Use of Colonoscopy for Colorectal Cancer Screening: Evidence from the 2000 National Health Interview Survey

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Abstract

Background: **The use of colonoscopy as a primary screening tool for colorectal cancer is gaining momentum owing to several studies suggesting superior effectiveness and the recent, favorable decision by Medicare to cover all routine screening colonoscopies. This study documents the use of colonoscopy versus other tests to screen for colorectal cancer.**
Materials and Methods: **Data from the 2000 National Health Interview Survey were analyzed. Fecal occult blood test (FOBT), sigmoidoscopy, and colonoscopy done for any reason and for routine screening only were analyzed for those ≥50 years without previously diagnosed colorectal cancer (n = 12,505).**
Results: **The proportion of the total eligible population receiving any of the recommended tests for all possible reasons and for screening purposes only is 34.6% and 25.1%, respectively. For routine screening purposes, the test most commonly utilized was FOBT (55.6%) followed by colonoscopy (29.1%) and sigmoidoscopy (15.3%). When usage was assessed for all reasons, FOBT was still most commonly utilized (45.8%) followed by colonoscopy (38.7%) and sigmoidoscopy (15.5%). The elderly, non-White males and those with private insurance have a higher probability of receiving colonoscopy than FOBT. Several regional differences exist, including higher probability of undergoing sigmoidoscopy versus colonoscopy in the West.**
Conclusions: **Only one fourth (upper limit one third) of the study population complied with colorectal cancer screening recommendations. Nearly one third of the routine screening tests done in 2000 were colonoscopies. This study provides baseline values that can be used to project future colonoscopy demand and identify potential supply barriers.** (Cancer Epidemiol Biomarkers Prev 2005;14(2):409–16)

Introduction

Colorectal cancer accounts for 10% of all new cancer cases and is the third leading cause of cancer-related mortality in the United States. Survival from colorectal cancer is inversely related to stage of cancer and up to 90% of colorectal cancer deaths are preventable with early detection (1, 2). Therefore, regular screening exams can significantly reduce colorectal cancer morbidity and mortality.

U.S. Preventive Services Task Force, American Cancer Society, American College of Gastroenterology, and American Gastroenterological Association have all published guidelines for colorectal cancer screening (1-4). There are minor differences between the published colorectal cancer screening guidelines but they are consistent in the recommendation that screening should begin at age 50 for all asymptomatic individuals, denoted as the average risk population. American Cancer Society, for instance, recommends that average-risk individuals obtain an annual take-home multiple-sample fecal occult blood test (FOBT), a flexible sigmoidoscopy every 5 years (or both FOBT and flexible sigmoidoscopy), double-contrast barium enema every 5 years, or a colonoscopy every 10 years (4).

The use of colonoscopy as a primary screening tool has gained momentum owing to several studies on its superior effectiveness in detecting polyps/cancer (5, 6) and recent changes in Medicare coverage, effective July 1, 2001, to provide payment for screening colonoscopy for all individuals, not just those at high risk of colorectal cancer. American College of Gastroenterology has also endorsed colonoscopy as the preferred colorectal cancer screening strategy (2). In addition, several studies have reported that a significant number of individuals (38-40%) surveyed identified colonoscopy as their preferred colorectal cancer–screening test (7, 8). Although colonoscopy is the most accurate of the recommended colorectal cancer–screening tests, it is also associated with the highest rates of complications and is the most expensive test (9, 10). Nevertheless, some studies have shown colonoscopy to be a cost-effective option for colorectal cancer screening (11, 12).

Several studies have analyzed the factors that impact compliance with colorectal cancer–screening recommendations (13-17). For instance, having insurance, usual source of care, and higher education are factors that increase the probability of screening. To the best of our knowledge, however, none have examined the choice among the recommended colorectal cancer–screening tests. The objective of this analysis is to document the use of colonoscopy to screen for colorectal cancer. Specifically, this study will identify the proportion of patients receiving colonoscopy for colorectal cancer screening and determine what factors impact choice of colonoscopy versus FOBT and colonoscopy versus sigmoidoscopy. To place the choice of screening test in context, we also present the proportion receiving any of the recommended screening tests.

The results from this analysis should assist policy makers in understanding which types of colorectal cancer–screening tests are utilized and provide baseline information to assess potential barriers to increasing compliance including those related to supply-side limitations, specifically related to colonoscopy use. The growing interest in screening colonoscopy has raised concerns regarding the availability of trained colonoscopists to perform the procedures demanded (18). There is anecdotal evidence that wait times for colonoscopies are between 3 and 6 months and with increasing demand for both screening and diagnostic colonoscopies the potential supply-side barriers need to be considered.

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Materials and Methods

The 2000 National Health Interview Survey (NHIS) is the data source used for this study. The NHIS is a multipurpose health survey and is the principal source of information on the health of the civilian, noninstitutionalized, household population in the United States. The data is gathered via telephone interviews on eligible households. From among the households identified, families, adults, and children are randomly selected for data collection. For the 2000 NHIS, 38,633 households were interviewed for a total household response rate of 88.9%. The interviewed sample for the adult component was 32,374 persons ages ≥18 years. The conditional response rate for the adult sample that was interviewed on their cancer-screening behavior was 82.6%.

The cancer supplement of the 2000 NHIS is the first national survey to specifically collect comprehensive information on tests selected for colorectal cancer screening. Other surveys in the past have questioned participants on choice of FOBT versus endoscopy but specifics on the type of endoscopic test done were not obtained. In the 2000 NHIS cancer control supplement, details on the type of endoscopic test done (colonoscopy, sigmoidoscopy, or proctoscopy) was collected. All respondents ≥40 years were asked whether they ever had an FOBT or endoscopic procedure (including specific endoscopic test as indicated above). In addition, for each test reported by the respondents, information was collected on when the last screening exam was received and the reason for the test (e.g., routine screening, specific problem, or follow-up test).

In this study, the use of colonoscopy, sigmoidoscopy, and FOBT to screen for colorectal cancer was analyzed. NHIS did not collect information on the use of double-contrast barium enema and, therefore, this test was excluded from our analysis. The sample analyzed in this study includes those ≥50 years because all major guidelines uniformly advocate initiation of screening at age 50. We excluded from our sample individuals previously diagnosed with colorectal cancer as these individuals would be undergoing frequent surveillance rather than screening. Surveillance recommendations for such individuals generally include undergoing colonoscopy within 1 year of their surgery and at 1- to 3-year intervals thereafter.

Colorectal cancer–screening tests used by our analytic sample for any reason and for routine screening only are separately presented (based on self-reported reason in the NHIS). Routine screening is considered as the search for polyps and early cancers in asymptomatic individuals with or without a family history of colorectal cancer. Stratifying in this manner allows for a detailed analysis of the use of colonoscopy for screening versus other diagnostic purposes (due to a specific problem or as a follow-up test for any other reason). In addition, we also present an analysis of the overall compliance with guideline recommendations (combining all three tests) for screening purposes only as well as for tests completed for any reason. The latter estimate is presented because individuals may miscategorize themselves and testing for any reason provides a more complete estimate of the utilization of all three tests. Based on American Cancer Society guidelines, we considered any colonoscopy done within the past 10 years, sigmoidoscopy done within the past 5 years, and FOBT within the past 1 year to be compliant with screening recommendations. For FOBT, only the take-home multiple-sample test and not the office-based tests was included in our assessment as recommended by American Cancer Society guidelines. When individuals reported receiving more than one test, we selected the most recent test done.

The variables to be included that might impact screening were identified from a review of the literature on factors impacting use of colorectal cancer–screening tests (13-17, 19-22). Among the variables analyzed were demographics, health system enablers, risk factors for colorectal cancer, propensity for screening, and geographic location. Demographic variables included age, gender, race, income, education, and living status (alone or with partner). Variables included to capture contact and ability to seek preventive care from health care providers, called health system enablers, were insurance status and usual source of care. Because a majority of those who receive colorectal cancer screening are individuals with some form of health insurance, we separated out those with private insurance from those with federal/state-sponsored insurance (Medicare, Medicaid, and Veterans Administration). Those with no insurance were also included as a study category. To capture impact of usual source of care on screening behavior, we identified individuals as having versus not having a usual source.

Colonoscopy is often identified as the preferred test for individuals at high risk for colorectal cancer and, therefore, we included both risk of cancer in the family and smoking status to control for this potential higher probability of selecting colonoscopy. Thus, the impacts of all other variables included in the model are estimated controlling for cancer risk. Cigarette smoking is associated with an increased tendency to form adenomas and develop colorectal cancer (23) but it can also be an indicator for propensity to seek preventive care (i.e., self-initiated attempts to lead a healthy lifestyle including obtaining regular screening check-ups). Individuals who do not smoke, take vitamin supplements, and obtain regular flu shots could be more concerned about their health and, therefore, more likely to seek screening tests. Region of residence (Northeast, Midwest, South, and West) was included to identify regional differences, if any, in the use of colorectal cancer–screening tests.

To account for the complex sampling design utilized in the NHIS, all estimation was done using SUDAAN and weighted values controlling for the nested sample design were generated. The weighting was done to adjust for nonresponse and poststratification. The sample adult weights, provided with the 2000 NHIS data for this purpose, were utilized to generate national estimates.

We did both univariate and multivariate analysis. In the univariate analysis, the proportion of individuals obtaining each type of test was derived by patient characteristics. χ^2 tests were done to identify statistically significant differences in choice of test. Multinomial logistic regressions were done to simultaneously identify factors that impact choice of FOBT, sigmoidoscopy, or colonoscopy. Therefore, the dependent variable was entered as a three-level variable to identify colonoscopy, sigmoidoscopy, or FOBT use. Because colonoscopy is emerging as the gold standard, we estimate the probability of choosing FOBT or sigmoidoscopy in relation to colonoscopy (i.e., we modeled the probability of choosing FOBT versus colonoscopy and sigmoidoscopy versus colonoscopy). In addition, we also present results on the overall probability of receiving any test (colonoscopy, sigmoidoscopy, or FOBT). The dependent variable in this case was a dichotomous (0,1) variable with ''1'' representing receiving any colorectal cancer screening within recommended time frames and logistic regressions were estimated to study the probability of receiving any colorectal cancer–screening test. All independent variables were entered as dichotomous (0,1) variables. Odds ratios (OR) and 95% confidence intervals (CI) were generated for each regression estimate.

Results

The proportions of tests done for any reason and for screening only are presented in Table 1. In addition, the proportion of the total eligible population receiving these tests is reported. A total of 12,677 individuals ≥50 years were identified from the 2000 NHIS and 172 individuals among these had a diagnosis of colorectal cancer. The unweighted sample size

Table 1. Tests done for any reason and screening only

	Percent (%, weighted)
Proportion of total eligible population receiving tests for screening only (n = 12,505)*	25.1
Proportion of total eligible population receiving tests for any reason (n = 12,505)*	34.6
Tests done for screening only (n = 2,986)	
FOBT†	55.6
Sigmoidoscopy	15.3
Colonoscopy	29.1
Tests done for any reason (n = 4,148)	
FOBT‡	45.8
Sigmoidoscopy	15.5
Colonoscopy	38.7

NOTE: ''Screening only'' includes those tests obtained for routine screening. Tests obtained for a ''specific problem'' or as ''follow-up test'' were not included. Source: 2000 NHIS.

*Individuals who had recommended tests within the time suggested in Colorectal Cancer Guidelines for normal-risk individuals were included. Therefore, colonoscopy done within the past 10 years, sigmoidoscopy within the past 5 years, and take-home FOBT within the past year were included.

†Among these individuals (before the FOBT indicated), 3.8% also had a sigmoidoscopy within the past 5 years and 4% also had a colonoscopy within the past 10 years. FOBT was considered the most recent tests.

‡Among these individuals (before the FOBT indicated), 3.7% also had a sigmoidoscopy within the past 5 years and 5.9% also had a colonoscopy within the past 10 years. FOBT was considered the most recent test.

for the population that met the inclusion criteria of ≥50 years with no history of colorectal cancer was 12,505. Of these, 4,148 underwent tests when any reason was considered and 2,986 when only tests done for screening were included. The proportion of the total eligible population receiving tests for any reason and for routine screening only is 34.6% and 25.1%, respectively. On average, 38.7% underwent colonoscopy when tests done for any reason were included and 29.1% when tests done for screening only were included. The proportion of sigmoidoscopies done remains similar at about 15.5% in both instances. FOBT is the most common test accounting for 45.8% of tests done for any reason and 55.6% of tests for screening only.

Characteristics of Individuals Receiving Colorectal Cancer–Screening Tests. As reported in Table 2, when the use of all tests received for routine screening are combined together, the proportion receiving tests is highest among those 65 to 80 years (30.2%), those with college or higher education (30.8%), those with medium or high risk of cancer in their family (30.2%), and those who take vitamin supplements (30.0%) or get flu shots (31.9%). Lowest levels of compliance are among those without insurance (6.9%), those without usual source of care (8.4%), Hispanics (15.5%), and current smokers (17.6%). Among the regions, those in the West have the highest proportions (28.6%), whereas those in the South have the lowest (23.2%). When including tests done for any reason, the proportions are higher than that for screening only but with similar trends.

Adjusted ORs and 95% CIs from the multinomial logistic regression on the probability of receiving any test are also reported in Table 2. The ORs provided are adjusted for factors including demographics, insurance status, risk factors for cancer, propensity for screening, and geographic location. After controlling for these factors, those 65 to 80 years are more likely to obtain tests for screening than those younger (OR, 1.30; 95% CI, 1.16-1.46). Hispanics and other races (Asian, Native American, etc.) have a lower probability of receiving screening tests than Whites (OR, 0.71; 95% CI, 0.56-0.89 and OR, 0.58; 95% CI, 0.38-0.87, respectively), whereas African American have a higher probability than Whites (OR, 1.21; 95% CI, 1.01-1.47). The result for the African Americans is not robust given that the 95% CI ranges from 1.01 to 1.47. Those with high incomes (OR, 1.21; 95% CI, 1.04-1.40) and those with high levels of education (OR, 1.41; 95% CI, 1.26-1.57) are more likely to obtain screening than those with lower levels, and those who live alone have a lower probability than those who do not (OR, 0.78; 95% CI, 0.70-0.88).

Individuals without insurance are half as likely to receive any screening tests compared with those with federal/state insurance coverage (OR, 0.47; 95% CI, 0.34-0.66). Usual source of care is by far the strongest predictor with those with a usual source being more than twice as likely to receive any screening test (OR, 2.36; 95% CI, 1.78-3.13). Those with higher levels of cancer in the family, nonsmokers, those who take vitamins or obtain flu shots, and those who live in the West (compared with those in the East) also have a higher probability of being tested.

When the probability of receiving a test for any reason is estimated, there are no significant differences among men versus women, African Americans versus Whites, and those with high income versus low. Additionally, those with private insurance compared with those receiving health coverage from federal/state programs are more likely to receive an FOBT, sigmoidoscopy, or colonoscopy (OR, 1.14: 95% CI, 1.00-1.29). The usual source of care variable remains the most dominant variable although those with a usual source are almost thrice more likely than those without a usual source to receive tests for any reason.

Selection of Specific Colorectal Cancer Test. The univariate analysis of the percentage distribution of colorectal cancer tests stratified by patient characteristics is presented in Table 3. The type of test done is stratified by patient demographics, health system enablers, risk factors for colorectal cancer, propensity to seek screening, and geographic location. χ^2 tests are done to measure whether there are any differences in the type of test selected for each variable studied. For instance, in the case of gender, the results indicate whether there are statistically significant differences in the type of test utilized by males versus females. P values are separately indicated for tests done for routine screening only and for tests done for any reason.

The highest proportion of screening colonoscopies were done among those ≥80 years (37.7%), Blacks (36.4%), Hispanics (38.3%), those without usual source of care (39.2%), and those residing in the South (33.8%). FOBT was the most commonly done test for colorectal screening by all patient types, accounting for 42.6% to 63.8% of the screening tests done. In all instances, the proportions receiving FOBT and colonoscopy were higher than sigmoidoscopy. The highest proportion of sigmoidoscopies was reported in the West (22.9%). The patterns for the tests done for any reason were similar to that done for screening only but with higher proportion of colonoscopies being done. For instance, for those ≥80 years, 45.2% of the tests done were colonoscopies; for those who lived in the South, 43.9% of the tests were colonoscopies.

In Table 4, the adjusted ORs and the 95% CIs from the multivariate analysis of the probability of receiving an FOBT or sigmoidoscopy versus a colonoscopy are reported. The probability of selecting FOBT versus colonoscopy and the probability of selecting sigmoidoscopy versus colonoscopy are presented for both screening only and for tests done for any reason.

Those >80 years (OR, 0.53; 95% CI, 0.70-1.12) are less likely than those 50 to 64 years to receive FOBT compared with colonoscopy as the colorectal cancer–screening test. Males (OR, 0.66; 95% CI, 0.54-0.82) are also less likely to receive FOBT and, therefore, more likely to have colonoscopy compared with females. Hispanics (OR, 0.60; 95% CI, 0.37-0.97) have a lower probability compared with Whites of obtaining a FOBT compared with a colonoscopy. Those with medium/high level of cancer in their family (OR, 0.64; 95% CI, 0.52-0.80) are also less likely to receive FOBT compared with colonoscopy for colorectal cancer screening.

Table 2. Compliance rate and multivariate analysis of the probability of receiving any test

	Test done for screening only		Test done for any reason	
	Compliance rate (%)	Probability of receiving any test	Compliance rate (%)	Probability of receiving any test
		Adjusted OR* (95% CI)		Adjusted OR* (95% CI)
Demographics				
Age				
50-65	22.6	1.00 (reference)	30.8	1.00 (reference)
65-80	30.2	1.30 (1.16-1.46)	42.1	1.50 (1.28-1.60)
>80	20.5	1.02 (0.83-1.25)	28.4	0.96 (0.76-1.11)
Gender				
Female	23.8	1.00 (reference)	35.0	1.00 (reference)
Male	26.7	1.16 (1.04-1.31)	34.3	1.03 (0.93-1.15)
Race				
White	26.6	1.00 (reference)	36.8	1.00 (reference)
African American	22.0	1.21 (1.01-1.47)	28.5	1.06 (0.89-1.25)
Hispanic	15.5	0.71 (0.56-0.89)	22.6	0.71 (0.60-0.89)
Other	17.4	0.58 (0.38-0.87)	21.1	0.49 (0.34-0.71)
Income				
Less than $20,000	19.2	1.00 (reference)	29.7	1.00 (reference)
$20,000 or more	27.5	1.21 (1.04-1.40)	37.0	1.10 (0.96-1.25)
Education				
High school or lower	20.9	1.00 (reference)	30.3	1.00 (reference)
Some college or higher	30.8	1.41 (1.26-1.57)	40.5	1.36 (1.22-1.51)
Live alone				
No	27.7	1.00 (reference)	37.2	1.00 (reference)
Yes	20.5	0.78 (0.70-0.88)	29.9	0.80 (0.72-0.89)
Health system enablers				
Insurance status				
Federal/state programs†	21.7	1.00 (reference)	30.7	1.00 (reference)
No insurance	6.9	0.47 (0.34-0.66)	11.2	0.52 (0.39-0.69)
Private insurance	27.6	1.11 (0.97-1.28)	37.7	1.14 (1.00-1.29)
Have usual source of care				
No	8.4	1.00 (reference)	12.1	1.00 (reference)
Yes	26.5	2.36 (1.78-3.13)	36.5	2.78 (2.02-3.27)
Risk factors for adenomas/cancer				
Cancer in family				
Low	24.9	1.00 (reference)	33.8	1.00 (reference)
Medium/high	30.2	1.25 (1.11-1.41)	43.0	1.41 (1.28-1.55)
Smoking status				
Current	17.6	1.00 (reference)	25.6	1.00 (reference)
Former smoker	30.1	1.46 (1.24-1.72)	40.8	1.47 (1.26-1.70)
Never smoked	24.6	1.31 (1.10-1.55)	33.8	1.24 (1.06-1.44)
Propensity for screening				
Take vitamin supplements				
No	20.2	1.00 (reference)	27.9	1.00 (reference)
Yes	30.0	1.37 (1.22-1.54)	41.3	1.47 (1.32-1.64)
Got flu shot				
No	19.5	1.00 (reference)	27.0	1.00 (reference)
Yes	31.9	1.60 (1.43-1.80)	43.8	1.71 (1.55-1.88)
Geographic location				
Region				
Northeast	24.9	1.00 (reference)	34.0	1.00 (reference)
Midwest	25.4	0.97 (0.84-1.11)	35.1	0.96 (0.85-1.09)
South	23.2	0.95 (0.83-1.08)	33.5	1.02 (0.91-1.16)
West	28.6	1.24 (1.07-1.44)	36.8	1.17 (1.01-1.35)

NOTE: Source: 2000 NHIS.
*ORs presented are adjusted for all other variables present in the regression model and reported in the table including demographics, health system enablers, risk factors, propensity for screening, and geographic location.
†Largely Medicare but also includes some Medicaid and Veterans Administration coverage.

On the other hand, those with usual source of care (OR, 1.81; 95% CI, 1.00-3.25) and those who obtain regular flu shots (OR, 1.26; 95% CI, 1.01-1.57) are more likely to have FOBT compared with colonoscopy as their screening test. Residents in the Midwest (OR, 1.47; 95% CI, 1.09-1.98), compared with those in the Northeast, are more likely to have FOBT compared with colonoscopy.

When tests done for any reason are analyzed, the coefficients for male versus female, African American versus White, and those with usual source of care versus those without are no longer statistically significant. Some differences that did not exist when tests obtained for routine screening only were included are also present when tests done for any reason are included. Those with cancer in the family (OR, 0.76; 95% CI, 0.64-0.92) are less likely to obtain an FOBT compared with colonoscopy and those who live in the West (OR, 1.33; 95% CI, 1.01-1.73) are more likely to obtain FOBT compared with colonoscopy.

Relatively fewer factors are significant determinants of the use of sigmoidoscopy versus colonoscopy. African Americans

(OR, 0.57; 95% CI, 0.33-0.99) and those with private insurance (OR, 0.68; 95% CI, 0.48-0.97) are less likely to receive sigmoidoscopy compared with colonoscopy for screening. Those living in the West (OR, 2.02; 95% CI, 1.33-3.07), compared with those in the Northeast, are more likely to have sigmoidoscopy than colonoscopy as their screening test. When tests for all reasons are included, those with some college or higher education (OR, 1.29; 95% CI, 1.01-1.64) and those who live in the West (OR, 1.76; 95% CI, 1.29-2.39) are more likely to obtain sigmoidoscopy compared with colonoscopy.

Discussion

Several tests are currently recommended for colorectal cancer screening. Each of these tests has different features and none clearly emerges as the ''gold standard.'' FOBT is the least invasive test, whereas colonoscopy is the most accurate. Colonoscopy is routinely used to follow-up positive results obtained from other less invasive tests and also used for surveillance after the detection of polyps or cancer. Recently, there has been increasing interest in using colonoscopy as a screening test because of its sensitivity in

Table 3. Type of test done stratified by patient characteristics

	Test done for screening only				Test done for any reason			
	FOBT (%)	Sigmoidoscopy (%)	Colonoscopy (%)	P^*	FOBT (%)	Sigmoidoscopy (%)	Colonoscopy (%)	P^*
Demographics								
Age				0.069				0.105
50-65	55.8	16.2	28.0		46.2	16.0	37.8	
65-80	56.8	14.3	28.9		46.5	14.8	38.7	
>80	46.9	15.4	37.7		38.6	16.2	45.2	
Gender				0.000				0.097
Male	51.4	16.8	31.8		44.3	16.9	38.8	
Female	59.6	13.9	26.5		47.1	14.3	38.6	
Race/ethnicity				0.084				0.026
White	56.2	15.7	28.1		45.9	15.7	38.4	
African American	52.4	11.2	36.4		46.2	11.2	42.5	
Hispanic	45.6	16.1	38.3		38.7	17.2	44.1	
Other	62.7	16.7	20.6		56.3	19.8	23.9	
Income				0.099				0.012
Less than $20,000	56.4	12.7	30.9		43.8	13.6	42.7	
$20,000 or more	55.6	16.1	28.4		46.4	16.3	37.3	
Education				0.016				0.004
High school or lower	55.9	13.2	30.9		44.7	13.9	41.4	
Some college or higher	55.5	17.3	27.2		47.0	17.2	35.8	
Live alone				0.300				0.053
No	54.9	15.9	29.2		45.6	16.3	38.0	
Yes	57.3	13.9	28.8		46.1	13.6	40.3	
Health system enablers								
Insurance status				0.695				0.613
Federal/state programs†	55.7	16.3	28.0		45.2	14.0	40.8	
No insurance	63.8	12.0	24.2		53.1	11.9	35.0	
Private insurance	55.4	15.2	29.4		46.2	17.5	36.4	
Have usual source of care				0.124				0.104
No	42.6	18.3	39.2		34.8	18.7	46.6	
Yes	56.0	15.3	28.8		46.1	15.4	38.5	
Risk factors for adenomas/cancer								
Cancer in family				0.004				0.024
Low	58.1	15.0	26.9		47.5	15.5	36.9	
Medium/high	51.0	16.2	32.8		42.8	15.4	41.8	
Smoking status‡				0.318				0.484
Current	59.4	12.6	28.0		46.9	14.0	39.1	
Former	55.9	14.9	29.2		46.1	15.1	38.8	
Never	54.4	16.4	29.2		45.3	16.3	38.5	
Propensity for screening								
Take vitamin supplements				0.506				0.089
No	54.0	15.4	30.6		43.7	14.9	41.4	
Yes	56.4	15.3	28.3		46.8	15.8	37.4	
Got flu shot				0.058				0.104
No	52.5	15.9	31.7		43.3	15.8	40.9	
Yes	57.7	15.0	27.2		47.4	15.4	37.2	
Geographic location								
Region				0.000				0.000
Northeast	53.4	15.0	31.9		44.5	15.4	40.1	
Midwest	62.2	12.1	25.7		49.5	12.9	37.6	
South	53.1	13.1	33.8		42.7	13.4	43.9	
West	54.1	22.9	23.0		47.9	22.5	29.6	

NOTE: Source: 2000 NHIS.
*P from χ^2 tests are separately indicated for tests done for routine screening and for tests done for any reason.
†Largely Medicare but also includes some Medicaid and Veterans Administration coverage.
‡This is also a proxy for propensity to screen. Individuals who never smoked or former smokers may be more likely to obtain screening and there may be differences in type of screening sought or provided.

detecting precancerous polyps or lesions and its ability to remove such lesions as part of the same procedure (called polypectomy). These benefits probably outweigh the invasive nature of this test and its potentially greater risk of complications.

In this study, we analyzed the 2000 NHIS cancer control module to document the use of colonoscopy for colorectal cancer–screening and to identify factors impacting the selection of colonoscopy versus FOBT and sigmoidoscopy. Tests done specifically for screening and tests done for any reason were examined. We also examined the probability of receiving any test (FOBT, sigmoidoscopy, or colonoscopy) for screening and for any reason.

This study reported an overall compliance rate associated with use of any of the three tests for screening purposes only to be 25.1%. Our intent was to identify as closely as possible the average risk, asymptomatic population; however, it is important to note that this estimate is based on self-reports where the respondents categorize themselves as having the test as part of routine screening. To provide a more comprehensive estimate

Table 4. Multivariate analysis of the probability of selecting a colorectal cancer–screening test

	Test done for screening only		Test done for any reason	
	Probability of FOBT versus colonoscopy	Probability of sigmoidoscopy versus colonoscopy	Probability of FOBT versus colonoscopy	Probability of sigmoidoscopy versus colonoscopy
	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)	Adjusted OR* (95% CI)
Demographics				
Age				
50-65	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
65-80	0.88 (0.70-1.12)	0.79 (0.58-1.09)	0.94 (0.78-1.13)	0.92 (0.72-1.17)
>80	0.53 (0.35-0.79)	0.67 (0.39-1.15)	0.66 (0.48-0.91)	0.86 (0.55-1.34)
Gender				
Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Male	0.66 (0.54-0.82)	0.93 (0.70-1.24)	0.89 (0.74-1.07)	1.07 (0.84-1.37)
Race				
White	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
African American	0.72 (0.51-1.02)	0.57 (0.33-0.99)	1.00 (0.74-1.34)	0.69 (0.44-1.09)
Hispanic	0.60 (0.37-0.97)	0.78 (0.44-1.40)	0.69 (0.47-1.02)	0.93 (0.58-1.51)
Other	1.24 (0.53-2.91)	1.02 (0.39-2.63)	1.59 (0.78-3.22)	1.54 (0.70-3.38)
Income				
Less than $20,000	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
$20,000 or more	1.06 (0.82-1.38)	1.18 (0.81-1.71)	1.14 (0.91-1.42)	1.17 (0.88-1.55)
Education				
High school or lower	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Some college or higher	1.11 (0.88-1.38)	1.32 (0.97-1.79)	1.16 (0.96-1.39)	1.29 (1.01-1.64)
Live alone				
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	1.05 (0.86-1.28)	0.97 (0.72-1.30)	0.97 (0.82-1.16)	0.83 (0.65-1.05)
Health system enablers				
Insurance status				
Federal/state programs†	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
No insurance	1.35 (0.61-2.96)	0.65 (0.22-1.95)	1.43 (0.80-2.53)	0.79 (0.35-1.80)
Private insurance	0.80 (0.60-1.07)	0.68 (0.48-0.97)	0.82 (0.66-1.03)	0.78 (0.58-1.05)
Have usual source of care				
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	1.81 (1.00-3.25)	1.38 (0.67-2.84)	1.38 (0.83-2.28)	0.96 (0.53-1.75)
Risk factors for adenomas/cancer				
Cancer in family				
Low	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium/high	0.64 (0.52-0.80)	0.88 (0.67-1.14)	0.76 (0.64-0.92)	0.90 (0.72-1.13)
Smoking status				
Current	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Former smoker	0.98 (0.70-1.37)	1.23 (0.74-2.06)	0.99 (0.76-1.28)	1.08 (0.72-1.64)
Never smoked	0.87 (0.63-1.19)	1.31 (0.80-2.15)	0.96 (0.75-1.23)	1.19 (0.80-1.75)
Propensity for screening				
Take vitamin supplements				
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	1.08 (0.86-1.35)	0.94 (0.69-1.28)	1.13 (0.95-1.36)	1.07 (0.83-1.37)
Got flu shot				
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	1.26 (1.01-1.57)	1.02 (0.76-1.37)	1.18 (0.99-1.41)	0.98 (0.77-1.23)
Geographic location				
Region				
Northeast	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Midwest	1.47 (1.09-1.98)	1.02 (0.68-1.52)	1.24 (0.99-1.55)	0.93 (0.70-1.23)
South	0.99 (0.77-1.28)	0.87 (0.58-1.30)	0.92 (0.74-1.15)	0.83 (0.62-1.11)
West	1.29 (0.93-1.79)	2.02 (1.33-3.07)	1.33 (1.01-1.73)	1.76 (1.29-2.39)

NOTE: Source: 2000 NHIS.

*ORs presented are adjusted for all other variables present in the regression model and reported in the table including demographics, health system enablers, risk factors, propensity for screening and geographic location.

†Largely Medicare but also includes some Medicaid and Veterans Administration coverage.

of utilization of the various tests, we also estimated the proportion receiving tests, when tests were done for any reason, to be 34.6%. If one was to assume that the problems were not those typically associated with colorectal cancer (e.g., polyps) and the follow-up tests were confirmation of earlier false-positive tests, then we can also consider this cohort to be the ''average-risk'' population. In other words, the 34.6% compliance rate might be considered as the upper limit of the previously reported rate for the screening only group (25.1%).

FOBT is most commonly utilized for screening only and also for any reason with a greater proportion (55.6%) utilizing it for screening only compared with any reasons (45.8%). Colonoscopy, on the other hand, is used by 29.1% of the cohort for screening only and by 38.7% when used for any reason. These findings suggest that patients may prefer FOBT due to its noninvasive nature and for cost reasons. However, colonoscopy is increasingly being recognized as the most sensitive and effective colon cancer screening strategy and consequently showing greater acceptance as an initial screening test even in average-risk persons (2).

There are some demographic differences in the probability of receiving tests. Hispanics and other minority groups, such as Asians and American Indians, have a lower probability of being screened than Whites. African Americans, however, may be more likely to receive routine screening tests than Whites, but there are no differences in obtaining testing for any reason. Similarly, males have a higher probability of receiving screening tests compared with females but no difference in probability of receiving tests for any reason. These results confirm the importance of stratifying tests into routine screening versus tests obtained for any reason as it allows us to pinpoint underlying differences between groups that may not otherwise be evident.

Having a usual source of care, however, is clearly the most dominant determinant of obtaining colorectal cancer–screening tests, confirming the results obtained in other studies (17, 24). Those with a usual source of care are more than twice as likely than those without such a source to receive tests for routine screening or for any reason. As expected, those with no insurance are less likely than those with coverage to receive screening tests. Only about 8% of those without a usual source or insurance obtain routine screening compared with the overall 25% average. Individuals with cancer in the family and those with higher propensity to seek screening (i.e., those who obtain flu shots and take vitamin supplements) also have a higher probability. Interestingly, former smokers and those who never smoked are more likely to obtain screening that those who smoke. Given that smoking is a risk factor for colorectal cancer, smokers as a group need to be targeted to increase their compliance with screening recommendations. Only 17.6% of smokers receive routine screening tests compared with 30.1% of former smokers and 24.6% of those who never smoked.

In terms of specific tests, the elderly, males, and those with private insurance have a higher probability of receiving colonoscopy for colorectal cancer screening than FOBT. In addition, as would be expected, high-risk individuals are more likely to receive colonoscopy than FOBT. Individuals who are likely to visit their physician annually, for instance those with a usual source of care or those who obtain preventive procedures, have a greater probability of having an FOBT than colonoscopy. Whether this finding is due to patient preference or physician referral based on anticipated compliance with screening schedules cannot be explained using the current data.

Those with lower levels of education are less likely to be compliant than those with higher education, but they tend to have a higher probability of having a colonoscopy versus sigmoidoscopy. Although we have controlled for cancer risk as related to the level of cancer in the family, we may not have accounted for all risk factors associated with cancer. For instance, individuals employed in certain types of occupations may be at higher risk for developing colorectal cancer (19, 25-27). These tend to be blue-collar jobs, which generally comprise a higher proportion of those with high school or lower level of education. African Americans are also more likely to receive colonoscopy compared with sigmoidoscopy or FOBT for routine screening than Whites, and this could again be a reflection of the occupations done. Further research, however, is required to determine whether this is indeed the reason for higher use of colonoscopy among these groups.

Regional differences were also observed in the type of tests done. Individuals in the Midwest and West have a higher likelihood of receiving an FOBT versus a colonoscopy compared with those in the Northeast and South. Those living in the West have a higher probability of having a sigmoidoscopy than colonoscopy. These variations could reflect differences in practice patterns or the availability of trained colonoscopists to perform the procedures (18). Overall, those in the West also have a slightly higher likelihood of obtaining colorectal cancer tests than those in the Northeast. Future analysis focusing on regional differences and supply factors will yield important information concerning potential barriers to increasing colorectal cancer screening compliance.

One potential limitation of this study is that the results are based on patient-reported use of screening services. Hence, recall bias could affect the results. For instance, individuals may not remember the reason why the test was done. One previous study on the validity of self-reported colorectal cancer screening behavior found that self-reported behavior was reliable (28). In addition, we did not include all recommended tests or combination of tests because data for double-contrast barium enema was not included in the survey and sufficient sample for combined FOBT and sigmoidoscopy testing was not available. The exclusion of double-contrast barium enema should not significantly impact the conclusions because only about 2% of primary care physicians who responded to a national survey reported that they select double-contrast barium enema as the primary colorectal cancer–screening test (29). Finally, we had to assign individuals to one particular colorectal cancer–screening test in this study. Longitudinal assessments to study the sequence of tests obtained by an individual over time will provide additional information on colorectal cancer screening behavior.

The 2000 NHIS is the first population-based survey to distinguish between the various endoscopic tests available for colorectal cancer screening. Colonoscopy was used to screen for colorectal cancer in more than a quarter of the individuals who reported undergoing tests within the time frames recommended by the guidelines in 2000. This percentage will likely increase because insurance coverage for screening colonoscopy has expanded since then, specifically for Medicare beneficiaries. The results provided in the study can serve as baseline data to be used to identify future trends in use of colonoscopy to screen for colorectal cancer.

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