Understanding the Factors Underlying Disparities in Cancer Screening Rates Using the Peters-Belson Approach

Results From the 1998 National Health Interview Survey

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Background: Cancer screening rates vary substantially by race and ethnicity. We applied the Peters-Belson approach, often used in wage discrimination studies, to analyze disparities in cancer screening rates between different groups using the 1998 National Health Interview Survey.

Methods: A regression model predicting the probability of getting screened is fit to the majority group and then used to estimate the expected values for minority group members had they been members of the majority group. The average difference between the observed and expected values for a minority group is the part of the disparity that is not explained by the covariates

Results: The observed disparities in colorectal cancer screening (5.88%) and digital rectal screening (8.54%) between white and black men were explained fully by the difference in their covariate distributions. Only half of the disparity in the observed screening rates (13.54% for colorectal and 17.47% for digital rectal) between white and Hispanic men was explained by the difference in covariates between the groups. The entire disparity observed in mammography screening rates for black and Hispanic women (2.71% and 6.53%, respectively) compared with white women was explained by the difference in covariate distributions

Conclusions: We found that the covariates that explain the disparity in screening rates between the white and the black population do not explain the disparity between the white and the Hispanic population. Knowing how much of a health disparity is explained by measured covariates can be used to develop more effective interventions and policies to eliminate disparity.

Key Words: ethnic/racial disparity, Peters-Belson, cancer screening, survey methods

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There are 2 overarching Healthy People 2010 (HP2010) goals. One is to increase quality and years of healthy life. The other is to eliminate health disparities, which requires understanding their causes. This is complex because disparities in the United States are associated with gender, race, ethnicity, education, income, disability, and geographic location. Disparities in early diagnosis and mortality could result from disparities in screening rates, especially for diseases like cancer and heart disease. Therefore, comparing screening rates could provide insights into reasons for disparities in healthcare outcomes. Because there is considerable evidence[1–9] that screening and early detection of breast, cervical, and colorectal cancer followed by timely treatment saves lives, increasing screening is an important HP2010 cancer objective. In this article, we study disparities in cancer screening rates using the Peters-Belson (PB) approach, which has been used in wage discrimination studies,[10–12] and race (sex) discrimination cases.[13]

A major HP2010 cancer objective is to reduce the number of new cancer cases as well as disability and death caused by cancer. A specific goal is to reduce deaths resulting from colorectal cancer from 21 to 14 per 100,000. Currently, the mortality rate for this cancer is 21, 28, and 13 per 100,000 women, respectively, among the whites, blacks, and Hispanics. For women, the objectives are to reduce mortality resulting from breast cancer from 28 to 22 per 100,000 and resulting from cervical cancer from 3 to 2 per 100,000. However, deaths from breast cancer are 29, 36, and 17 per 100,000 women, and from cervical cancer are 3, 6 and 3 per 100,000 women, for whites, blacks, and Hispanics, respec-

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tively. Although these figures do not provide a comprehensive overview of disparities in cancer outcomes, they do illustrate consistent disparities for blacks relative to whites.[14] Achieving the HP2010 objectives will require accelerated reductions in mortality among blacks. One way to achieve this is to ensure they receive screening and timely follow up for breast, cervical, and colorectal cancer.[15]

Similar differences among nonwhites relative to whites have also been reported in cancer incidence rates and stage at diagnosis,[16,17] and for utilization of cancer screening services.[18] Previous research has suggested these differences could be the result of differences in demographics, socioeconomic status, type of insurance coverage, attitudes toward screening and treatments, physician specialty and physicians' attitudes toward screening and treatments.[19] Understanding underlying causes of disparity can help policymakers and researchers target programs to more effectively achieve a major HP2010 objective, the elimination of health disparities among the various racial/ethnic groups.

An extensive literature has examined disparities in cancer screening, especially mammography,[19,20] and interventions designed to eliminate disparities in its use.[21] Screening helps prevent cervical and colorectal cancers because precancerous conditions can be removed. Because survival rates are higher for cancers detected at an early stage, screening can lower mortality from breast and other cancers. Between 1987 and 2000, when screening use was first monitored nationally, screening increased, especially mammography. There is general agreement in the literature that cancer screening is negatively correlated with older age, racial/ethnic minority status, less education, and lower income.[22–25] Income and education appear to be more powerful predictors of recent screening than race.[26] Nevertheless, older black women who are poor and/or less educated report they are less likely to be screened than their white counterparts.[27] Hispanic women, particularly Mexican-Americans, are less likely to use mammography than blacks or whites. These women also tend to have lower socioeconomic status (SES), and are more likely to lack health insurance and to cite cost as a reason for not having had a mammogram.[22,28–33] The purpose of this study is to build on existing literature by using a new method to reexamine consistently observed disparities in cancer screening.

In this article, we use the Peters-Belson (PB) method to examine observed disparities in cancer screening between the 3 major race/ethnic groups in the United States: non-Hispanic whites ("whites"), non-Hispanic blacks ("blacks"), and Hispanics using the 1998 National Health Interview Survey (NHIS). This approach uses regression methods to partition the observed disparity into a component that is explained by the independent variables in the regression model and a remaining component that they cannot explain. These components will be referred to as "explained disparity" and "unexplained disparity," respectively, for each type of cancer screening. Like in most applications of regression, the analysis depends on correctly selecting the independent variables to be used in the model. The unexplained disparity reflects both the omission of important independent variables and possible inequity in the health system. Some independent variables, eg, insurance coverage, that explain a disparity could be subject to intervention. Programs can be developed to reduce group differences in those variables.

The PB approach has been used in wage discrimination studies[10–12] and race (sex) discrimination cases[13] to predict the experience a minority (female) individual would have had if they were white (male). The conventional regression approach, which includes a dummy variable to identify race/ethnicity, assumes a common amount (degree) of disparity for all minority group members regardless of their individual characteristics. In contrast, the PB method produces estimates of disparity for each minority group member by incorporating their individual characteristics. Our study explores how the PB approach can be similarly used to understand disparities in public health outcomes as illustrated from studying cancer screening.

The 1998 NHIS is an excellent data source for studying differences in health practices and behavior between the major minority groups because it oversamples blacks and Hispanics. Thus, sample sizes are adequate to accurately estimate measures of the between-group differences for blacks, Hispanics, and whites. In addition, population-based estimates of disparity can be obtained from the NHIS. This dataset is well-suited for our study because both self-reported cancer screening and a wide range of important covariates predictive of cancer screening are available.

METHODS

National Health Interview Survey

The NHIS is a nationally representative household interview survey of the civilian noninstitutionalized population of the United States. It has been conducted annually since 1957 by the National Center for Health Statistics of the Centers for Disease Control and Prevention. In-person interviews of the NHIS core questionnaire are used to collect data on demographic, socioeconomic, and healthcare service access characteristics as well as health-related information on everyone in the household. In 1998, the U.S. Department of Health and Human Services sponsored a Health Prevention Supplement (HPS) to the core of the NHIS, which included questions on utilization of cancer screening. In each of the eligible 38,209 households selected for interview, an adult respondent (≥18 years old) was randomly selected to complete the HPS. The overall response rate to the 1998 NHIS–HPS was 72.6%. Participants provided informed consent. In the questions about their most recent fecal occult blood test (FOBT), endoscopy, digital rectal examination, mammogra-

TABLE 1A. Distribution of the Characteristics by Race Among the Male Population

	All Races		White		Black		Hispanics	
Characteristic	**No.* (14202)**	**Percent†**	**No. (9799)**	**Percent**	**No. (1670)**	**Percent**	**No. (2240)**	**Percent**
Education (years)								
<12	2613	16.1	1223	12.1	403	22.8	930	39.6
12	312	2.2	166	1.8	58	3.5	81	4.0
>12	11,155	80.9	8347	85.6	1195	72.9	1195	54.6
Income								
Poor	1319	7.3	606	5.0	238	13.1	412	16.2
Near poor	2084	12.8	1141	10.6	297	16.4	563	23.3
Middle/high	8042	60.0	6198	65.0	774	47.8	813	38.5
Region								
Northeast	2650	19.1	1915	20.1	316	18.3	341	14.9
Midwest	3321	25.7	2792	29.7	300	18.9	156	8.3
South	5082	35.9	3268	33.8	898	55.7	814	37.1
West	3149	19.3	1824	16.4	156	7.1	929	39.7
MSA								
Yes	11,338	78.6	7479	75.7	1452	86.0	1982	89.0
No	2864	21.4	2320	24.3	218	14.0	258	11.0
Insurance coverage								
Covered	11,744	83.9	8618	87.9	1335	79.2	1402	62.4
Not covered	2404	15.7	1150	11.8	325	20.2	829	37.0
Usual source of care								
Yes	11,093	79.6	8016	82.6	1272	75.5	1433	64.0
No	2996	19.7	1712	16.8	383	23.5	787	35.4

*Sample size.
†Proportion weighted to the population. Percentages do not always add up to 100 as a result of missing values.
The differences in proportions by race were all statistically significant $P < 0.001$.
MSA indicates metropolitan statistical area.

phy, or Papanicolaou test, HPS respondents were asked to choose among the following precoded categories: <1 year ago, 1–<2 years ago, 2–<3 years ago, 3–<5 years ago, and ≥5 years ago.

The design of the NHIS is complex with stratified multistage probability cluster sampling.[34] All estimates were weighted using the NHIS sample weights to the U.S. total population. A stratified cluster sample version of the leaving-one-out jackknife variance estimation was used to compute standard errors for the results from the PB analyses.[35] All analyses were conducted using the statistical software packages SAS version 8.2[36] and SUDAAN version 8.0.[37]

A poverty status indicator was created using published information from the U.S. Bureau of the Census regarding 1997 federal poverty thresholds.[38] A ratio of 1997 income value reported by respondents to the poverty threshold for the same year was constructed, given information on family size and the number of children aged 17 and under. The resulting ratio was subsequently ordered into a poverty gradient consisting of 14 categories. For this study, we regrouped the categories into poverty (below 100% of the federal poverty threshold), near poor (100–199% of the federal poverty threshold), and middle or high income (≥200% of the federal poverty threshold).

The 1998 NHIS collected race and ethnicity information following guidelines set forth by the Office of Management and Budget in a policy known as OMB Directive 15 (Office of Management and Budget, 1977). The NHIS relied on respondents to provide self-identified race and ethnicity information. Precoded responses for persons identifying Hispanic origin were Puerto Rican, Cuban/Cuban-American, Dominican (Republic), Mexican, Mexican-American, Central or South American, other Latin American, and other Hispanic/Latino. The survey consisted of 15 precoded race responses and an "other race" category, which were recoded into 5 broad groupings in the Public Use Dataset.[39] We coded all respondents into Hispanic, non-Hispanic white, or non-Hispanic black for this study.

There is increasing awareness in health services and social epidemiology literature on the relationship among race,

TABLE 1B. Distribution of the Characteristics by Race Among the Female Population

Characteristic	All Races		White		Black		Hispanics	
	No.* (18,238)	Percent†	No. (12,034)	Percent	No. (2675)	Percent	No. (2946)	Percent
Education (years)								
<12	3499	15.9	1561	12.0	617	21.1	1219	38.7
12	427	2.2	208	1.8	99	3.7	111	3.8
>12	14,104	80.9	10182	85.6	1909	73.5	1552	55.2
Income								
Poor	2695	10.8	1117	7.3	703	23.6	773	20.7
Near poor	3083	14.7	1834	13.4	535	19.0	633	21.1
Middle/high	8407	52.4	6496	58.0	783	32.8	844	33.8
Region								
Northeast	3617	20.2	2471	20.9	514	18.7	528	17.0
Midwest	4181	25.3	3402	29.1	514	18.6	175	7.5
South	6490	35.7	3977	33.5	1405	55.8	979	33.0
West	3950	18.8	2184	16.5	242	6.9	1264	42.5
MSA								
Yes	14,621	78.7	9170	75.6	2298	84.9	2946	91.2
No	3617	21.3	2864	24.4	377	15.1	300	8.8
Insurance coverage								
Covered	15,513	86.1	10872	89.8	2166	79.4	1984	66.6
Not covered	2653	13.6	1127	9.9	489	19.7	945	32.8
Usual source of care								
Yes	16,153	89.3	10946	91.0	2355	87.9	2374	80.1
No	1977	10.2	1040	8.7	285	10.9	555	19.5

*Sample size.
†Proportion weighted to the population. Percentages do not always add up to 100 as a result of missing values.
The differences in proportions by race were all statistically significant ($P < 0.001$).
MSA indicates metropolitan statistical area.

ethnicity, and health outcomes, including use of health services. For purposes of this study, we adopt the argument that race and ethnicity are socially constructed historical categories.[40–42] We test the relationship between race (ethnicity, gender) and disparities in screening use as if it were similar to the relationship between race (ethnicity, gender) and inequalities in earnings.

Variables

For all screening modalities studied, we compared whites, blacks, and Hispanics. To examine disparities between men and women, colorectal cancer screening (FOBT for screening during the past 2 years or endoscopy for screening during the past 3 years) and digital rectal examination during the past 2 years were studied. Among women, group differences in rates by race/ethnicity of Papanicolaou test in the 3 years before the interview and mammography in the previous 2 years were examined. Only subjects who reported information on all covariates in the model were included in the analysis. Hence, sample size varied with the type of cancer screening. The amount of missing information was 21% for information on income and, at most, 1% for other covariates. As a result of age-specific guidelines for screening use, the analysis was restricted to subjects over the age of 49 years for colorectal screening and digital rectal examination, over the age of 39 years for mammography, and over the age of 24 for Papanicolaou test.[18,43]

The group with the highest rate of use ("best" group) was used as the benchmark: men when the disparity between genders was analyzed and whites for all cancer screenings except Papanicolaou test screening.

Based on conceptual models and empirical findings from earlier cancer screening studies,[18–20,44,45] we tested the following covariates: age, education (less than high school graduate, high school graduate, and at least some college), income (below poverty level [poor], 100–199% of poverty level [near poor], and ≥200% of poverty level [middle/high]), region of residence (Northeast, Midwest, South, and West), residing (yes/no) in a metropolitan statistical area

TABLE 2A. Regression Coefficients* and Standard Errors of the Factor in the Models Fit to the Men to Predict Cancer Screening for Evaluating Disparity by Gender

	Type of Cancer Screening			
	Colon Cancer†		Digital Rectal Examination†	
Factors in the Model	**β**	**Standard Error**	**β**	**Standard Error**
Age (years)	0.2054	0.0543	0.2697	0.0573
Agesq	−0.0015	0.0004	−0.0018	0.0004
Education recoded (years)				
<12	Ref			
12	−0.2267	0.3488	0.1641	0.3001
>12	0.4230	0.1022	0.5012	0.1039
Ratio of family income to poverty threshold (version B)				
Below poverty level	Ref			
100–199% of poverty level	0.3706	0.1861	0.1761	0.1745
200% or more of poverty level	0.6849	0.1854	0.4976	0.1696
Region				
Northeast	Ref			
Midwest	−0.4995	0.1257	−0.2503	0.1204
South	−0.4774	0.1211	−0.2798	0.1144
West	−0.3093	0.1364	−0.0073	0.1261
MSA				
MSA	Ref			
Non-MSA	−0.5095	0.1041	—	—
Insurance coverage recoded				
Not covered	Ref			
Covered	0.7816	0.2553	0.7688	0.2090
Usual source of care				
No or hospital ER	Ref			
Yes	1.6106	0.2414	1.7489	0.2162
Race/ethnicity				
Non-Hispanic white	Ref			
Hispanic	−0.4268	0.1564	−0.4202	0.1526
Non-Hispanic black	0.0136	0.1406	0.0015	0.1291
Non-Hispanic other	−0.3092	0.2398	−0.8945	0.2817

*$P < 0.001$.
†P values from goodness-of-fit tests: colon cancer screening = 0.04 (including an interaction between usual source of care and region improved the fit — $P = 0.21$ but the interaction itself was not significant — $P = 0.98$); digital rectal examination = 0.61.
MSA indicates metropolitan statistical area; ER, emergency room.

(MSA), health insurance coverage (yes/no), and having a usual source of care (yes/no). Initially, these variables were included in the logistic regression models. Final models included only variables that remained significant at the 2-sided level $\alpha = 0.05$ after adjusting for other factors. The models were different for each cancer screening type (Tables 2A–2C). We evaluated the fit of these models using a version of the Hosmer-Lemeshow test for goodness-of-fit for logistic regression that was modified to account for the complexity of the NHIS sample design.[35]

Statistical Analysis

The PB approach,[46–49] is described in the setting where the white population has the highest observed screening rate and the other groups are compared with it.

TABLE 2B. Regression Coefficients* and Standard Errors of the Factor in the Models Fit to the Men to Predict Cancer Screening for Evaluating Disparity by Race/Ethnicity

	Type of Cancer Screening			
	Colon Cancer†		Digital Rectal Examination†	
Factors in the Model	β	Standard Error	β	Standard Error
Age (years)	0.2209	0.0609	0.2748	0.0656
Agesq	−0.0016	0.0005	−0.0019	0.0005
Education recoded (years)				
<12	Ref			
12	−0.1531	0.3855	0.1433	0.3340
>12	0.4844	0.1211	0.5580	0.1181
Ratio of family income to poverty threshold (version B)				
Below poverty level	Ref			
100–199% of poverty level	0.4313	0.2487	0.2929	0.2164
200% or more of poverty level	0.7683	0.2398	0.5654	0.2014
Region				
Northeast	Ref			
Midwest	−0.5827	0.1388	−0.3472	0.1301
South	−0.5199	0.1367	−0.3615	0.1274
West	−0.3976	0.1478	−0.0749	0.1394
MSA				
MSA	Ref		—	—
Non-MSA	−0.4588	0.1044		
Insurance coverage recoded				
Not covered	Ref			
Covered	0.8106	0.3086	0.7770	0.2505
Usual source of care				
No or hospital ER	Ref			
Yes	1.6215	0.2815	1.8759	0.2608

*$P < 0.001$.
†P values from goodness-of-fit tests: colon cancer screening = 0.65; digital rectal examination = 0.61.
MSA indicates metropolitan statistical area; ER, emergency room.

Let O_w and O_b, respectively, denote the observed (sample-weighted) proportion of whites and blacks who reported using a particular type of cancer screening. The observed disparity between the screening rates of whites and blacks is represented by

$$D_{w,b} = (O_w\text{-}O_b)$$

This difference can be further separated into a portion that is explained by the covariates (explained disparity) and a portion that is *not* explained by variables in the model (unexplained disparity). The unexplained disparity measures the effect of relevant covariates not in the model and any unfairness in access to screening.

To compute these portions of the difference between the screening rates of whites and blacks, we first fit a logistic regression model to the white sample for the particular type of cancer screening. We then insert the covariate values of each black into the equation derived for whites to estimate their expected probability of being screened. Because the equation uses coefficients estimated from the data on whites, we are estimating the probability of a black respondent being screened if he or she were white. The proportion, E_b, of blacks who would have been screened had they been white is then calculated as the (sample-weighted) average of the estimated expected probabilities for the sample of blacks. The difference between E_b and the observed proportion, O_b, measures the part of the overall difference, $D_{w,b}$, that is *not* explained by the covariates. This difference is called D_{2b} (= E_b-O_b) and is used in the discrimination literature as a

TABLE 2C. Regression Coefficients* and Standard Errors of the Factor in the Models Fit to the Women to Predict Cancer Screening for Evaluating Disparity by Race/Ethnicity

	Type of Cancer Screening							
	Colon Cancer† Screening		Digital Rectal Examination†		Mammography†		Papanicolaou Test†	
Factors in the Model	**β**	**Standard Error**	**β**	**Standard Error**	**β**	**Standard Error**	**β**	**Standard Error**
Age (years)	0.3271	0.0498	0.1591	0.0499	0.2804	0.0242	−0.0473	0.0036
Agesq	−0.0024	0.0004	−0.0013	0.0004	−0.0023	0.0002	—	—
Education recoded (years)								
<12			Ref					
12	—	—	0.1534	0.3109	0.2142	0.2841	—	—
>12			0.3476	0.1141	0.3983	0.0957		
Ratio of family income to poverty threshold (version B)								
Below poverty level	Ref						—	—
100–199% of poverty level	0.4106	0.1543	0.3352	0.1363	0.0674	0.1230		
200% or more of poverty level	0.8528	0.1346	0.4852	0.1263	0.6192	0.1112		
Region								
Northeast	Ref							
Midwest	−0.2981	0.1126	—	—	−0.2446	0.0900	—	—
South	−0.2197	0.1055			−0.0049	0.0898		
West	−0.2097	0.1172			−0.0489	0.0949		
MSA								
MSA	—	—			Ref			
Non-MSA					−0.1467	0.0794		
Insurance coverage recoded								
Not covered	—	—	Ref				—	—
Covered			0.8381	0.2219	0.8123	0.1518		
Usual source of care								
No or hospital ER	Ref							
Yes	1.2173	0.2604	1.2583	0.2179	1.5060	0.1381	1.5000	0.1809

*$P < 0.001$.
†P values from goodness-of-fit tests: colon cancer screening = 0.40; digital rectal examination = 0.47; mammogram = 0.19; Papanicolaou test = 0.06.
MSA indicates metropolitan statistical area; ER, emergency room.

measure of possible societal inequality. In our context, D_{2b} will be called the unexplained disparity between the groups being compared, after accounting for group differences in the independent covariates. The explained disparity is D_{1b} (= O_w-E_b). So, the observed disparity is decomposed as

$$D_{w,b} = O_w\text{-}O_b = D_{1b} + D_{2b} = (O_w\text{-}E_b) + (E_b\text{-}O_b)$$

Thus, the percent of the disparity explained by the known covariates is given by

$$\%\text{Explained} = (D_{1b}/D_{w,b}) \times 100$$

RESULTS

The mean age (data not shown) of the male population was 43.8 years: 45.2 years for whites, 41.2 years for blacks, and 38.1 year for Hispanics; and the mean age of the female population was 45.6 years: 47.1 year for whites, 42.2 years for blacks, and 39.9 years for Hispanics. (These differences between the groups were statistically significant, P <0.0001.) The distribution of other covariates among the different races is displayed separately for the males and females in Tables 1A and 1B, respectively. Although a higher proportion of women than men are poor or near poor, women are more

TABLE 3A. Disparity in Recent Cancer Screening* Between Genders

Type of Screening	Gender	Observed (%)	Predicted† (%)	Percent Explained‡ (SE§)
Colorectal (age 50+)	Male	36.18		
	Female	29.56	35.34	12.59 (6.94)
Digital rectal examination (age 50+)	Male	49.60		
	Female	41.68	49.56	0.57 (11.36)

*For colorectal screening, "recent" is if the respondent reported fecal occult blood test for screening during the past 2 years or endoscopy for screening during the past 3 years, and for digital rectal examination, "recent" is defined as during the past 2 years preceding the interview.

†Predicted using the logistic regression model fit among the majority group (male). Variables predictive of colorectal screening are age, age^2, income (below the poverty level [poor], 100–199% of poverty level [near poor] and ≥200% of poverty level [middle/high]), education (less than high school graduate, high school graduate, and at least some college), region of residence (Northeast, West, Midwest, and South), metropolitan statistical area (in MSA or not), health insurance coverage (yes or no), and usual source of care (yes or no). MSA was not predictive of digital rectal examination and hence was excluded from the model.

‡((Observed (male)—predicted (female))/(observed (male)—observed (female)))*100.

§Standard error.

likely to have a usual source of care. Within each gender, whites are older, better educated, in higher income categories, insured, from non-MSA regions, and more likely to have a usual source of care compared with other race/ethnic groups.

In the logistic regression models fitted to the majority groups, screening increased with age (except for Papanicolaou test use), education, income, having insurance coverage, and having a usual source of care. The goodness-of-fit test compared the expected and observed number screened by deciles of the predicted probabilities from the logistic regressions. In general, these counts were close even though the P value was just under 0.05 for the colorectal test model to evaluate gender disparity. This was the result of the large sample size for the colorectal analysis (number of males = 3911). Thus, the model fits were adequate for our purpose. Although the PB method does not require fitting the equation to the minority groups, we examined whether the same covariates affect the probability of being screened for all groups. We found that the major covariates in the models for each type of screening were similar for both whites and blacks. For colorectal cancer screening and digital rectal examination, the major covariates associated with screening for both men and women were the same.

Table 3A displays results for the disparity in rates of colon cancer screening and digital rectal examination between men and women. The observed disparity between men and women is 6.62% for colorectal screening and 7.92% for the digital rectal examination. Only 12% of the observed disparity in colorectal screening rates (and less than 1% of the observed disparity in digital rectal examination rates) is explained by differences between the distributions of the measured covariates in both genders. These results indicate that factors studied do not explain much of the observed disparities in the screening rates.

TABLE 3B. Disparity in Recent Cancer Screening* by Race/Ethnicity Among Men

Type of Screening	Race	Observed (%)	Predicted† (%)	Percent Explained‡ (SE§)
Colorectal (age 50+)	White	37.75		
	Black	31.87	31.19	111.48 (53.67)
	Hispanic	24.21	31.30	47.60 (12.33)
Digital rectal examination (age 50+)	White	52.10		
	Black	43.56	43.20	104.20 (34.80)
	Hispanic	34.63	43.08	51.60 (10.78)

*For colorectal screening, "recent" is if the respondent reported fecal occult blood test for screening during the past 2 years or endoscopy for screening during the past 3 years, and for digital rectal examination, "recent" is defined as during the past 2 years preceding the interview.

†Predicted using the logistic regression model fit among the majority group (white). Variables predictive of colorectal screening are age, age^2, income (below the poverty level [poor], 100–199% of poverty level [near poor], and ≥200% of poverty level [middle/high]), education (less than high school graduate, high school graduate, and at least some college), region of residence (Northeast, West, Midwest, and South), metropolitan statistical area (in MSA or not), health insurance coverage (yes or no), and usual source of care (yes or no). MSA was not predictive of digital rectal examination and hence was excluded from the model.

‡((Observed (white)—predicted (black/Hispanic))/(observed (white)—observed (black/Hispanic)))*100.

§Standard error.

TABLE 3C. Disparity in Recent Cancer Screening* by Race/Ethnicity Among Women

Type of Screening	Race	Observed (%)	Predicted† (%)	Percent Explained‡ (SE#)
Colorectal (age 50+)	White	31.14		
	Black	24.66	26.45	72.38 (26.09)
	Hispanic	19.17	26.46	39.09 (10.29)
Digital rectal examination (age 50+)	White	43.35		
	Black	38.19	38.53	93.42 (47.62)
	Hispanic	32.30	34.98	75.74 (21.50)
Mammography (age 40+)	White	66.65		
	Black	63.94	60.56	224.87 (156.72)
	Hispanic	60.12	56.58	154.27 (47.65)
Papanicolaou test (age 25+)	Black	80.06		
	White	77.02	77.65	79.20§ (26.57)
	Hispanic	73.81	79.95	1.78§ (8.78)

*For colorectal screening, "recent" is if the respondent reported fecal occult blood test for screening during the past 2 years or endoscopy for screening during the past 3 years; for digital rectal examination and mammography, "recent" is defined as during the past 2 years preceding the interview; and for Papanicolaou test, "recent" defined as during the 3 years preceding the interview.

†Predicted using the logistic regression model fit among the majority group (white) except for Papanicolaou test when the majority group was black. Variables predictive of mammography use are age, age^2, income (below the poverty level [poor], 100–199% of poverty level [near poor], and ≥200% of poverty level [middle/high]), education (less than high school graduate, high school graduate, and at least some college), region of residence (Northeast, West, Midwest, and South), metropolitan statistical area (in MSA or not), health insurance coverage (yes or no), and usual source of care (yes or no). Education, MSA, and health insurance coverage were not predictive of colorectal screening and hence were not included in the model. MSA and region of residence were not predictive of digital rectal examination and hence were excluded from the model. Only age and usual source of care were predictive of Papanicolaou test.

‡((Observed (white)—predicted (black/Hispanic))/(observed (white)—observed (black/Hispanic)))*100.

§((Observed (black)—predicted (white/Hispanic))/(observed (black)—observed (white/Hispanic)))*100.

#Standard error.

Table 3B displays results for cancer screening rates for men by race/ethnicity. All of the observed disparity (5.88%) in colorectal screening and digital rectal examinations (8.54%) for black men is explained by covariate differences between them and white men. In contrast, only approximately 50% of the observed disparity (13.54% in colorectal screening and 17.47% in digital rectal examination) in cancer screening rates between white men and Hispanic men is explained by differences in the distributions of the same covariates. The implications of finding an explained disparity in excess of 100% are: 1) minority group members have higher screening rates than comparable whites, suggesting that some of the programs directed at minority groups have been successful and similar programs should be developed for the white population; and 2) for the crude screening rates of nonwhites to achieve levels equal to whites, the covariate distributions for nonwhites will need to move closer to that of the whites but need not become the same.

The racial/ethnicity disparities in cancer screening rates for women are displayed in Table 3C. Figure 1 illustrates disparities between white women and black or Hispanic women for colorectal cancer screening, digital rectal examination, and mammogram. Note that covariates explain *more* than the observed difference in rates for mammography screening for both black (observed disparity of 2.71%) and Hispanic women (6.53%) indicating that, after adjusting for covariates, whites (the reference group) would have lower screening rates for mammography than otherwise comparable blacks and Hispanics. For colorectal and digital screening, differences in covariate distributions explain substantially more of the observed difference in screening between white and black women than they do for the difference between white and Hispanic women. Notice, however, that the same covariates explaining nearly 80% of the observed disparity in black–white Papanicolaou screening rates for cervical cancer apparently explain very little of the difference between blacks and Hispanics.

DISCUSSION

Eliminating disparities in cancer screening rates would contribute to the reduction of health disparities by 2010. The technique described in this article helps to identify factors that affect the disparity and the extent to which they explain the overall observed difference between the "*best*" and other groups. The covariates examined were age, education, income, region of residence, metropolitan residence area, having health insurance coverage, and having a usual source of care.

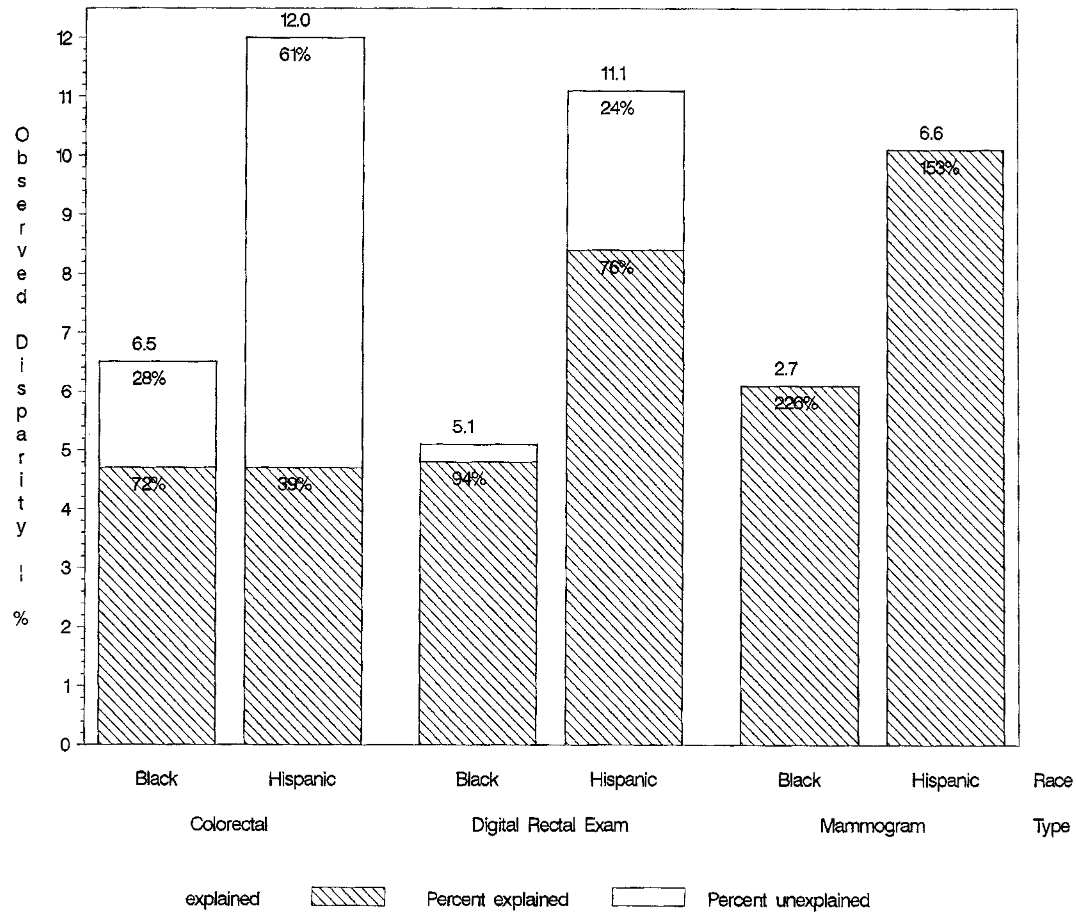

FIGURE 1. Percent disparity in cancer screening explained among black and Hispanic women compared to white women. The number on top of each of the bars represents the observed disparity, ie, the difference in the crude screening rates between the non-Hispanic white women and nonwhite women (black or Hispanic).

The covariates considered for use in our models reflect important aspects of prior conceptual models of cancer screening. Lane et al.[20] reviewed the effects of *predisposing* (eg, sociodemographics, health beliefs, and attitudes), *enabling* (eg, insurance coverage, usual place of care, patient's health status), and *reinforcing* (eg, geographic location and access to care) factors on breast cancer screening and studied their effects among older women (>65 years of age). They found that mammography use was associated with physician's recommendation, which declined with the woman's age and increased with the patient's income, education, and insurance. Physicians who were younger, female, and internists recommended screening more often. We also examined covariates based on findings from earlier cancer screening studies.[18,19,44,45] Hiatt et al.[19] compared 73 publications that analyzed cancer screening practices using various years of NHIS data. Sixty-five of these studies investigated correlates of screening, which were grouped into sociodemographic, healthcare system, knowledge/behavioral/attitudinal, and health status/health profile categories. Most of these studies found age, education, income, region of residence, health insurance coverage, and having a usual source of care to be associated with utilization of cancer screening. This is consistent with our findings.

Our study found that observed differences in screening rates between the white and black populations were largely explained by known covariates. However, only a small proportion of the differences in rates of colon cancer screening and digital rectal examination between males and females was explained by known covariates. The observed differences in screening rates between the white and Hispanic population were larger than the differences between the white and black population, and covariates that explained the white–black differences did not explain the white–Hispanic differences.

Haas et al.[50] found in their analysis of the 1996 Medical Expenditure Panel Survey that Hispanics and whites with insurance who belonged to a managed care plan used preventive services more than those in fee-for-service health plans. Although we did not include information on the type of health plans in our analysis, it is worth considering in any future analyses. In an editorial accompanying the article by Haas et al., Meredith and Griffith-Forge[51] note that use of preventive services appears to be dependent on the cultural norms and "contextual factors." So, to eliminate disparities between different racial/ethnic groups, programs and policies might need to be culturally appropriate for each socioeconomic group that is lagging behind the "best" group.

Our study confirmed that significant modifiable variables potentially related to screening were having a usual source of care, having health insurance, and education. Previous research using the NHIS suggests that programs or policies to ensure that everyone has health insurance that is readily usable to obtain timely, convenient services, covers standard care, and reimburses at going rates (ie, Medicare or higher) and a usual source of health care would help reduce disparities in cancer screening.[18,19,,52] Age, race, and gender, although not modifiable, can be used to target programs and policies more effectively. Where cancer screening rates differ by geographic location, programs would need to address the specific needs of people with low rates living in the regions.

As noted earlier, the advantage of the PB method is that it does not assume that the disparity is the same for all blacks after other covariates have been accounted for. The standard approach using indicator variables for race/ethnicity status makes this strong assumption and uses the estimated coefficient of the indicator variable as the measure of disparity that is not explained by covariates. In contrast, the PB method provides an individualized estimate of the disparity remaining after the covariates have been accounted for. The weighted average of these differences estimates the average disparity in the population. Another advantage of the PB method is that it leads to a natural decomposition of the observed disparity into explained and unexplained components.

There are some limitations to using regression methods to analyze cross-sectional studies. In cross-sectional samples, variables reflecting the time between events could be subject to length bias because a snapshot is more likely to sample longer intervals. For example, insurance coverage is related to employment. The estimated fraction of minorities without insurance might have a larger bias than that of whites if they have higher unemployment rates or longer durations of unemployment. Because the PB method uses the majority equation to predict the screening status of minorities, if possession of insurance in the minority population were underestimated, then the explanatory power of insurance and the explained disparity would also be underestimated. It is difficult to estimate the overall directional effect of bias in situations in which several variables in the regression model are subject to various biases, which could differ among the groups compared.

Although sample sizes in the NHIS were moderately large, we found that the "%Explained" had relatively large standard errors. Because the crude differences in screening rates between any 2 groups appear in the denominator of the "%Explained," when it is small, the variability of the "%Explained" can be large.

The PB method we used can be applied to a wide variety of regression-type analyses of health outcomes that focus on differences in proportions, including comparison of incidence and prevalence or survival rates.[53] The PB method is a useful tool for understanding the factors underlying many types of disparities between groups in the health field because it assesses the role of covariates in explaining between-group differences in continuous variables, eg, blood pressure, blood levels of high-density lipoprotein, or homocysteine, and so on.

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