Prevalence of Colon Polyps Detected by Colonoscopy Screening in Asymptomatic Black and White Patients

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Context Compared with white individuals, black men and women have a higher incidence and mortality from colorectal cancer and may develop cancer at a younger age. Colorectal cancer screening might be less effective in black individuals, if there are racial differences in the age-adjusted prevalence and location of cancer precursor lesions.

Objectives To determine and compare the prevalence rates and location of polyps sized more than 9 mm in diameter in asymptomatic black and white individuals who received colonoscopy screening.

Design, Setting, and Patients Colonoscopy data were prospectively collected from 67 adult gastrointestinal practice sites in the United States using a computerized endoscopic report generator between January 1, 2004, and December 31, 2005. Data were transmitted to a central data repository, where all asymptomatic white (n=80 061) and black (n=5464) patients who had received screening colonoscopy were identified.

Main Outcome Measures Prevalence and location of polyps sized more than 9 mm, adjusted for age, sex, and family history of colorectal cancer in a multivariate analysis.

Results Both black men and women had a higher prevalence of polyps sized more than 9 mm in diameter compared with white men and women (422 [7.7%] vs 4964 [6.2%]; $P<.001$). Compared with white patients, the adjusted odds ratio (OR) for black men was 1.16 (95% confidence interval [CI], 1.01-1.34) and the adjusted OR for black women was 1.62 (95% CI, 1.39-1.89). Black and white patients had a similar risk of proximal polyps sized more than 9 mm (OR, 1.13; 95% CI, 0.93-1.38). However, in a subanalysis of patients older than 60 years, proximal polyps sized more than 9 mm were more likely prevalent in black men ($P=.03$) and women ($P<.001$) compared with white men and women.

Conclusion Compared with white individuals, black men and women undergoing screening colonoscopy have a higher risk of polyps sized more than 9 mm, and black individuals older than 60 years are more likely to have proximal polyps sized more than 9 mm.

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Colorectal cancer incidence and mortality are higher in black patients compared with white patients. Mortality rates for black men (34.3 per 100 000 population per year) and women (24.5 per 100 000 population per year) are 38% to 43% higher than for white men and women.[1] Incidence rates are 15.5% to 23% higher in black individuals.[1] Since 1985 as incidence rates have declined in white individuals by 20% to 25%, rates in black men have increased and remained unchanged in black women.[1] There are many possible reasons for these differences. Factors such as poor access to care, failure of health care professionals to recommend screening, and lower rates of participation when screening is offered, could delay diagnosis, which could result in more advanced stage disease at the time of diagnosis. Disparities in screening rates have been documented in the Medicare population.[2,3] Differences in cancer prevention knowledge may also delay screening efforts.[4]

See also p 1459 and Patient Page.

There is considerable evidence that tumor biology and genetics play a role in some of the racial differences.[5,6] These differences may impact the effectiveness and cost of screening efforts.[7] There is some evidence that black patients may have higher likelihood of proximal polyps and tumors than white patients, which would render sigmoi-

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doscopy less effective in black patients.[8-13] If black patients develop colorectal cancer at a younger age, they may not be detected at an early stage with screening.[6] Current colorectal cancer screening guidelines from the American Cancer Society, the Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology recommend initiation of screening at age 50 years for all races.[14] Recommendations from the American College of Gastroenterology call for initiation of screening at age 45 years in black patients.[6] However, few studies have determined if black patients undergoing screening are more likely to have cancer precursor lesions and benefit from early screening.

We hypothesized that in patients undergoing screening colonoscopy, black patients are more likely to have polyps sized more than 9 mm in diameter than white patients, particularly in the proximal colon, after adjusting for age and sex. Our primary goals were to measure the prevalence and location of polyps sized more than 9 mm in diameter in black and white patients who received colonoscopy screening in diverse practice settings across the United States. We identified asymptomatic black and white patients who had received colonoscopy screening and compared these outcomes.

METHODS

Clinical Outcomes Research Initiative

The Clinical Outcomes Research Initiative (CORI) represents a consortium of 67 adult gastrointestinal practices, including 500 physicians in 25 states, which use a computerized endoscopic procedure report generator to produce their endoscopic reports. Reports from each site are transmitted electronically to a central data repository and merged for analysis. Practice sites include private practice (79% of colonoscopy reports), academic sites (10%), and Department of Veterans Affairs sites (11%). In clinical practice, screening examinations are performed in outpatients, either in ambulatory endoscopy centers or in hospitals. Practice sites were selected to represent a complete spectrum of gastrointestinal practices and include both urban and rural sites in each region of the country.

All patient and physician identifiers were removed from the data file before transmission from the local site to protect both patient and physician confidentiality. The data were subjected to quality control checks to identify missing fields. Internalized quality control checks included parameters for size descriptions and drug dosage. After completion of quality control checks, data from all sites were merged in the data repository for analysis. Site compliance was assessed annually. Sites provided record counts of procedures, which were compared with procedure counts in the data repository. If sites failed to record more than 95% of endoscopic reports using CORI software, they were notified to improve compliance. Failure to improve compliance resulted in exclusion of the site's data from analysis.

The CORI database is reviewed annually by the institutional review board at Oregon Health and Science University. The use of de-identified data, as outlined above, is subject to a waiver of consent.

Patients

Data were prospectively collected between January 1, 2004, and December 31, 2005. Patients were included in the analysis if they received colonoscopy for screening and were 18 years or older. In most cases, the screening examination was the initial colonoscopy for each patient. However, it is possible that some patients had prior examinations that were not captured in the CORI database. Patients were excluded if they had any other indication for colonoscopy, such as presence of lower gastrointestinal symptoms or positive fecal occult blood test result. Patients undergoing colonoscopic surveillance after prior removal of polyps or cancer or with a history of familial adenomatous polyposis or hereditary nonpolyposis colorectal cancer syndrome were excluded.

Patients demographics, including age and sex, were entered by the endoscopist. Race and ethnicity were mandatory field requirements. Using the US Census definitions, white patients were defined as white, non-Hispanic and black patients were defined as non-Hispanic. Race information was provided by the endoscopist, not directly from the patient, which could result in some misclassification.

Colonoscopy End Points

In this structured database, physicians are asked to provide detailed descriptors of every polyp, including size, location, morphology (pedunculated, sessile, or flat), and method of removal. Because pathology results are provided for 23.1% of colonoscopy reports, we used the finding of 1 or more polyps sized more than 9 mm in diameter as a surrogate end point for prevalence of advanced polyps in the cohorts.

To determine if the surrogate end point was representative of patients with advanced neoplasia, we performed an analysis of 13 609 screening examinations in which histology for each polyp was determined. Based on sites that provide pathology results, we found that 84% of polyps sized more than 9 mm are advanced adenomas defined as tubular adenoma sized at least 10 mm, serrated adenoma, adenoma with villous histology, or high-grade dysplasia or invasive cancer. We compared the demographic characteristics of patients with histologically proven advanced histology with patients with the surrogate end point and found that age, sex, race, and screening indication were similar. We also compared the proportions of white and black patients with either histologically proven advanced neoplasia, or advanced polyp based on the surrogate. For white patients, the proportion with advanced neoplasia in the histology cohort was 5.6% compared with an advanced polyp rate of 6.2% in the surrogate analysis. For black patients, the proportion with advanced neoplasia in the histology co-

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hort was 6.3% compared with an advanced polyp rate of 7.7% in the surrogate analysis. The primary difference in both groups was due to the rate of hyperplastic polyps sized more than 9 mm, which may be clinically important.[15] Based on these data, we found that the surrogate advanced polyp was representative of patients with histology proven advanced neoplasia.

Proximal location was defined as colon including and proximal to the splenic flexure. Proximal findings also included patients having 1 or more polyps sized more than 9 mm in diameter in both proximal and distal locations.

Statistical Analysis

We constructed 2 multivariate logistic regression analyses for the following end points: (1) polyps sized more than 9 mm and (2) patients with polyps sized more than 9 mm, the risk of having a proximal lesion. Using a range of risks for the white, non-Hispanic group, we calculated that with a sample size of more than 85 000, differences (and odds ratios [ORs]) relative to the black cohort can be detected with 80% power using a 2-sided test to compare proportions at $P \leq .05$. Potential covariates in the models included age, sex, screening indication, and site type. Variables were retained in the model if they demonstrated statistical significance or confounding with white vs black race. The adjusted OR of each outcome was separately calculated with 95% confidence intervals (CIs). Comparison of demographic data was performed by using Pearson χ^2 tests or Fisher exact tests due to small cell sizes. All analyses were performed by using SAS verson 9.1 (SAS Institute Inc, Cary, North Carolina).

RESULTS

Between January 1, 2004, and December 31, 2005, 259 980 unique patients had a colonoscopy reported to the CORI database. A total of 71 130 patients (27.4%) received colonoscopy for average-risk screening and 21 767 patients (8.4%) received colonoscopy because of a family history of colorectal cancer or polyps. Of 92 897 patients, 85 525 were included in the analysis (80 061 white and 5464 black) and 7372 patients were excluded because of other race or ethnicity. Patient characteristics are shown in TABLE 1. Almost 50% of patients were women. Sixty-four percent of black patients vs 52% of white patients were younger than 60 years ($P < .001$). Eighty percent of both groups came from community-based practices.

The prevalence of polyps sized more than 9 mm in diameter is shown in TABLE 2. A total of 422 black patients (7.7%) and 4964 white patients (6.2%) had 1 or more polyps sized more than 9 mm ($P < .001$). These differences ex-

Table 1. Patient Demographics by Race/Ethnicity

	No. (%) of Patients		
	White (n = 80 061)	Black (n = 5464)	*P* for Trend
Indication[a]			
Average risk	60 380 (75.4)	4366 (79.9)	<.001
Family history	19 681 (24.6)	1098 (20.1)	
Age, y			
<50	5279 (6.6)	421 (7.7)	<.001
50-59	36 400 (45.5)	3100 (56.7)	
60-69	24 125 (30.1)	1378 (25.2)	
70-79	12 194 (15.2)	501 (9.2)	
≥80	2063 (2.6)	64 (1.2)	
<60	41 679 (52.1)	3521 (64.4)	<.001
Female sex	38 268 (47.8)	2813 (51.5)	<.001
Practice site			
Community	64 205 (80.2)	4392 (80.4)	<.001
Academic	8263 (10.3)	310 (5.7)	
VA or military	7593 (9.5)	762 (14.0)	

Abbreviation: VA, Veterans Affairs Medical Centers.
[a] Asymptomatic patients with no family history of colorectal cancer (average risk) or with a family history of colorectal cancer (family history).

Table 2. Unadjusted Prevalence of Polyps Sized More Than 9 Millimeters by Race/Ethnicity

	No./Total No. (%) of Patients		
Prevalence	White	Black	*P* Value
Overall	4964/80 061 (6.2)	422/5464 (7.7)	<.001
Average risk[a]	3822/60 380 (6.3)	339/4366 (7.8)	<.001
Male	2546/33 028 (7.7)	183/2185 (8.4)	.26
Female	1276/27 352 (4.7)	156/2181 (7.2)	<.001
Family history[a]	1142/19 681 (5.8)	83/1098 (7.6)	.02
Male	649/8765 (7.4)	42/466 (9.0)	.20
Female	493/10 916 (4.5)	41/632 (6.5)	.02
Age, y			
<50	222/5279 (4.2)	26/421 (6.2)	.06
50-59	1942/36 400 (5.3)	190/3100 (6.1)	.06
60-69	1717/24 125 (7.1)	145/1378 (10.5)	<.001
70-79	934/12 194 (7.7)	54/501 (10.8)	.01
≥80	149/2063 (7.2)	7/64 (10.9)	.23[b]
Practice site			
Community	3910/64 205 (6.1)	350/4392 (8.0)	<.001
Academic	453/8263 (5.5)	18/310 (5.8)	.81
VA or military	601/7593 (7.9)	54/762 (7.1)	.42

Abbreviation: VA, Veterans Affairs Medical Centers.
[a] Asymptomatic patients with no family history of colorectal cancer (average risk) or with a family history of colorectal cancer (family history).
[b] Fisher exact test used to calculate *P* value due to small cell sizes.

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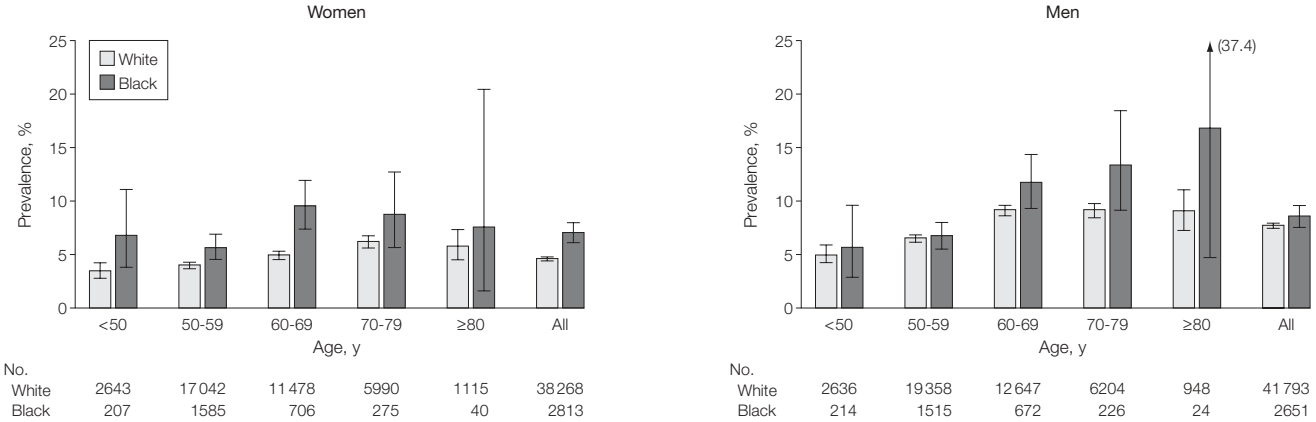
Figure. Prevalence of Polyps Sized More Than 9 Millimeters in White and Black Women and Men



Error bars represent 95% confidence intervals. The prevalence of the upper limit of 95% confidence interval for black men aged 80 years or older was 37.4%.

Table 3. Relative Risk Estimates of Polyps Sized More Than 9 Millimeters by Multivariate Analysis

	Odds Ratio (95% Confidence Interval)
Age, y[a]	
<50	1 [Reference]
50-59	1.23 (1.08-1.41)
60-69	1.72 (1.50-1.97)
70-79	1.88 (1.63-2.17)
≥80	1.81 (1.47-2.23)
Practice site	
Community	1 [Reference]
Academic	0.85 (0.77-0.93)
VA or military	1.10 (1.01-1.20)
Comparisons based on sex and race	
Black women vs white women	1.62 (1.39-1.89)
Black men vs white men	1.16 (1.01-1.34)

Abbreviation: VA, Veterans Affairs Medical Centers.
[a]Test of trend for age, $P \leq .001$.

tended across all age groups in women and men (FIGURE).

The adjusted risk of polyps sized more than 9 mm in diameter is shown in TABLE 3. There is an increased risk associated with age older than 50 years. There was also a significant increase in risk when patients aged 60 to 69 years were compared with those aged 50 to 59 years (Table 3). Risk appears to plateau in the 8th decade of life (≥80 years). There was no statistically significant increase in risk associated with a positive family history of colorectal cancer for either race and thus this covariate did not remain in our multivariate model. Overall, the risk of polyps sized more than 9 mm in diameter was higher in men compared with women for both racial groups, but there were within-group differences. White women had a much lower risk of polyps sized more than 9 mm in diameter when compared with white men (OR, 0.59; 95% CI, 0.55-0.63). However, black women had only a borderline difference in risk compared with black men (OR, 0.82; 95% CI, 0.67-1.00). When adjusting for age, sex, and site type (Table 3), there was a large difference in risk between black and white women (OR, 1.62; 95% CI, 1.39-1.89). Statistically significant differences were also observed between black and white men (OR, 1.16; 95% CI, 1.01-1.34).

A second goal of our analysis was to determine and compare the risk of proximal polyps sized more than 9 mm in black and white patients. We identified all patients who had 1 or more proximal polyps sized more than 9 mm, with or without distal polyps. There were differences based on age, sex, and race; therefore, the prevalence data were presented in a stratified manner (TABLE 4). For patients older than 60 years, there was a higher prevalence of proximal polyps sized more than 9 mm in black patients compared with white patients in both men ($P = .03$) and women ($P < .001$). The difference was more striking in women than men. Overall, there was no difference in risk of proximal vs distal polyps sized more than 9 mm based on race (TABLE 5). Factors that were associated with increased risk of proximal vs distal polyps sized more than 9 mm included older than 60 years, female sex, and family history of colorectal cancer or polyps (Table 5).

COMMENT

Prior work has established that there are important differences in incidence and mortality of colorectal cancer between white and black patients.[1,6] However, no prior multicenter study has compared outcomes in asymptomatic individuals undergoing colorectal cancer screening to determine if there are important racial differences. These results have important implications for colorectal cancer screening recommendations.

Our results show that in an asymptomatic screening population, cancer precursor lesions (polyps sized >9 mm) are more common in black patients compared with white patients. The disparities were greater in women (OR, 1.62; 95% CI, 1.39-1.89) than in men (OR, 1.16; 95% CI, 1.01-1.34). These data strongly emphasize the importance of timely screening in black

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Table 4. Prevalence of Proximal Polyps Sized More Than 9 Millimeters, Stratified by Age, Sex, and Race

	No./Total No. (%) of Women			No./Total No. (%) of Men		
Age, y	Black	White	*P* Value	Black	White	*P* Value
<50	6/207 (2.90)	47/2643 (1.78)	.28[a]	6/214 (2.80)	56/2636 (2.12)	.46[a]
50-59	44/1585 (2.78)	350/17 042 (2.05)	.56	53/1515 (3.50)	546/19 358 (2.82)	.13
60-69	42/706 (5.95)	304/11 478 (2.65)	<.001	41/672 (6.10)	592/12 647 (4.65)	.09
70-79	9/275 (3.27)	190/5990 (3.17)	.93	16/226 (7.08)	311/6204 (5.01)	.17
≥80	3/40 (7.50)	34/1115 (3.05)	.13[a]	2/24 (8.33)	45/948 (4.75)	.33[a]
>60	54/1021 (5.29)	528/18 583 (2.84)	<.001	59/922 (6.40)	948/19 799 (4.79)	.03

[a] Computed with Fisher exact test (2-tailed) due to small cell sizes.

women and men. The prevalence of polyps sized more than 9 mm in black women before the age of 50 years is similar to that of white men and black men aged 50 to 59 years. However, the sample of black women aged younger than 50 years (n = 207) is small. If this finding is confirmed in other studies, consideration should be given to initiation of screening before age 50 years in black women.

The location of neoplasia can be an important determinant of the type of screening test selected. Sigmoidoscopy will be less effective in populations that have higher rates of proximal neoplasia. Prior work has suggested that black patients are more likely to have proximal tumors than white patients.[6,8-13] In the analysis of both sexes, we did not find that black patients were more likely than white patients to have proximal polyps sized more than 9 mm. Subgroup analysis by sex and age revealed that black women (vs white women) and black men (vs white men) older than 60 years had a higher prevalence of proximal polyps sized more than 9 mm. Our multivariate analysis suggested that individuals older than 60 years, female sex, and patients with a family history of colorectal cancer were more likely to have proximal lesions. These results are consistent with prior work.[16-18] Therefore, a complete structural examination of the colon may be a preferred screening test for all individuals older than 60 years.

Our study has several limitations. Our data describe only those patients who received screening colonoscopy. We recognize that many patients may not receive screening colonoscopy, and these patients may differ in important ways from those who do. Race/ethnicity information was provided by the endoscopist and therefore subject to misclassification. We used a surrogate end point for advanced neoplasia (polyps sized >9 mm), which we have shown to be related to the actual rate of histologically proven advanced neoplasia in a screening cohort. Ten percent to 20% of patients with polyps sized more than 9 mm do not have neoplasia,[16,18] introducing possible misclassification bias. Most of these patients without histology proven advanced neoplasia have hyperplastic polyps sized more than 9 mm, which may be clinically important.[15] There are no data suggesting that the rates of neoplasia are different in large polyps (>9 mm) based on race. Large screening colonoscopy studies have found that 2% to 10% of polyps sized less than 9 mm have advanced histological features.[16,18-20] Therefore, a small number of patients with advanced histology were excluded from this analysis by virtue of polyp size, which could introduce bias if there were differences in rates of advanced histology in small or large polyps based on race. Estimates of polyp size at endoscopy could be subject to error, based on prior work.[21,22] It is possible that some individuals may have had prior screening examinations, which if negative, could bias the sample toward a lower rate of polyps sized more than 9 mm. Finally, the CORI consortium may not be representative of endoscopic practice in the United States. Physicians who participate in CORI are comfortable using computers to generate endoscopy reports and sharing data. However, in a recent analysis, we compared CORI data in patients aged 65 years or older with a Medicare data set and found the CORI patients to be similar to the Medicare population receiving endoscopy.[23]

Table 5. Relative Risk Estimates of Proximal vs Distal Polyps Sized More Than 9 Millimeters by Multivariate Analysis

	Odds Ratio (95% Confidence Interval)
Sex, male vs female	0.88 (0.79-0.98)
Race/ethnicity, black vs white	1.13 (0.93-1.38)
Age	
<50	1 [Reference]
50-59	1.12 (0.85-1.47)
60-69	1.44 (1.09-1.90)
70-79	1.48 (1.10-1.98)
≥80	1.51 (1.00-2.28)
Family history vs average risk[a]	1.17 (1.03-1.34)

[a] Asymptomatic patients with a family history of colorectal cancer (family history) or with no family history of colorectal cancer (average risk).

In summary, we find that asymptomatic black men and women undergoing colonoscopy screening are more likely to have 1 or more polyps sized more than 9 mm compared with white individuals. The differences were especially striking among women. These findings emphasize the importance of encouraging all black men and women to be screened. We found that black women younger than 50 years have similar rates of polyps sized more than 9 mm compared with white men aged 50 to 59 years. Further study is needed to confirm this finding. This result raises the question of whether colorectal cancer screening should be initiated before age 50 years in this cohort. How-

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ever, there is genuine concern that current screening guidelines are complex, and that adding layers of customization based on race or sex could increase confusion, and paradoxically reduce screening rates.[14] Further study is needed to determine how customized screening would affect adherence and key outcomes, such as incidence and mortality of colorectal cancer. Finally, we found that proximal polyps sized more than 9 mm are more common after age 60 years, suggesting that a complete structural examination of the colon may be the preferred screening test for all individuals older than 60 years.

Author Contributions: Dr Lieberman had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Lieberman, Holub, Moravec, Eisen, Peters, Morris.
Study concept and design: Lieberman, Holub.
Acquisition of data: Lieberman, Holub, Moravec, Morris.
Analysis and interpretation of data: Lieberman, Holub, Eisen, Peters, Morris.
Drafting of the manuscript: Lieberman, Holub.
Critical revision of the manuscript for important intellectual content: Lieberman, Holub, Moravec, Eisen, Peters, Morris.
Statistical analysis: Holub, Peters, Morris.
Obtained funding: Lieberman.
Administrative, technical, or material support: Eisen.
Study supervision: Lieberman, Morris.
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REFERENCES

1. Jemal A, Siegel R, Ward E, Murray T, Xu J, Thun MJ. Cancer statistics 2007. *CA Cancer J Clin*. 2007; 57(1):43-66.
2. McMahon LF, Wolfe RA, Huang S, et al. Racial and gender variation in the use of diagnostic colonic procedures in the Michigan Medicare population. *Med Care*. 1999;37(7):712-717.
3. Ananthakrishnan AN, Schellhase KG, Sparapani RA, Laud PAW, Neuner JM. Disparities in colon cancer screening in the Medicare population. *Arch Intern Med*. 2007;167(3):258-264.
4. Jepson C, Kessler LG, Portnoy B, Gibbs T. Black-white differences in cancer prevention knowledge and behavior. *Am J Public Health*. 1991;81(4):501-504.
5. Weber TK, Chin H-M, Rodriguez-Bigas M, et al. Novel hMLH1 and hMSH2 germline mutations in African Americans with colorectal cancer. *JAMA*. 1999; 281(24):2316-2320.
6. Agrawal S, Bhupinderjit A, Bhutani MS, et al. Colorectal cancer in African Americans [published correction appears in *Am J Gastroenterol*. 2005; 100(6):1432]. *Am J Gastroenterol*. 2005;100(3): 515-523.
7. Theuer CP, Wagner JL, Taylor TH, et al. Racial and ethnic colorectal cancer patterns affect the cost-effectiveness of colorectal cancer screening in the United States. *Gastroenterology*. 2001;120(4): 848-856.
8. Johnson H, Carstens R. Anatomical distribution of colonic carcinomas: interracial differences in a community hospital population. *Cancer*. 1986;58(4): 997-1000.
9. Thomas CR, Jarosz R, Evans N. Racial differences in the anatomical distribution of colon cancer. *Arch Surg*. 1992;127(10):1241-1245.
10. Ozick LA, Jacob L, Donelson SS, et al. Distribution of adenomatous polyps in African Americans. *Am J Gastroenterol*. 1995;90(5):758-760.
11. Nelson RL, Collear T, Freels S, et al. The relation of age, race and gender to the subsite location of colorectal carcinoma. *Cancer*. 1997;80(2): 193-197.
12. Rex DK, Khan AM, Shah P, et al. Screening colonoscopy in asymptomatic average-risk African Americans. *Gastrointest Endosc*. 2000;51(5):524-527.
13. Thornton JG, Morris AM, Thornton JD, Flowers CR, McCashland TM. Racial variation in colorectal polyp and tumor location. *J Natl Med Assoc*. 2007;99 (7):723-728.
14. Levin B, Lieberman DA, McFarland B, et al. Screening and surveillance for early detection of colorectal cancer and adenomatous polyps, 2008: a joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. *CA Cancer J Clin*. 2008;58(3):130-160.
15. Jass JR. Hyperplastic polyps and colorectal cancer: is there a link? *Clin Gastroenterol Hepatol*. 2004; 2(1):1-8.
16. Lieberman DA, Weiss DG, Bond JH, Ahnen DJ, Garewal H, Chejfec G. Use of colonoscopy to screen asymtomatic adults for colorectal cancer: Veterans Affairs Cooperative Study Group 380. *N Engl J Med*. 2000;343(3):162-168.
17. Imperiale TF, Wagner DR, Lin CY, Larkin GR, Rogge JD, Ransohoff DF. Risk of advanced proximal neoplasms in asymptomatic adults according to the distal colorectal findings. *N Engl J Med*. 2000;343(3):169-174.
18. Regula J, Rupinski M, Kraszewska E, et al. Colonoscopy in colorectal-cancer screening for detection of advanced neoplasia. *N Engl J Med*. 2006;355 (18):1863-1872.
19. Butterly LF, Chase MP, Pohl H, Fiarman GS. Prevalence of clinically important histology in small adenomas. *Clin Gastroenterol Hepatol*. 2006;4 (3):343-348.
20. Kim DH, Pickhardt PJ, Taylor AJ. Characteristics of advanced adenomas detected at CT colonography screening: implications for appropriate polyp size thresholds for polypectomy versus surveillance. *AJR Am J Roentgenol*. 2007;188(4):940-944.
21. Fennerty MB, Davidson J, Emerson SS, Sampliner RE, Hixson LJ, Garewal HS. Are endoscopic measurements of colonic polyps reliable? *Am J Gastroenterol*. 1993;88(4):496-500.
22. Schoen RE, Gerber LD, Margulies C. The pathologic measurement of polyps size is preferable to the endoscopic estimate. *Gastrointest Endosc*. 1997; 46(6):492-496.
23. Sonnenberg A, Amarosi SL, Lacey MJ, Lieberman DA. Patterns of endoscopy in the United States: analysis of data from the Centers for Medicare and Medicaid Services (CMS) and the National Endoscopic Database. *Gastrointest Endosc*. 2008;67 (3):489-496.

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