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Journal of Health Disparities Research and Practice

Volume 6 | Issue 2 Article 8



2013

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## Abstract

Background: Colorectal cancer (CRC) remains the third leading cause of cancer death in the United States. The incidence, mortality, and screening vary by race/ethnicity, with African Americans and Hispanics being disproportionately represented. Early detection through screening prolongs survival and decreases mortality. CRC screening (CRCS) varies by race/ethnicity, with lower prevalence rates observed among minorities, but the factors associated with such disparities remain to be fully understood. The current study aimed to examine the ethnic/racial disparities in the prevalence of CRCS, and the explanatory factors therein in a large sample of U.S. residents, using the National Health Interview Survey, 2003.

Materials and Methods: A cross-sectional, epidemiologic design was used with a chi squareto assess the prevalence of CRCS, while a survey logistic regression model was used to assess the odds of being screened.

Results: There was a significant variability in CRCS, with minorities demonstrating lower prevalence relative to Caucasians $\chi^2$ (3) = 264.4, $p$< 0.0001. After controlling for the covariates, racial/ethnic disparities in CRCS persisted. Compared to Caucasians, African Americans/Blacks were 28% (adjusted prevalence odds ratio [APOR] = 0.72, 99% CI, 0.60-0.80), while Hispanics 33% (APOR, 0.67, 99% CI, 0.53-0.84) and Asians 37% (APOR, 0.63, 99% CI, 0.43-0.95) were less likely to be screened for CRC.

Conclusion: Among older Americans, racial/ethnic disparities in CRCS exist, which was unexplained by racial/ethnic variance in the covariates associated with CRCS. These findings recommend further studies in enhancing the understanding of confounders and mediators of disparities in CRCS and the application of these factors including the health belief model in improving CRCS among ethnic/racial minorities.



## Keywords

colorectal cancer screening; health disparities; African Americans; ethnic/racial minorities; prevalence



## Cover Page Footnote

We thank the National Center for Health Statistics (NCHS) for the availability of the National Health Interview Survey (NHIS) data. The interpretation and the inference from these data are the responsibility of the authors and not that of NHIS or the institutions affiliated with the authors.

**Journal of Health Disparities Research and Practice**
**Volume 6, Issue 2, Summer 2013, pp. 107-123**

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**Disclosure:** All authors have declared no conflicts of interest.

## ABSTRACT

**Background**: Colorectal cancer (CRC) remains the third leading cause of cancer death in the United States. The incidence, mortality, and screening vary by race/ethnicity, with African Americans and Hispanics being disproportionately represented. Early detection through screening prolongs survival and decreases mortality. CRC screening (CRCS) varies by race/ethnicity, with lower prevalence rates observed among minorities, but the factors associated with such disparities remain to be fully understood. The current study aimed to examine the ethnic/racial disparities in the prevalence of CRCS, and the explanatory factors therein in a large sample of U.S. residents, using the National Health Interview Survey, 2003.
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**Results**: There was a significant variability in CRCS, with minorities demonstrating lower prevalence relative to Caucasians $\chi 2$ (3) = 264.4, $p < 0.0001$. After controlling for the covariates, racial/ethnic disparities in CRCS persisted. Compared to Caucasians, African Americans/Blacks were 28% (adjusted prevalence odds ratio [APOR] = 0.72, 99% CI, 0.60-0.80), while Hispanics were 33% (APOR, 0.67, 99% CI, 0.53-0.84) and Asians were 37% (APOR, 0.63, 99% CI, 0.43-0.95) less likely to be screened for CRC.
**Conclusion**: Among older Americans, racial/ethnic disparities in CRCS exist, which was unexplained by racial/ethnic variance in the covariates associated with CRCS. These findings recommend further studies in enhancing the understanding of confounders and mediators of disparities in CRCS and the application of these factors including the health belief model in improving CRCS among ethnic/racial minorities.

**Keywords:** Racial Disparities, Health Disparities, Colorectal Cancer, Cancer Screening, Cross-sectional Design, Public Health, Cancer Epidemiology

## INTRODUCTION

Colorectal cancer remains the third most diagnosed noncutaneous neoplasm, and the third leading cause of cancer death among United States men (25,240) and women (24,680) when cancer mortality is stratified by sex, but the second leading cause of death when both sexes are combined (49,920), (American Cancer Society, 2009). The most recent American Cancer Society (ACS) data estimates the lifetime risk of developing colorectal cancer to be 1 in 19 (5.2%), (American Cancer Society, 2009). The 2009 Surveillance Epidemiology and End Result (SEER) of the National Cancer Institute (NCI) estimated that 146,140 Americans (75,590 men and 71,380 women) would be diagnosed with colorectal cancer and that 49, 920 would die from the disease (National Cancer Institute, 2009).

The incidence is intermediate among Whites (56.9 per 100,000 men and 42.1 per 100,000 women) and lowest among Hispanics (46.3 per 100,000 men and 32.2 per 100,000 women) and Asians (46.9 per 100,000 men and 34.6 per 100,000 women) as well as American Indian/Alaskan natives (43.1 per 100,000 men and 41.2 per 100,000 women) (National Cancer Institute, 2009). The mortality rate is highest among African Americans (31.4 per 100,000 men and 21.6 per 100,000 women), intermediate among Caucasians (21.4 per 100,000 men and 14.9 per 100,000 women) and American Indians/Alaska natives (20.0 per 100,000 men and 13.7 per 100,000 women) and lowest among Asian Pacific Islanders (13.8 per 100,000 men and 10.0 per 100,000 women) and Hispanics (16.1 per 100,000 men and 10.7 per 100,000 women) (National Cancer Institute, 2009).

Like most malignancies, colorectal cancer increases with advancing age, with median age at diagnosis estimated as 71 years (National Cancer Institute, 2009). The risk is slightly higher among men (American Cancer Society, 2009). The carcinogenesis of colorectal cancer has repeatedly implicated dietary patterns namely high caloric intake regardless of nutrient source (fat, protein or carbohydrate). The dietary implication while widespread remains epidemiologically inconsistent but supported by the mechanistic framework of the digestive process. Lifestyle factors, including smoking and alcohol consumption, HIV risk behaviors, such as homosexual preference, have been implicated in colorectal cancer. Other risk factors implicated include: (a) adenomatous polyps, (b) hereditary, (c) inflammatory bowel disease, (d) urbanization and socio-economic status, (e) fiber, fruits and vegetable deficiency and (f) mutagens formed in cooking. Whereas familial patterns have been persistently documented, early screening to identify colon polyps has been associated with increased survival (Burch, Soares-Weiser, St John, Duffy, Smith, Kleijnen, 2007; National Cancer Institute, 2010; Ouyang, Chen, Getzenberg, Schoen, 2005). The stage and the tumor grade at diagnosis are important to the prognosis of the tumor. Data have shown that an estimated 39% of colorectal cancer is diagnosed while confined to the primary site, 37.9% diagnosed with spread to the regional lymph nodes and 36.9% diagnosed at metastasis. The 5-year relative survival rate is associated with 90.8% for localized tumor, 55.5% for regional, and 11.3% for metastasis (NCI, SEER, 2009). Colorectal cancer screening has been shown to lead to early detection, where the tumor is confined to the primary site (localized) thus prolonging survival and increasing relative survival (90.8%) (Burch, Soares-Weiser, St John, Duffy, Smith, Kleinen, 2007; National Cancer Institute, 2010; Ouyang, Chen, Getzenberg, Schoen, 2005). The ACS attributes the reduction in mortality from colon and rectal cancer during the past twenty years to screening and early detection, as well as improvement in the treatment (American Cancer Society, 2009).

Clearly, several studies have shown that disease screening in general and that of colorectal in particular is associated with educational status (Burch, Soares-Weiser, St John,

Duffy, Smith, Kleijnen, 2007; National Cancer Institute, 2010; Ouyang, Chen, Getzenberg, Schoen, 2005). Compared with those with low educational status, individuals with college and graduate degrees are more likely to be screened for colorectal cancer (Kwon, Lim, Lee, Cho, Park, Son, 2009). The association between education level and screening has been correlated with income, implying that education, which serves as indicator for income or in combination with income increases the likelihood of being screened for colorectal cancer.

Studies have demonstrated that education level is associated with access to and availability of healthcare (Gutiérrez, & Wallace, 2005; Reyes-Gibby, & Aday, 2005). The availability of colorectal cancer screening through private or public health insurance coverage may increase the proportion of those being screened at any given time in the U.S. Colorectal cancer screening in the U.S varies by race/ethnicity, but it is not fully understood if race/ethnicity influences the screening pattern or factors associated with race as well as disease screening. Examination of factors related to disease screening that may be disproportionately distributed across racial/ethnic minorities, may provide some explanation to the persistently observed health disparities in colorectal cancer screening. To our knowledge, while racial/ethnic disparities had been observed in colorectal cancer screening, much effort had not been dedicated to the etio-pathogenesis of such variance. In addition studies have not addressed these variances using representative samples of the U.S. population. These two gaps are addressed by the current study by not merely affirming racial/ethnic disparities in colorectal cancer screening, but attempting to remove such variances by multivariable model; as well as using the National Health Interview Survey as a representative sample of the U.S. population.

The current study aimed to examine CRC screening in the U.S. non-institutionalized residents, racial/ethnic disparities therein and the factors that may help in explaining the observed disparities. We postulated that racial/ethnic disparities in CRC may be associated with racial/ethnic distributions of educational status, socioeconomics, and lifestyle factors. Consequently, the variability in these social, economic and lifestyle factors may predispose to racial/ethnic variances in CRCS.

## MATERIALS AND METHODS

After an IRB approval from Walden University, we utilized preexisting data to conduct a cross-section non-experimental epidemiologic study to examine colorectal cancer prevalence in the U.S. and the racial/ethnic prevalence. But most importantly, we determined the factors that may explain the observed disparities.

### Study Population and Sample

The NHIS comprises a children and an adult component. The children component was not used. The pathology of colorectal cancer is not common in children. Colorectal cancer increases with advancing age, with median age at diagnosis estimated as 71 years (NCI, SEER Cancer Statistic 2009). Since 2003 was the most recent year in which the NHIS survey data were available to the public, the subjects in this study were sampled from the 2003 NHIS adult sample. This sample comprised 30,852 persons from a total of 36,524 adult individuals. The racial/ethnic composition of the selected participants were non-Hispanic Whites, n=20,169 (65.37%), non-Hispanic Blacks, n = 4,168 (13.51%), Hispanics n = 5,416 (17.55%), and others, n = 1,099 (3.56%). Forty-four percent of the participants were male, n = 13,427 (43.52%) and the remaining 56% were female, n = 17,425 (56.48%), ages 18 years and older. The sample constitutes participants from all states in the United States.

The data are self-response information from participants including socio-demographic variables, health outcomes, health care utilization, clinical diagnoses, and prognostic factors. The conditional response rate for this component was 84.5% of persons identified as sample adults, and the final response rate for the Adult Sample Person component was calculated as (Overall Family Response Rate) X (Sample Adult Response Rate), or (87.9%) X (84.5%) = 74.2%. The conditional Sample Adult response rate is the rate only for those sample adults identified as eligible and does not take into account household or family non-response.

**Data Source**

Data for this study was obtained from the National Health Interview Survey (NHIS), 2003. The adult sample component of the survey was used to address the specific aims and to test the proposed hypotheses. The NHIS has been used since the 1950s to examine the pattern of acute and chronic disease in the U.S.

**Data Collection Procedures**

The United States Census Bureau is the collection agent for the 2003 NHIS. Data were collected via a personal household interview by Census interviewers. The details of the sampling are published in Design and Estimation for the National Health Interview Survey, 1995—2004, CDC, and The National Center for Health Statistics.

**Sample Size and Power Estimations**

The sample size for this study is 30,852, requiring power estimation. Power estimation is the ability of the study to detect a minimum difference in colorectal cancer screening prevalence (proportion) between racial/ethnic groups. To calculate the power estimation, we used $\alpha = 0.01$ (1% type 1 error tolerance), cross-sectional design with logistic regression-based prevalence odds ratio, and effect size of 0.2 (20%), which is the postulated difference in colorectal cancer screening between Caucasian (n=20,169) and African Americans, (n=4,168). With these parameters, the power was estimated to be 100%. Also, since ethnic/racial differences in colorectal cancer screening may be explained by ethnic/racial differences in education, sex, income, marital status, and insurance coverage, we used these variables in computing the power, and found power in all these variables to be more than 80%. All power estimates were performed using STATA, version 11.0 (STATA Corporation, College Station, Texas).

**Variables Measures and Ascertainment**

**I. Outcome Variable**

***Colorectal cancer screening*:** The study outcome variable is colorectal cancer screening. In the dataset, colorectal cancer screening (CCS) was measured as a self-reported variable and was dichotomized as yes and no. CCS was coded 1 for having been screened for CCS, and 0 for not having been screened for CCS. Subjects were asked if they had participated in colorectal cancer screening during the last 12 months. And the responses were: (a) yes, (b) no, (c) not ascertained, (d) don't know, and (e) refused. For the purpose of this study, responses b and d were merged as negation, while responses c and e were declared missing (not from part of the final analysis) due to their insignificant contribution to the total sample.

**II. Independent Variables**

***Race/ethnicity-*** The main independent or explanatory variable for this study was race/ethnicity. In the dataset, race/ethnicity is categorized into Non-Hispanic Whites, Non-Hispanic Blacks, Hispanics, and Others. For this study, Caucasian (Non-Hispanic Whites) was used as the reference group comparing outcomes in Caucasians with Non-Hispanic Blacks, and Hispanics. Since it is difficult to interpret "others" in terms of race/ethnicity, focus was not placed on this racial/ethnic category on the interpretation of the findings of this study. Using the

STATA statistical package for the analysis of categorical data, the lowest category in terms of the order (1, 2, 3) is considered the reference group. Thus with Caucasian to be coded as "1", this racial/ethnic group was used in comparing to African Americans and Hispanics.

**III. Other Independent Variables**

***Insurance and family income-*** Insurance coverage is measured by any family members having insurance coverage and is categorized into yes, no, refuse, not ascertained, and don't know. This variable was dichotomized by recoding it into yes and no responses. The responses refuse, not ascertained, and don't know, because of the small numbers, were not included in the analysis. Income is measured by family income greater than $20,000 and less than $20,000. This variable is collected as: (a) greater than $20,000, (b) less than $20,000, (c) refuse, (d) not ascertained, and I don't know. The family income variable were recoded into a binary scale, i.e., greater than or equal to $20,000 and less than $20,000. The responses refuse, not ascertained, and don't know were not included in the analysis.

***Age and Sex***- Participants' age in the NHI survey is measured on a continuous scale. Age was categorized into seven groups commencing with 18 years and older, and further dichotomized given that colorectal cancer screening increases with advancing age, 50 years and older. Thus age was assessed as: (a) < 50 years, and (b) > 50 years.

Both males and females were eligible for the survey provided the age requirement was satisfied. This variable was self-identified, and was coded such that 1=male and 2 =female.

***Education, Employment and Marital Status***- Education level was measured by the years of attainment at an educational institution. This variable is collected as categorical but was recoded for suitable categories in comparing *less or equal to high school, some college and greater than or equal to a bachelor's degree*, with the outcome variables.

Employment status was measured by a categorical variable that elicited information on job profile. This variable was recoded in order to examine unemployment versus employment, with respect to racial distribution and the association with the outcome variables. This was coded as 1= employment and 0 = unemployment.

Marital status was measured by a categorical variable and was used to examine the influence of a social support system on colorectal cancer screening. This variable was recorded as binary: 1= married and 2= non-married.

**Statistical Analysis**

Categorical and discrete data were summarized using frequency and percentages, while continuous variables were summarized with mean and standard deviation. Chi-squared statistic was used to examine the distribution of the study variables by race/ethnicity.

The unconditional univariable survey logistic regression model was used to assess the association between race/ethnicity and CRCS. To examine the variables that may be associated with race/ethnicity and/ or CRCS in order to address the confounding effects of these variables, an unconditional multivariable survey logistic regression model was built.

All test were two-tailed and the significance level (type I error tolerance) was set at 0.01. STATA statistical software (version 11.0) was used to analyze the data. (StataCorp, College Station, TX.)

**RESULTS**

The adult U.S. sample of the National Health Interview Survey (NHIS) comprised of subjects who were 50 years and older was used to assess the prevalence of colorectal cancer, screening prevalence by race/ethnicity, as well as demographic lifestyle and prognostic factors as

a possible explanation for ethnic/racial disparities. Of the 30,852 participants, data on colorectal cancer screening for older Americans (50 years and older) were available on 18,698 participants. The racial/ethnic composition of these participants was 71.7% Caucasian (n-=12,925), 12.7% Hispanic (n=2,291), 12.7% African American/Black (n=2,290), and 2.9% Asian (n=514). Of these participants, a total of 5,789 individuals (32.1%) had been screened for colorectal cancer.

**Colorectal cancer screening variability by socio-demographic and prognostic factors**

Table 1 presents the study participants stratified by colorectal cancer screening. Compared to the screened and unscreened for CRC, there was no statistically significant difference in their reports of obesity or health insurance, $p > 0.01$. However, there was a statistically significant difference in their educational attainment, marital status, occupation, income, physician visits, specialist visits, alcohol use, smoking, physical activity, depression, and digestive disorders, $p > 0.01$.

The proportion of those screened for colorectal cancer was highest among those with a post college education (42.5%), intermediate among those with some college (35.3%) or High School education (33.7%), and lowest among those who had attained less than a high school education (28.7%), $p<0.0001$. A greater proportion of those who were screened for colorectal cancer had been employed at some time (41.4%) relative to those who had never worked (23.3%), $p < 0.0001$. Likewise a greater proportion of those who were screened for colorectal cancer (37.3%) had visited their general practitioner compared to those who had not (16.6%), $p<0.0001$.

African Americans were less likely to be married, relative to Caucasians and Hispanics, 37.8% versus 62.9% and 57.7% respectively.

Compared to Caucasians, African Americans/blacks, Hispanics, and Asians, were less likely to see physicians during the past 12 months, $\chi2(3)=131.8$, $p< 0.0001$. A significant association was observed between race and physician visits. Compared to minorities, Caucasians were more likely to visit a physician during the 12 months, Caucasian $\chi2(3) = 2053$, $p< 0.0001$. Whereas 35.3% of Caucasians visited their physicians during the past 12 months, an estimated 27.6% of African Americans/blacks, 21.6% of Hispanics, and 25.3% of Asians did so.

African Americans did differ from Caucasians with respect to education. African Americans were less likely to have any college or a postgraduate education (0.86%) compared to Caucasians (20.8%).

Among Caucasians, 82.2% who were screened for colorectal cancer had an occult fecal blood test, while among African Americans, 51.1% of those who were screened for colorectal cancer had undergone fecal occult blood tests. African Americans compared to Caucasians and Hispanics were less likely to undergo colorectal cancer screening and occult fecal blood tests as a combined preventive procedure to reduce the risk of colorectal cancer, $\chi2(3) = 214.5$, $p< 0.0001$.

Table 1. Study characteristics of older American residents describing those who had and had not been screened for Colorectal Cancer Screening, National Health Interview Survey (NHIS), 2003

| Variable | Colorectal Cancer Screening: Age > 50 years | | | | | |
|---|---|---|---|---|---|---|
| | YES | | NO | | $X^2$(df) | *p* |
| | Number | % | Number | % | | |
| **Sex** | | | | | 3.77(1) | 0.05 |
| Male | 2,501 | 32.9 | 7,134 | 67.1 | | |
| Female | 3,288 | 31.5 | 5,097 | 68.5 | | |
| **Education** | | | | | 144.9(3) | < 0.0001 |
| < HS | 2,679 | 28.7 | 6,648 | 71.3 | | |
| HS | 1,564 | 33.7 | 3,076 | 66.3 | | |
| College | 866 | 35.3 | 1,586 | 64.7 | | |
| Post College | 680 | 42.5 | 921 | 57.5 | | |
| **Marital Status** | | | | | 8.4(1) | 0.004 |
| Single | 1,2718 | 31.1 | 6,026 | 68.9 | | |
| Married | 3,071 | 33.1 | 6,205 | 66.9 | | |
| **Occupation** | | | | | 146.1(1) | < 0.0001 |
| Ever worked | 3,044 | 41.4 | 4,314 | 58.6 | | |
| Never worked | 291 | 23.3 | 956 | 76.7 | | |
| **Income** | | | | | 41.6(1) | < 0.0001 |
| < $20,000.00 | 1,731 | 28.9 | 4,250 | 71.1 | | |
| >$20,00.00 | 4,058 | 33.7 | 7,981 | 66.3 | | |
| **Physician visit** | | | | | | |
| Yes | 5,044 | 37.3 | 8,489 | 62.7 | 660.1(1) | < 0.0001 |
| No | 745 | 16.6 | 3,742 | 83.4 | | |
| **Specialist visit** | | | | | 889.3 (1) | < 0.0001 |
| Yes | 2,742 | 47.2 | 3,073 | 52.8 | | |
| No | 3,047 | 25.0 | 9,158 | 75.0 | | |
| **Alcohol use** | | | | | 87.8 (1) | < 0.0001 |
| Yes | 1,219 | 26.5 | 3,372 | 73.5 | | |
| No | 4,570 | 34.0 | 8,859 | 66.0 | | |
| **Smoking** | | | | | 72.9 (1) | < 0.0001 |
| Ever | 3,052 | 35.2 | 5,616 | 64.8 | | |
| Never | 2,737 | 29.3 | 6,615 | 70.7 | | |
| **Physical Activity** | | | | | 37.0 (1) | < 0.001 |
| Yes | 1,488 | 36.0 | 2,645 | 64.0 | | |
| No | 4,301 | 31.0 | 9,586 | 69.0 | | |
| **Depression** | | | | | 7.6 (1) | 0.006 |
| Yes | 143 | 32.7 | 294 | 67.3 | | |
| No | 2,958 | 39.4 | 4,558 | 60.6 | | |
| **Digestive disorder** | | | | | 13.6 (1) | < 0.0001 |
| Yes | 53 | 57.6 | 39 | 42.4 | | |
| No | 3,048 | 38.8 | 4,813 | 61.2 | | |
| **Obesity** | | | | | 2.7 (1) | 0.10 |
| Yes | 127 | 34.9 | 237 | 65.1 | | |
| No | 2,974 | 39.2 | 4,615 | 60.8 | | |

Note. $X^2$(df) = chi square and degrees of freedom, *p*= significance level, set at 0.01(1 %)

**Racial/ethnic variability in socio-demographic and colorectal cancer prognostic factors**

Table 2 presents the crude and unadjusted prevalence of colorectal cancer by race/ethnicity. There was a significant association between being screened for colorectal cancer and race/ethnicity, $\chi 2$ (3) = 934, p< 0.0001. Overall, relative to Caucasians and Hispanics, African Americans were less likely to be screened for colorectal cancer. Specifically, 22.9% of Caucasians, and 29.8% of Hispanics were screened for colorectal cancer as compared to 6.2% of

African Americans. There were racial/ethnic disparities in the crude prevalence of colorectal cancer screening among older Americans (50 years and older). The prevalence was highest among Caucasians (35.4%), intermediate among African Americans/blacks (27.9%), but lowest among Hispanics (20.5%), and Asians, (19.5%), $\chi 2$ (3) = 264.5, p< 0.0001.

The prevalence of colorectal cancer screening among older Americans (age 50 years and older) was 32.1%. However, there was a slight variability by sex. The prevalence among older American men was 32.9%, and 31.5% among older American women.

Table 2. Prevalence of Colorectal Cancer screening among older US residents and prevalence by race/ethnicity, National Health Interview Survey (NHIS), 2003

| US Population-Race/ethnicity | Screened | Unscreened | $\chi^2$(df) | *p* |
|---|---|---|---|---|
| | n (%) | n (%) | | |
| US sample | 5,789 (32.1) | 12,231 (67.9) | ------ | ------- |
| **Race/Ethnicity** | | | 264.5(3) | < 0.0001 |
| Caucasian | 4,581 (35.4) | 8,334(64.6) | | |
| African American/Black | 639 (27.9) | 1,651(72.1) | | |
| Hispanic | 469 (20.5) | 1,822(79.5) | | |
| Asian | 100 (19.5) | 414(80.5) | | |

**Notes and abbreviations**: United States (US) non-institutionalized residents, $\chi^2$(df) = chi square and Degree of freedom = df. The significance level (*p*) = 0.01.

**Racial/ethnicity variance in colorectal cancer screening**

Table 3 presents the crude or unadjusted relationship between race/ethnicity and other covariates, and colorectal cancer screening. There was a statistically significant relationship between older married Americans and being screened for colorectal cancer. Married adult Americans were 11% more likely to be screened for colorectal cancer, prevalence odds ratio (POR), 1.11, 99% CI, 1.01-1.22, p = 0.003.

Whereas those with health insurance were 6% more likely to be screened for colorectal cancer, this observation was not statistically significant, p > 0.01.

Among older Americans, income was related to being screened for colorectal cancer. Compared to those who reported an average income of less than $20,000, those who reported > $20,000 were 27% more likely to be screened for colorectal cancer, POR, 1.27, 99% CI, 1.16-1.40.

Compared to older Americans without a high school (HS) education, those with a HS education were 24% more likely to be screened for colorectal cancer, POR, 1.24, 99% CI, 1.11-1.38, p <0.0001. A monotonic pattern (dose response) was observed in the association between colorectal cancer screening and education attainment, implying the more educated individuals were, the more likely they were to be screened for colorectal cancer. Consequently, those with a college education were 33% more likely to be screened (POR, 1.33, 99% CI, 1.16-1.54), while those with a post-college education were 91% more likely to be screened (POR, 1.91, 99% CI, 1.64-2.22), relative to those without HS education, p< 0.0001. The homogeneity test for the odds

indicated $\chi 2$ (3) = 144.9, p< 0.0001; while the trend test showed a significant trend as well, $\chi 2(1)$ = 139.0, p< 0.0001.

Among older Americans, compared to those who had never worked, those who ever worked were two times as likely to be screened for colorectal cancer, POR, 2.30, 99% CI, 1.87-2.83, p < 0.0001.

There was no significant association between obesity and being screened for colorectal cancer screening, p > 0.01. There was an association between digestive disorders and being screened for colorectal cancer among older Americans. Compared to those without digestive disorders, those with digestive disorders were 2 times as likely to be screened for colorectal cancer, POR, 2.18, 99% CI, 1.44-3.29, p < 0.0001.

Fecal blood test positive responses were associated with colorectal cancer screening. Compared to those with no fecal blood test, those who had the test performed were five times as likely to be screened for colorectal cancer, POR, 5.4, 99% CI, 5.00-5.75, p< 0.0001.

Compared to older Americans who did not report visits to a physician office, those who visited physicians during the past 12 months were almost 3 times as likely to be screened for colorectal cancer, POR, 2.97, 99% CI, 2.61-3.37, p< 0.0001.

There was a significant association between specialist visits and colorectal cancer screening. Compared to older Americans who did not see a specialist during the past 12 months, those who did were more than 2 times as likely to be screened for colorectal cancer, POR, 2.67, 99% CI, 2.42-2.93, p< 0.0001.

Table 3. The crude association between race/ethnicity and other covariates and colorectal cancer screening prevalence among older US residents, National Interview Survey (NHIS), 2003

| Variable | Prevalence Odds Ratio | 99% CI | *p* |
|---|---|---|---|
| Race/ethnicity | | | |
| Caucasian | 1.0 | Referent | |
| African American/Black | 0.69 | 0.60-0.80 | < 0.0001 |
| Hispanic | 0.48 | 0.41-0.56 | < 0.0001 |
| Asian | 0.45 | 0.33-0.61 | < 0.0001 |
| Sex | | | |
| Male | 1.0 | Referent | |
| Female | 0.92 | 0.84-1.00 | 0.02 |
| Education | | | |
| < HS | 1.0 | Referent | |
| HS | 1.24 | 1.11-1.38 | < 0.0001 |
| College | 1.33 | 1.16-1.54 | < 0.0001 |
| Post College | 1.91 | 1.64-2.22 | < 0.0001 |
| Marital Status | | | |
| Single | 1.0 | Referent | |
| Married | 1.11 | 1.02-1.22 | 0.003 |
| Occupation | | | |
| Ever worked | 1.0 | Referent | |
| Never worked | 2.30 | 1.87-2.83 | < 0.0001 |
| Income | | | |
| < $20,000 | 1.0 | Referent | |
| >$20,000 | 1.27 | 1.16-1.40 | < 0.0001 |
| Physician Visit | | | |
| No | 1.0 | Referent | |
| Yes | 2.97 | 2.61-3.38 | < 0.0001 |
| Specialist Visit | | | |
| No | 1.0 | Referent | |

| | | | |
|---|---|---|---|
| Yes | 2.67 | 2.42-2.93 | < 0.0001 |
| Alcohol | | | |
| No | 1.0 | Referent | |
| Yes | 0.70 | 0.63-0.77 | <0.0001 |
| Smoking Status | | | |
| No | 1.0 | Referent | |
| Yes | 1.28 | 1.18-1.40 | < 0.0001 |
| Physical Activity | | | |
| No | 1.0 | Referent | |
| Yes | 1.24 | 1.12-1.38 | < 0.0001 |
| Health Insurance | | | |
| No | 1.0 | Referent | |
| Yes | 1.06 | 0.91-1.34 | 0.31 |
| Depression | | | |
| No | 1.0 | Referent | |
| Yes | 1.02 | 0.89-1.18 | 0.64 |
| Digestive Disorder | | | |
| No | 1.0 | Referent | |
| Yes | 2.18 | 1.44-3.29 | < 0.0001 |
| Obesity | | | |
| No | 1.0 | Referent | |
| Yes | 0.83 | 0.67-1.04 | 0.10 |
| Fecal Blood Test (+Ve) | | | |
| No | 1.0 | Referent | |
| Yes | 5.36 | 4.89-5.86 | < 0.0001 |

Abbreviation and notes: CI= Confidence Interval. The significance level was set at 0.01.

**Association between race/ethnicity and colorectal cancer screening: A multivariable model**

Table 4 presents several models used to examine the confounding effect of covariates on the relationship between race/ethnicity and colorectal cancer screening. Even after adjustment for the socio-demographic factors, namely health insurance, income level, education, sex and marital status; the racial/ethnic disparities in colorectal cancer persisted. Compared to Caucasians, African Americans were 26% (adjusted Prevalence Odds Ratio (APOR), 0.74, 99% CI, 0.64-0.85) less likely to be screened for colorectal cancer, while Hispanics 48% (APOR, 0.52, 99% CI, 0.44-0.61) and Asians 56% (APOR, 0.44, 99% CI, 0.32-0.59) were less likely to be screened, $p < 0.0001$ (Model II).

After adjustment for lifestyle variables, namely smoking, alcohol, and physical activities, racial/ethnic disparities persisted, $p < 0.0001$. Compared to Caucasians, African Americans/blacks were 28% (APOR, 0.72, 99% CI, 0.62-0.82) less likely to be screened for colorectal cancer while, Hispanics were 49% (APOR, 0.51, 0.43-0.60) and Asians 52% (APOR, 0.48, 99% CI, 0.35-0.66) less likely to be screened.

After controlling for factors that may influence colorectal cancer screening, such as visits to a physician during the last 12 months, visits to a specialist during the past 12 months and a state of helplessness as surrogate for depression, ethnic and racial disparities in colorectal cancer screening persisted, $p< 0.0001$. Compared to Caucasians, African Americans/blacks were 26% (APOR, 0.74, 99% CI,0.64-0.85, $p< 0.0001$) while Hispanics and Asians were 46% (APOR, 0.56, 99% CI, 0.48-0.66) and 50% (APOR, 50.5, 99% CI, 0.37-0.69) respectively less likely to be screened for colorectal cancer.

Table 4 also presents the simultaneous adjustment for socio-demographics, life style and prognostic factors in the relationship between colorectal cancer screening and race/ethnicity. After controlling for these factors, the racial/ethnic disparities persisted, implying that one cannot

explain the racial/ethnic disparities in colorectal cancer screening by the racial variability in demographics, lifestyle and prognostic factors, $p < 0.0001$. Compared to Caucasians, African Americans/blacks were 28% (APOR, 0.72, 99% CI, 0.60-0.88) less likely to be screened for colorectal cancer, while Hispanics were 33%, (APOR, 0.67, 99% CI, 0.53-0.84) and Asians were 37% (APOR, 0.63, 99% CI, 0.43-0.95) less likely to be screened.

Table 4. Adjusted Relationship between colorectal cancer screening and race/ethnicity among older Americans, National Health Interview Survey (NHIS), 2003.

| Model | African Americans/Black | | | Hispanic | | | Asian | | |
|---|---|---|---|---|---|---|---|---|---|
| | APOR | 99% CI | *p* | APOR | 99% CI | *p* | APOR | 99% CI | *p* |
| **Model I** - Crude Race/ethnicity | 0.69* | 0.60-0.80 | < 0.0001 | 0.48 | 0.41-0.56 | < 0.0001 | 0.45 | 0.33-0.61 | < 0.0001 |
| **Model II** – Socio-demographic | 0.74 | 0.64-0.85 | < 0.0001 | 0.52 | 0.44-0.61 | < 0.0001 | 0.44 | 0.32-0.60 | < 0.0001 |
| **Model III** – Life style | 0.71 | 0.62-0.82 | < 0.0001 | 0.51 | 0.43-0.60 | < 0.0001 | 0.48 | 0.35-0.66 | < 0.0001 |
| **Model IV** – Prognostic factors | 0.74 | 0.64-0.85 | < 0.0001 | 0.56 | 0.48-0.66 | < 0.0001 | 0.50 | 0.37-0.69 | < 0.0001 |
| **Model V** – Socio-demographic, life style & prognostic factors | 0.67 | 0.56-0.82 | < 0.0001 | 0.59 | 0.48-0.74 | < 0.0001 | 0.58 | 0.39-0.86 | < 0.0001 |

**Notes and abbreviation:** Model I = Crude and unadjusted; Model II: Controlled for sex, health insurance, income, education, occupation and marital status; Model III: Controlled for smoking, alcohol, and physical activities; Model IV: Controlled for depression, physician visit, and specialist visit; Model V: Controlled for socio-demographic, life style variables and prognostic factors for colorectal cancer screening. The significance level was $p< 0.01$. APOR = Adjusted prevalence odds ratio; CI= Confidence Interval. *

## DISCUSSION

Colorectal cancer is uncommon before age 50 years, hence screening for early detection is recommended at age 50 in the United States. Analysis of data from the 2003 National Health Interview Survey (NHIS), revealed that among older Americans, the prevalence of colorectal cancer screening varied by race/ethnicity, and that minorities were less likely to be screened for colorectal cancer relative to Caucasians. Specifically, colorectal cancer screening was lowest among Hispanic and Asians, intermediate among African Americans/blacks and highest among Caucasians. There were racial/ethnic disparities in education, marital status, income, occupation, smoking, alcohol, physical activities, educational attainment, depression, physician visits, specialist visits, and digestive disorders, but not with sex and health insurance. Also, there were significant differences in marital status, education, alcohol, smoking, physical activities, income, physician visit, specialist visit, digestive disorders, depression, but not with insurance coverage, obesity, and sex, comparing those screened and unscreened for colorectal cancer. The fact that racial disparities persisted, even after controlling for the socio-demographic, lifestyle and colorectal cancer screening prognostic factors, shows that the racial/ethnic disparities which persisted are indicative of the inability of these factors to fully explain the racial/ethnic disparities in colorectal cancer screening among this large sample of community-based U.S. residents.

The prevalence of colorectal cancer screening among older Americans was less than 32.1%. This prevalence was further lowered among minorities, African Americans/blacks (27.9%), Hispanics (20.5%) and Asians (19.5%). However, the prevalence was higher among Caucasians (35.4%) relative to the total population of older Americans. Some studies have shown racial disparities (white versus blacks) in colorectal cancer screening, with African Americans/blacks identified with a lower rate of screening compared to their white counterparts

(Freeman, 2002; Ries, 2000; Jemal, 2006; Mayberry, 1995; Marcella, 2001). The finding in this current study thus validates these earlier studies.

Since colorectal cancer is uncommon before age 50 years, and in the case of early detection, wherein rectal polyps are removed from the rectum and colon renders the treatment of the benign tumor highly successful; the prevalence of screening among older Americans was expected to be higher than observed in this data. Specifically, colorectal cancer screening prevalence in the U.S. or any population of participants younger than age fifty years will yield a very sparse data, and hence inappropriate for epidemiologic investigation.

If data were available on family history of colorectal cancer, this could have allowed one to examine whether or not family history would have increased the proportion of those screened in the households with a positive history of colorectal cancer. However, a previous study showed that family history did not predict screening in African Americans when the analysis was controlled for age, education, and insurance. African Americans who have a family history of colorectal cancer were less likely to be screened compared with their white counterparts and compared with African Americans who were at average risk for colorectal cancer ($p< 0.05$) (Griffith et al., 2008).

The observed limitation remains inherent in the use of pre-existing or secondary data in the analysis of health related outcomes. Previous studies have shown racial/ethnic disparities in colorectal cancer screening as well as breast and prostate cancer screening (Etzioni, 2006; Holmes-Royner, 2002; Peterson, 2008; Peterson, 2007; Vlahov, 2005; Janz, 2003; Shokar, 2007, Shokar, 2008, Zhao, 2006).

Evidence of disparities by race/ethnicity was observed in this current study with socio-demographics, life style and colorectal cancer screening prognostic factors. Regarding educational attainment, minorities were less likely to have post college education, which directly correlated with CRC screening. The NHIS 2003 data used in this analysis showed that relative to those without a high school diploma, those with a post college education were 91% more likely to be screened for CRC. Therefore given the CRC screening variability in education and race/ethnicity, educational status was adjusted as one of the variables in the socio-demographic model (Model II), but the racial/ethnic disparities in colorectal cancer screening persisted. Therefore education per se cannot fully explain the ethnic/racial disparities in colorectal cancer screening among older Americans. The findings in this study regarding increased propensity of being screened, given higher education supports a previous study by Shokar (2007) which found a two-fold increase in screening given greater education. Although this current study did not assess the knowledge of CRC screening, Shokar (2008) also showed that the knowledge of CRC screening increased the odds of being screened for CRC, and that African Americans were less likely relative to Whites to have knowledge of CRC screening.

Marital status was found in this study to be associated with CRC screening, with the odds of being screened higher among older married Americans. Racial/ethnic disparities were also observed by marital status, and minorities, mainly African Americans were less likely compared to Caucasians to be married. This finding is plausible since marriage may increase the social support network system which has been shown to enhance healthful behaviors including screening for disease, early disease detection, and hence good prognosis. (Ebrahim, 1995)

Income was shown to be associated with colorectal cancer screening. Specifically older Americans who made an annual income > $20,000 were more likely to be screened for colorectal cancer, relative to those in the < $20,000 stratum. Minorities were more likely to be in the lower socio-economic stratum, and were less likely to be screened for colorectal cancer. Previous

studies had related lower socioeconomic status which was measured by education and income (Shokar, 2008, Zhao, 2006, Peterson 2008). Remarkably, White race and higher socioeconomic status are associated with higher rates of physician recommendation of screening (Peterson, 2007). A study has shown that having either a screening sigmoidoscopy or colonoscopy was positively associated with educational status, being married, higher household income, recent medical visit, higher age and public or private insurance among African Americans (Peterson 2008). In effect, those with higher education, higher income, health insurance and those with routine health visits were more likely screened for CRC. The CRC screening rate varies less by race than by region (Coughlin, 2002). This study concentrated on Southern U.S. regions where there are high concentrations of African Americans as well as high levels of unemployment and poverty (Coughlin, 2002). The CRC screening disparities between Blacks and Whites were eliminated after adjusting for socioeconomic status (O'Malley, 2005). This current study adjusted for income, education, occupation, marital status, sex, but the racial/ethnic disparities in screening persisted. Therefore racial /ethnic variability in socio-demographic factors could not fully explain the racial/ethnic disparities in colorectal cancer screening.

Whereas no association was found between health insurance and colorectal cancer screening, Shih showed that Medicare coverage of colonoscopy since 2001, did reduce racial screening disparities between elderly Whites and Blacks/African Americans (Shih, 2006).While health insurance, implying access and utilization of health care may assist in explaining the racial/ethnic disparities in colorectal cancer screening in the U.S., this data failed to show any racial/ethnic disparities in screening associated with insurance status.

Individuals who are health-conscious are more likely to undergo screening for disease as recommended, and are more likely to maintain healthful behaviors. This current data indicated that older Americans who exercise were more likely to be screened. Likewise, screening for CRC was higher among those who do not smoke nor drink. Despite our search efforts, there were no studies found that have assessed lifestyle variables and CRC screening. The present finding is plausible since individuals who perceive themselves to be at disease risk, and believe that sigmoidoscopy and colonoscopy can reduce their risk of CRC, will seek health protective behaviors including screening for early detection of CRC, and abstaining from smoking and alcohol use.

Some clinical conditions may hinder screening for disease in general. This study examined depression, which if not managed may be associated with decreased concentration, impaired focus, distractibility, and poverty in the elderly. In this sample, older Americans who were depressed were less likely to be screened for CRC. There are no previous studies to our knowledge that had examined mental illness such as depression and its relationship with screening for CRC. However, it is plausible to expect that depression may hinder one's ability to seek screening for a disease such as CRC. Such impediment may be due to the fact that major depression such as unipolar affective disorder is associated with decreased concentration, lack of focus, helplessness and distractibility. Compared to Caucasians, minorities were more likely to be depressed and hence less likely to be screened for CRC. However, controlling for depression and other prognostic factors such as digestive disorders, did not remove the racial/ethnic disparities in colorectal cancer screening.

As part of the CRC screening prognostic factor, physician visits and specialist visits were examined. Clearly the data showed that visits to physician or specialists during the past twelve months were associated with increased odds of being screened for CRC. Previous studies had

shown that routine visits to physicians and physician recommendation of CRC screening increased the propensity of being screened for CRC (Shokar, 2008).

Since many factors may influence CRC screening, and racial/ethnic variability in such factors may account for racial/ethnic disparities in CRC screening, this study adjusted for these factors (socio-demographic, lifestyle and prognostic factors) as indicated in the adjustment model (V). However, after these adjustments, the racial/ethnic disparities in CRC persisted. The purpose of adjustment or covariates controlling is to balance these factors among the racial/ethnic groups, in order to observe the prevalence odds of colorectal cancer, with Caucasian as the reference group. Thus, by placing these factors at constant and examining the distribution of CRC screening by race/ethnicity, the racial/ethnic variance or disparities persisted with minorities, namely African Americans, Hispanics and Asians, less likely to be screened for CRC. With this model (V), one can claim that there were factors that influenced CRC screening that were not available for adjustment in the NHIS 2003, such as access and utilization of care. Similarly, a study assessing CRC screening, and after demographic adjustment, found that minorities reported less CRC screening than non-Hispanic whites. Disparities were largest for combined screening in Asians (adjusted prevalence odds ratio [APOR], 0.40; 99% Confidence Interval [CI], 0.32-0.49) and Hispanics (APOR, 0.43; 95% CI, 0.39-0.48) and for endoscopic screening in Asians (APOR, 0.41; 95% CI, 0.33-0.50) and Hispanics (APOR, 0.43; 95% CI, 0.38-0.48). With full adjustment, all Hispanic/non-Hispanic white disparities and black/non-Hispanic white fecal occult blood test (FOBT) disparities were eliminated, whereas Asian/non-Hispanic white disparities remained significant (FOBT: APOR, 0.72 [95% CI, 0.52-1.00]; endoscopic screening, [APOR, 0.63, 95% CI, 0.49-0.81]; and combined screening, APOR, 0.66, 95% CI, 0.52-0.84).

Despite the strengths of this current study, there are some limitations. First, the present study utilized a cross-sectional design, which makes it difficult to establish temporal sequence in terms of effect and cause with respect to some of the variables examined in relation to CRC screening and race/ethnicity. Secondly because this study used pre-existing data, there might have been variables that were not available for adjustment on the relationship between CRC screening and race/ethnicity such as knowledge of CRC screening guidelines, access and utilization of the health care system, and physicians recommendation of CRC screening. These unmeasured confounding might very well influence the findings in this study. Thirdly, like in most epidemiologic or non-experimental designs, these findings might have been influenced in part by residual confounding, since no matter how sophisticated the statistical software is that is used to control for confounding, some confounding remains to be adjusted. (Holmes, 2008). Our data represent a ten year retrospective cross-sectional assessment, due to unavailability of recent complete data on colorectal cancer screening. Current cross-sectional data illustrate some variability of findings, but this is unlikely given the trends for colorectal cancer incidence and mortality in the SEER data.

Finally, because the outcome or response variable was self-reported screening for colorectal cancer during the past twelve months, there is a possibility of misclassification, and hence information bias. However, the result of this study is not driven solely by such misclassification bias.

## CONCLUSION

In summary, racial/ethnic disparities in CRC screening exist among older Americans, with ethnic/racial minorities being disproportionately affected. The observed disparities with

Hispanics, African Americans/blacks and Asians demonstrating lower prevalence of CRC screening relative to Caucasians, persisted after adjustment for socio-demographic, lifestyle and colorectal cancer screening prognostic factors. Therefore ethnic/racial disparities in CRC screening cannot be completely explained by racial/ethnic differences in socio-demographic, lifestyle and prognostic factors. Further studies utilizing prospective design are urgently needed to assess factors that may fully explain the racial/ethnic disparities in CRC screening among older non-institutionalized U.S. residents.

**ACKNOWLEDGEMENTS**

We thank the National Center for Health Statistics (NCHS) for the availability of the National Health Interview Survey (NHIS) data. The interpretation and the inference from this data are the responsibility of the authors and not that of NHIS or the institutions affiliated with the authors.

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