeast, though the difference between regions was lower compared to the 12 month period.

Table 2: Marginal Effects Following a Probit Regression Cervical Cancer Screening Utilization in the Preceding 12 months in the US

	12 Months					3 Years				
	US	**White**	**Black**	**Hispanic**	**Other**	**US**	**White**	**Black**	**Hispanic**	**Other**
Income Quintiles										
Income 1 (Lowest)	-0.079***	-0.087***	-0.048***	-0.079*	-0.050*	-0.024	-0.039**	-0.001	0.003	0.006
	(0.026)	(0.029)	(0.016)	(0.042)	(0.026)	(0.017)	(0.019)	(0.013)	(0.022)	(0.035)
Income 2	-0.112***	-0.132***	-0.054	-0.089***	-0.137***	-0.050***	-0.059***	-0.024	-0.021**	-0.071***
	(0.024)	(0.025)	(0.013)	(0.033)	(0.049)	(0.015)	(0.019)	(0.018)	(0.011)	(0.024)
Income 3	-0.088***	-0.094***	-0.038	-0.085***	-0.077**	-0.042**	-0.051***	0.001	-0.020	-0.024
	(0.022)	(0.022)	(0.049)	(0.026)	(0.033)	(0.018)	(0.018)	(0.011)	(0.014)	(0.033)
Income 4	-0.055***	-0.047***	-0.041	-0.104***	-0.049	-0.025**	-0.018	-0.015	-0.033***	-0.062**
	(0.016)	(0.016)	(0.029)	(0.020)	(0.042)	(0.011)	(0.016)	(0.019)	(0.003)	(0.027)
Income 5 (Highest)	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
Education										
Degree or higher	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
High school degree	-0.067***	-0.077***	-0.046***	-0.010	-0.066**	-0.051***	-0.059***	-0.029**	-0.021	-0.035
	(0.013)	(0.020)	(0.011)	(0.024)	(0.032)	(0.007)	(0.010)	(0.011)	(0.022)	(0.031)
No high school degree	-0.100***	-0.149***	-0.090***	-0.034*	-0.103	-0.079***	-0.123***	-0.046***	-0.030	-0.086
	(0.023)	(0.030)	(0.022)	(0.018)	(0.071)	(0.016)	(0.016)	(0.007)	(0.020)	(0.065)
Marital Status										
Married or cohabitating	0.035***	0.024*	0.028**	0.067***	0.056*	0.048***	0.033***	0.037***	0.089***	0.091***
	(0.006)	(0.013)	(0.013)	(0.025)	(0.029)	(0.009)	(0.005)	(0.009)	(0.013)	(0.029)
Unmarried	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
Insurance Status										
Private Insurance	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
Public Insurance	-0.028**	-0.054***	0.002	-0.001	0.050*	-0.036***	-0.060***	-0.011	-0.002	0.036
	(0.011)	(0.020)	(0.024)	(0.025)	(0.028)	(0.008)	(0.013)	(0.011)	(0.024)	(0.022)
Uninsured	-0.221***	-0.255***	-0.253***	-0.136***	-0.175***	-0.153***	-0.172***	-0.117***	-0.108***	-0.086
	(0.014)	(0.018)	(0.004)	(0.018)	(0.016)	(0.005)	(0.005)	(0.007)	(0.015)	(0.065)
Age Group										
Age 21-24	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
Age 25-29	0.055***	0.035***	0.032	0.106***	0.111**	0.066***	0.055***	0.049***	0.087**	0.116***
	(0.014)	(0.012)	(0.027)	(0.038)	(0.042)	(0.007)	(0.015)	(0.011)	(0.010)	(0.019)

Age 30-34	0.033	-0.009	0.014	0.137***	0.105***	0.078***	0.045***	0.067***	0.121***	0.162***
	(0.030)	(0.031)	(0.042)	(0.014)	(0.027)	(0.006)	(0.013)	(0.003)	(0.003)	(0.021)
Age 35-39	-0.010	-0.042*	-0.023	0.072***	0.055**	0.046**	0.014	0.035***	0.088***	0.129***
	(0.023)	(0.024)	(0.025)	(0.015)	(0.025)	(0.017)	(0.024)	(0.010)	(0.006)	(0.017)
Age 40-44	-0.029	-0.088***	0.001	0.104***	0.056***	0.025	-0.014	0.042***	0.072***	0.095*
	(0.030)	(0.033)	(0.037)	(0.025)	(0.019)	(0.024)	(0.034)	(0.006)	(0.006)	(0.042)
Age 45-49	-0.066**	-0.116***	-0.066	0.043*	0.085*	-0.003	-0.063**	0.014	0.067***	0.152**
	(0.032)	(0.032)	(0.048)	(0.024)	(0.047)	(0.026)	(0.033)	(0.018)	(0.008)	(0.039)
Age 50-54	-0.100**	-0.151***	-0.134***	0.048	0.075*	-0.036	-0.088**	-0.021	0.038***	0.073*
	(0.051)	(0.051)	(0.030)	(0.030)	(0.040)	(0.035)	(0.046)	(0.021)	(0.011)	(0.033)
Age 55-59	-0.111***	-0.152***	-0.168***	0.028*	0.001	-0.058*	-0.125***	-0.050*	0.060***	0.100***
	(0.035)	(0.031)	(0.044)	(0.016)	(0.061)	(0.034)	(0.032)	(0.032)	(0.005)	(0.031)
Age 60-65	-0.144***	-0.184***	-0.202***	-0.029	-0.009	-0.079***	-0.137***	-0.062***	0.021	0.028
	(0.032)	(0.028)	(0.033)	(0.025)	(0.025)	(0.032)	(0.031)	(0.022)	(0.026)	(0.069)
Region										
Northeast	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
Midwest	-0.029***	-0.028***	-0.016***	-0.037***	-0.021***	-0.025***	-0.022***	0.008***	-0.036***	-0.073***
	(0.001)	(0.007)	(0.001)	(0.006)	(0.003)	(0.001)	(0.002)	(0.002)	(0.006)	(0.007)
South	-0.022***	-0.010***	-0.015***	-0.088***	-0.003	-0.021***	-0.011***	-0.018***	-0.012***	-0.056***
	(0.004)	(0.003)	(0.004)	(0.009)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.007)
West	-0.048***	-0.062***	-0.092***	-0.025***	-0.036***	-0.024***	-0.025***	-0.033***	-0.012***	-0.072***
	(0.006)	(0.002)	(0.002)	(0.005)	(0.006)	(0.002)	(0.000)	(0.002)	(0.003)	(0.007)
Ethnicity										
White	Base	-	-	-	-	Base	-	-	-	-
Black	0.104***	-	-	-	-	0.069***	-	-	-	-
	(0.006)					(0.005)				
Hispanic	0.059***	-	-	-	-	0.042***	-	-	-	-
	(0.026)					(0.009)				
Other	-0.088***	-	-	-	-	-0.070***	-	-	-	-
	(0.009)					(0.007)				

Robust standard errors in parenthesis
*** 90% statistical significance; ** 95% statistical significance; *** 99% statistical significance**

Conclusions

This study finds evidence of significant disparities in cervical cancer screening utilization across socioeconomic groups in the US, supporting the findings of previous studies. Interestingly these disparities, as measured by Concentration Indices, are larger than those observed in many other countries.[17, 18] *Ceteris paribus*, the probability of screening is higher among Black and Hispanic which also supports the findings of previous studies.[3,8,10] Furthermore, this study adds to the small body of literature which has examined within and between group differences related to ethnicity *and* socioeconomic status.

This study finds that women with high income (as measured by CIs and regression analyses), a college degree or private health insurance have the largest probability to screen, and the probability of women screening in each of these high socioeconomic groups differs little regardless if they are White, Black or Hispanic (some differences are observed with Other ethnicities). However, among lower socioeconomic women, those in lower income groups, who are uninsured or have low educational attainment, utilization rates are higher for Blacks and Hispanics than for White women. Only by portioning the analysis across ethnic groups rather than analyzing the US as one entity has this novel result become known. Age-adjusted 5 year survival for low socioeconomic (measured by area level poverty rates) Black women were 65.2% versus 70% for White and 81% for Hispanic women.[24] Interestingly, the largest difference between the most and least deprived (9.2 percentage points) was observed among White women.[24] Therefore, as lower socioeconomic women Black women *currently* have a greater probability of acquiring and dying from cervical cancer than poorer White and Hispanic women, risk perception may in part explain their decision to screen, though it is unlikely to explain all of the differences observed in our results.

While screening utilization at 12 months and 3 years is high in the US by international standards [17,25,26,27]; this conceals large socioeconomic disparities. The high utilization amongst socioeconomically advantaged women and/or those with private health insurance also demonstrate that too frequent screening may be taking place, despite recommendations not to do so. [3,12,14,28] This may be largely due to how screening is delivered and the large incentive for some practitioners to offer annual screening. While the USPSTF and the American Cancer Society both recommended Pap smears every three years, 92% of obstetricians and gynecologists' stated that they recommend annual screening to women[29] and as noted above, the Affordable Care Act mandates this in many states for insured women. It follows that issues of both over screening and under screening are evident in the United States.

While the nature of the health care system, and the importance of insurance in acquiring a screen, may underlie much of the disparities observed in this study, the lack of an organized screening program is also likely to be a significant factor. Organized population-based screening such as in Europe has been shown to reduce socioeconomic disparities in cervical cancer screening.[30,31] Additionally, organized programs are more cost-effective. For example, the US has four times as many cervical cancer screens as the organized Netherlands screening program, but the extra screens have not lead to improved mortality rates.32 Using a timely screening interval, such as every 3 years rather than annual screening, would result in estimated savings of $404 million in the US.[33] Reducing too frequent screening would additionally reduce unnecessary non-pecuniary costs and psychological harms for over screened women associated with false positives. Policy should be focused not on facilitating the too frequent screening of some groups, but on encouraging screening among women who never or rarely screen.[34] It is the low utilization women that make up the majority of all

cervical cancer deaths in the US, and most of these women are in the lowest socioeconomic groups.[35] Organized screening programs could more accurately include these poorer, under-screened women. An organized program may also help reduce screening for women with short life expectancies, many of whom screen at a high rate with little chance of the screen reducing the probability of dying from cervical cancer.[36]

Cancer researchers and policy advocates in the US have increasingly acknowledged that organized screening is superior to the opportunistic approach currently in place.[37, 38] A key element of organized programs, invitations to screen, can be tailored to individual risk, at timely intervals and would aid screening low utilization (poorer) groups, while reducing too frequent screening in other groups.[38,39,40] An organized program may additionally serve to reduce any stigma that might be associated with cervical cancer screening that might serve to deter utilization across groups. As the effectiveness of early diagnosis is contingent upon early access to treatment, any organized programs should also strive to offer quick access to treatment to women regardless of insurance status.

As these results find that uninsured women have utilization rates much lower than their publicly or privately insured counterparts, the expansion of Medicaid under the Affordable Care Act is likely to reduce the number of women under screening. Our results suggest that this may be especially true case for Black and Hispanic women where no difference in screening is observed across publicly and privately insured women. The failure of half of the states to expand Medicaid following the Affordable Care Act is likely to be a significant barrier in reducing disparities observed in this study and increase screening for those poorer women who need this screen the most.

Owing to the lower screening rates and higher incidence and death rates among Black and Hispanic, the greater utilization is to be welcomed, though over screening among more affluent Black and Hispanics is still a concern. However, improving utilization to poorer Black and Hispanics should be the focus of policy women. Disparities in screening are greatest for Whites and screening rates for poorer Whites are far lower than their Black and Hispanic counterparts. But it is clear from these results that interventions are needed to improve screening among poorer White women. A system of organized cancer screening may simultaneously serve to improve efficiency and reduce disparities in screening. But due to the differences in screening behavior both across ethnic and socioeconomic groups, a multi-faceted policy, with a strong focus on poor White women, is needed to achieve parity in screening utilization the US.

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