REVIEW

Participation in Colorectal Cancer Screening: a Review

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The purpose of this review is to evaluate the published literature on adherence to colorectal cancer (CRC) screening with fecal occult blood testing (FOBT) and sigmoidoscopy. Specifically, the review addresses the following: 1) prevalence of FOBT and sigmoidoscopy; 2) interventions to increase adherence to FOBT and sigmoidoscopy; 3) correlates or predictors of adherence to FOBT and sigmoidoscopy; and 4) reasons for nonadherence. Other objectives are to put the literature on CRC screening adherence in the context of recently reported findings from experimental interventions to change prevention and early detection behaviors and to suggest directions for future research on CRC screening adherence. CRC screening offers the potential both for primary and for secondary prevention. Data from the 1992 National Health Interview Survey show that 26% of the population more than 49 years of age report FOBT within the past 3 years and 33% report ever having had sigmoidoscopy. The Year 2000 goals set forth in *Healthy People 2000* are for 50% of the population more than 49 years of age to report FOBT within the past 2 years and for 40% to report that they ever had sigmoidoscopy. Thus, systematic efforts to increase CRC screening are warranted. To date, attempts to promote CRC screening have used both a public health model that targets entire communities, e.g., mass media campaigns, and a medical model that targets individuals, e.g., general practice patients. Most of these efforts, however, did not include systematic evaluation of strategies to increase adherence. The data on FOBT show that the median adherence rate to programmatic offers of FOBT is between 40% and 50%, depending on the type of population offered the test, e.g., patients or employees. Approximately, 50% of those initially offered testing in unselected populations will respond to minimal prompts or interventions. A salient issue for FOBT, however, is whether or not the behavior can be sustained over time. Fewer studies examined adherence to sigmoidoscopy. Adherence was highest in relatives of CRC cases and in employer-sponsored programs offered to workers at increased risk of CRC. At present, we know very little about the determinants of CRC screening behaviors, particularly as they relate to rescreening. [J Natl Cancer Inst 1997;89:1406–22]

Colorectal cancer (CRC) ranks third among cancer sites in incidence and in mortality for both sexes *(1)*. In 1997, it is estimated that 131 200 new cases will be diagnosed and that 54 900 persons will die of the disease. The lifetime risk of dying from CRC is approximately 2.6%.

From 1988 through 1992, the age-specific incidence and mortality rates for African-Americans and whites were higher for men than for women in all age groups after 45 years of age *(2)*. In almost all age groups, African-Americans had higher incidence rates than whites, and in all age groups, mortality rates for African-Americans were higher than rates for whites *(2)*. During this period, overall incidence and mortality rates decreased for whites while they increased for African-Americans. The 5-year survival rate is more than 90% for persons diagnosed with localized disease, but it decreases to approximately 5% for persons with distant metastases *(3)*. Over half of all cases, however, are diagnosed with regional or distant disease.

CRC screening offers the potential both for primary and for secondary prevention. The scientific evidence to support the effectiveness of population-based screening with fecal occult blood testing (FOBT) and proctosigmoidoscopy (hereafter sigmoidoscopy) in reducing mortality from CRC is accumulating *(4–9)*. There also is evidence to support the role of polypectomy in preventing the development of CRC *(10,11)*, and recent epidemiologic studies [reviewed in *(12)*] show support for the protective role of dietary fiber and the harmful role of dietary fat as well as the possible protective effect of increased physical activity and of the use of nonsteroidal anti-inflammatory drugs.

It is noteworthy that the 1990 *Health Objectives for the Nation* did not include targets for CRC early detection, perhaps due to the lack of epidemiologic evidence for effectiveness of existing screening modalities at that time. However, targets for screening with FOBT and sigmoidoscopy were adopted from a 1987 National Cancer Institute (NCI) document on working guidelines *(13)*, and in 1996, cancer control objectives for the nation were added to the year 2000 Objectives under the category preventive services *(14)*. Compared with a baseline of 14.7 per 100 000 in 1987, the year 2000 Objectives for Health target a reduction in CRC deaths to 13.2 per 100 000 *(15)*.

The year 2000 goals for CRC screening are 50% of the population more than 49 years of age to report FOBT within the past 2 years and for 40% to report that they ever had sigmoidoscopy.

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See ''Notes'' following ''References.''

Table 1 shows estimates from the National Health Interview Survey (NHIS) for FOBT and sigmoidoscopy based on self-reported past behavior. Between 1987 and 1992, there was an increase overall and for both men and women in the percentage who reported ever having these procedures or who had them in the recent past *(16)*. Data from the 1987 NHIS showed that, in general, African-Americans and Hispanics of both sexes were less likely than whites to report having FOBT or sigmoidoscopy for screening purposes *(17)*. Thus, we are far from attaining either goal, suggesting that systematic efforts to promote CRC screening may be needed.

Table 2 shows the population-based recommendations or guidelines for CRC screening of five groups or organizations *(13,18–21)*. Most are now in agreement that population screening with FOBT and sigmoidoscopy should be initiated at age 50 years in asymptomatic persons with no personal or family history of colorectal cancer or related conditions, although consensus is lacking about the frequency for sigmoidoscopy.

The purpose of this review is to evaluate the published literature on adherence to CRC screening with FOBT and sigmoidoscopy. Digital rectal examination is excluded because epidemiologic evidence about its effectiveness as a screening modality for CRC is limited and because there are few studies of adherence to this procedure. Specifically, the review will address the following: 1) prevalence of FOBT and sigmoidoscopy; 2) interventions to increase adherence to FOBT and sigmoidoscopy; 3) correlates or predictors of adherence to FOBT and sigmoidoscopy; and 4) reasons for nonadherence. Types of adherence that are not reviewed include physician adherence to early detection guidelines and patient and physician adherence to diagnostic follow-up. Other objectives are to put the literature on CRC screening adherence in the context of recently reported findings from experimental interventions to change prevention and early detection behaviors and to suggest directions for future research on CRC screening adherence.

Procedures

The methodologic guidelines for review articles described by Weed *(22)* were followed. Weed recommends that authors explicitly state the questions to be addressed, provide a description of the information sources searched, the criteria used to evaluate the evidence, the methods used to summarize the evidence, and the methods used to draw conclusions.

Only empiric studies that addressed one or more of the four questions listed above were eligible for inclusion. Although selection criteria varied somewhat for the four questions, at the minimum, the investigators had to describe the study population, the setting, and the data collection methods. Because this is the first systematic review of the topic, a wide range of study designs, varying in rigor, was included. The strengths and limitations of different approaches were identified and discussed.

Five computerized databases were searched: MEDLINE, CANCERLIT, PSYCINFO, Social Science Citation Index (SSCI), and Current Contents. Where possible, the start date for a search was 1973, the earliest date that guaiac testing was likely to be used on a widespread basis for detection of asymptomatic

Table 1. Prevalence of colorectal cancer screening for persons over 49 years of age: National Health Interview Survey data, 1987 and 1992*

Type of procedure by sex	1987			1992		
	Ever	Past 3 y	Past year	Ever	Past 3 y	Past year
FOBT						
Men	—	20	—	—	25	—
Women	—	23	—	—	27	—
Total	41	22	15	48	26	17
Proctoscopy						
Men	—	7	—	—	12	—
Women	—	6	—	—	7	—
Total	26	6	3	33	9	5

*Source: adapted from Anderson and May (*16*). FOBT = fecal occult blood testing.

Table 2. Recommendations/guidelines for early detection of colorectal cancer*

Source	Recommendations/guidelines
NCI Working Guidelines *(13)*	Digital rectal examination as part of periodic health examinations; annual FOBT for age ⩾50 y; sigmoidoscopy every 3–5 y for age ⩾50
ACS Recommendations *(18)*	For persons ⩾50 years not at increased risk: Annual FOBT with sigmoidscopy every 5 y or a total colon examination either by colonscopy every 10 y or by double-contrast barium enema every 5–10 y For persons at moderate or high risk: Recommendations vary depending on family and personal history of CRC and related conditions
Guidelines Panel *(21)*	For persons ⩾50 y and no other risk factors: Annual FOBT; sigmoidoscopy every 5 y; double-contrast barium enema every 5–10 y For persons at increased risk for CRC: Recommendations vary depending on family and personal history of CRC and related conditions
U.S. Preventive Services Task Force *(20)*	Persons aged ⩾50 with annual FOBT or sigmoidoscopy (periodicity unspecified); persons with a family history of CRC should be referred for diagnosis and management; no recommendation for or against screening (or referring) persons at increased risk based on characteristics other than family history
Canadian Task Force on the Periodic Health Examination *(19)*	Insufficient evidence either for or against FOBT or sigmoidoscopy in asymptomatic average risk individuals ⩾40 y; fair evidence to support screening with colonoscopy of patients in kindreds with the cancer family syndrome and patients with ulcerative colitis

*FOBT = fecal occult blood testing; CRC = colorectal cancer.

CRC *(23)*. MEDLINE, CANCERLIT, and PSYCINFO were searched from 1973 through 1996; SSCI was searched from 1981, the time of initialization of the database; and Current Contents was searched for the past 3 years. The search was limited to studies of humans published in English. Medical subject headings were used to scan titles, abstracts, and subject headings in all databases using the keywords colorectal cancer, screening, and compliance and colorectal cancer, screening, and adherence. The author reviewed all abstracts identified in the search and obtained articles that appeared relevant for more detailed evaluation. Sixty-eight articles retrieved through computerized searches met the criteria for the review; 64 additional articles were identified through the reference lists of those articles.

The terms adherence and compliance are used interchangeably in the literature. In this review, adherence is used in a general sense to refer to the completion of a colorectal cancer screening test or procedure. Compliance refers to completion of all tests or examinations when sequential offers are made to the same persons regardless of whether they completed a prior test. During the time period covered by this review, the technology for examining the colon changed from a proctoscope to a flexible sigmoidoscope; these technologies were not differentiated in this review in evaluating the literature on adherence.

Prevalence of Colorectal Cancer Screening

Fecal Occult Blood Testing

Table 3 summarizes the data on adherence to FOBT by type of study population and geographic location. The study population was further described in terms of whether the invitation to screening was made in the context of a program in which all eligible persons were offered the test or whether the investigators tested an intervention to increase screening adherence or to evaluate whether characteristics of the test, e.g., restrictions on diet, affected adherence. Community-based studies were further classified as media campaigns or surveys. Most studies measured behavior prospectively in response to an invitation to undergo CRC screening. Surveys, including reports from the NHIS *(16,24,25)*, measured self-reported past behavior using different time periods, e.g., ever or past year. In media campaigns, persons were offered an opportunity to pick up a kit, or kits were handed out to ''all comers'' in a variety of settings, e.g., shopping malls and drug stores. The denominator for the prevalence calculations in media campaigns was the number of tests distributed. In contrast, community-based studies classified as programs generally were based on well-defined populations as were some of the programs offered to patients identified through registries of general practitioners. Some investigators reported interim results from ongoing clinical trials or programs or they used the same study population to address different research questions. In most instances, prevalence data from the most recent report were used here.

There were 38 studies of patient populations *(9,26–62)*. Of these studies, 13 evaluated strategies to increase adherence *(27,37,42,43,45,48–50,52,53,56,58,60)*, and seven evaluated the effect on adherence of diet restrictions, type of test (e.g., Hemoccult versus Hemeselect), or length of testing (e.g., 3 versus 6 days) *(40,41,51,54,59,61,62)*.

Table 3. Range of rates of adherence to fecal occult blood testing by type of study population and geographic location

Type of study population	Geographic location					
	US/Canada		Europe		Other countries	
	%	n*	%	n*	%	n*
Patient						
Program†	19–86	7	26–77	9	44–68	3
Intervention‡	0–94	7	21–58	5	23–60	1
Intervention§	60–97	3	28–73	4	—	0
Community						
Media Campaign	20–98	19	—	0	46, 95	2
Program†	77, 74‖	1	51–67	10	69	1
Intervention‡	—	0	—	0	19, 42	1
Surveys¶	12–44	7	—	0	2, 53	2
Worksite						
Program†	20	1	51–92	3	37	1
Intervention‡	4, 9	1	22, 45	1		
Other						
Program†	42–88	4	10–87	6	—	0
Intervention‡	9–93	2	—	0	—	0

*Number of studies.

†Program circumstances where all eligible persons were offered a test, including the study arm of randomized clinical trials of the efficacy of fecal occult blood testing.

‡Intervention studies of methods to increase adherence. All intervention studies reported at least two prevalence rates; therefore, categories represented by only one study include more than one rate.

§Intervention studies to evaluate the effects of diet restrictions, length of testing, or type of test on adherence. These studies reported at least two prevalence rates; therefore, categories represented by only one study include more than one rate.

‖Percentages are for two sequential time periods (6).

¶Surveys asked about past behavior using different time frames. The range for ever was 30%–44%; the range for recent was 12%–34%.

Thirty community-based studies reported prevalence of prospective adherence to FOBT *(5,6,63–90)*, but only one of them *(87)* evaluated an intervention to increase adherence. There were nine reports of community-based surveys of past adherence *(16,24,25,91–96)*, several of which *(16,24,25)* used the same data source, i.e., the NHIS for 1987 and 1992, but reported adherence for different time periods.

Seven studies *(97–103)* reported adherence rates for employed populations; two of these *(100,101)* evaluated methods to increase adherence.

Reports categorized as other included two interventions *(104,105)* and 11 programs or surveys *(106–118)*. In one instance, three reports were based on the same study population *(113–115)*, and in another *(105,112)* it was unclear whether or not the same population was studied. The study populations in these reports included nontwin siblings of CRC patients and control subjects *(113–115);* twins of colorectal and breast cancer cases *(111);* first-degree relatives of CRC patients and other volunteers *(107);* high-risk patients *(106);* volunteers at meal sites *(105,110,112);* registered blood donors *(117);* participants from another study *(116);* and members of voluntary organizations *(104)*. In a few reports, the study population was not clearly described *(108,109)*.

As shown on Table 3, the range of adherence was most variable for studies conducted in the United States, many of which used volunteers from patient or community populations that

were not clearly defined. With two exceptions *(84,119)*, community-based studies classified as programs were conducted in Europe *(63,69,71,74,75,120–124)*. These European studies showed the greatest consistency in adherence rates.

Table 4 summarizes data from reports of programs offering sequential opportunities for FOBT screening *(4,6,37,69,74,75, 106,121,125–127)*. Data are presented for three definitions of rescreening: 1) coverage refers to completion of at least one test or examination when sequential offers are made to the same people, regardless of whether they completed a prior test; 2) compliance refers to completion of all tests or examinations when sequential offers are made to the same people, regardless of whether they completed a prior test; and 3) repeat refers to completion of all tests or examinations when sequential offers are made only to persons completing a prior test or examination. Definitions for ''coverage'' and ''compliance'' are from a summary of an NCI preapplication meeting for an RFA (CA-89-05) on worksite health promotion interventions (January 1989). As shown on Table 4, in all studies but two *(74,127)*, repeat adherence is greater than 75%, indicating that persons who are initially receptive to FOBT are willing to complete subsequent tests. The data are generally consistent with the statement that the longer the interval between tests, the higher the adherence to rescreening. Data from the Mandel et al. *(6)* study show a consistent decline in adherence with greater frequency of testing (annual versus biennial) and as persons are asked to complete more tests (Table 4).

The yield from offering initial nonparticipants another opportunity to be screened is low. Hardcastle et al. *(4)* reported that only 6% of those refusing the first FOBT completed a subsequent test; other investigators also found low adherence to FOBT among initial nonparticipants offered a second chance to be tested *(47,69,74)*.

Sigmoidoscopy

Table 5 summarizes findings from studies reporting adherence to sigmoidoscopy by type of study population. Adherence was highest in studies of relatives of CRC cases *(111,128)*. With one exception *(129)*, worksite-based studies showed prospective adherence of at least 30% *(99,130–132);* studies of workers at increased risk for CRC reported higher rates *(131,132)*. Schroy et al. *(129)* mailed invitations to more than 6000 city of Boston employees 50 years of age and older offering free sigmoidoscopy; only 3% were screened *(129)*. However, of the 564 employees who returned a prepaid postcard expressing interest, 35% were screened. Low participation also was observed in one community-based program that mailed invitations for free screening

Table 4. Rates of adherence to rescreening fecal occult blood testing by type of study population for three definitions of rescreening

Type of study popuation author(s) (ref. No.)	Type of rescreening						
					Repeat‡		
	No.	Interval, y	Coverage,* %	Compliance,† %	No.	%	Interval, y
Patient							
Caffarey *(106)*	2212	1		53			
Hardcastle et al. *(37)*					3286	85	2
Hardcastle et al. *(125)*					9510	77	Biennial
					3639	80	
Hardcastle et al. *(4)*	75 253	Biennial§	60	38			
Myers et al. *(127)*	1565	1	48	23	647	56	1
Community							
Faivre et al. *(69)*	17 967	1	53	44	9813	80	1
	25 395	2	58	48	14 131	86	2
Jansen *(74)*	324	1	39	35	192	58	1
Kewenter et al. *(121)*	13 357	1½–2		54	9040	80	1½–2
Kewenter et al. *(75)*	33 373	1½–2	68				
Kronborg et al. *(126)*‖	30 762	Biennial		46	20 113	93	Biennial
					18 236	94	
					16 746	94	
					15 279	92	
Mandel *(6)*¶	15 570/15 587	Annual/biennial	⩾1: 90/90 ⩾50%: 77/82 ⩾75%: 69/77	46/60			

*Offered more than one sequential opportunity to be screened and participated one or more times. Denominator includes all persons offered a test at baseline who remained eligible, e.g., were alive, lived in the geographic area, remained free of colorectal cancer.

†Offered more than one sequential opportunity to be screened and participated in all of them. Denominator includes all persons offered a test at baseline who remained eligible, e.g., were alive, lived in the geographic area, remained free of colorectal cancer.

‡Subsequent testing was offered only to participants in a prior round who remained eligible, e.g., were alive, lived in the geographic area, remained free of colorectal cancer.

§People who did not complete the first round, which began in 1985, were initially not reinvited. In September 1990, initial nonparticipants were reinvited every 2 years. By the end of the study in February 1995, all persons had been invited between three and six times.

‖Only persons completing the first round (n = 20 113) were invited to the 2nd round. Thus, coverage cannot be calculated. It appears that participation in each round was required to be invited to a subsequent round.

¶Persons in the Minnesota trial were randomized to annual (n = 15 570) or biennial (n = 15 587) screening. Percentages for coverage and compliance are reported for those two groups, i.e., annual/biennial. ⩾1 = a participant who was screened at least once during the trial; ⩾50% = a participant who completed at least 50% of the tests offered; and ⩾75% = a participant who completed at least 75% of the tests offered.

Table 5. Rates of adherence to sigmoidoscopy and other characteristics of the study by type of study population

Type of study population and author(s) (ref. No.)	Selected study characteristics					
	% adherent*	No.	Year	Location	Age, y	Comments
Patient						
Program, Burack and Liang *(29)*	47	17	1982	MI	?	Prospective
Intervention						
Bejes and Marvel *(27)*	2/29	527	?	Mid-west city	⩾50	Prospective; control/intervention
Kelly and Shank† *(134)*	30	704	1989	OH	⩾50	Prospective
Selby et al. *(135)*	25/30	4619/4274	1960–1984	CA	⩾40	Prospective
Struewing et al. *(58)*	5/4	~300	?	MD	⩾40	Prospective; pre/post intervention
Survey						
Lewis and Jensen *(136)*	52	276	?	WI	50–75	Ever
Lipkus et al. *(116)*	35/54	547	?	NC	⩾50	Ever/past year
Community						
Program	2/29	527				
Olynyk et al. *(133)*	12	2881	1995	Australia	55–59	Prospective
Survey						
NHIS						
Anderson and May *(16)*	17	4428	1992	U.S.	⩾50	Past year
Brown et al. *(24)*	16/12	~8000	1987	U.S.	⩾50	Ever/past 3 y
CDC *(25)*	Men: 30/11 Women: 26/7	?	1992	U.S.	⩾40	Ever/past 3 y
CDC/BRFSS‡ *(93)*	28	38 063	1993	U.S.	⩾50	Past 5 years
Byles et al. *(92)*	13/7	657	?	Australia	⩾40	Ever/past 3 y
Bostick et al. *(91)*	Men: 52/39 Women: 48/38	?	1987–1989	MN, SD, ND	50–74	Ever/past 5 y
Polednak *(94)*	35/11	893	1988	NY, CT	40–74	Ever/past y
Price *(95)*	30	500	1992	OH	⩾20	Ever
Worksite						
Krevsky et al. *(130)*	31	650	?	PA	⩾40	Prospective
Laville et al. *(99)*	31	411	1985–1986	TX	⩾35	Prospective
Neale et al. *(131)*	46	980	1981	MI	?	Prospective
Schroy et al.§ *(129)*	3	6137	?	MA	>50	Prospective
Vernon et al. *(132)*	53	406	1986	TX	>40	Prospective
Other						
Richardson et al. *(111)*	69/49	75	1988	U.S.	⩾50	Ever/past 5 y for twins of CRC cases
Stephenson et al. *(128)*	69/47	154/64	1987–1991	U.K.	35–75	Prospective; first degree relatives/spouses of colorectal cancer cases

*Studies reporting two adherence rates are explained in the comments column. For example, Bejes and Marvel *(27)* reported rates for control/intervention groups.

†Of the eligible clinic patients (n = 704), 47% received a recommendation from a physician; 30% of patients receiving a recommendation completed an examination, representing 14% of the eligible population.

‡Behavioral Risk Factor Surveillance Survey (BRFSS) conducted by the Centers for Disease Control and Prevention. Screening and diagnostic tests were not differentiated.

§Of the 564 employers who returned a postcard indicating interest and who were contacted by telephone to discuss the program, 227 scheduled sigmoidoscopy, and 198 completed it.

to a random sample of Australian adults 55–59 years of age *(133)*. In patient populations, prospective adherence to an offer of screening sigmoidoscopy was 25% or greater *(27,29,134,135)* in all but one study *(58)*.

The data on sigmoidoscopy based on self-reports of past adherence covered different time periods and age ranges and included studies of patient populations *(116,136)* and community-based samples *(16,24,25,91–95,111,128)*. Surveys that included respondents aged 50 years and over reported rates between 16% and 52% for ever having had sigmoidoscopy *(16,24,25,91–95,116,136)*. The most recent national survey, the Behavioral Risk Factor Surveillance Survey conducted in 1993, found that 28% of persons 50 years of age and over reported having sigmoidoscopy, for any reason, in the past 5 years *(93)*.

Three studies examined rescreening rates for sigmoidoscopy (Table 6). All three *(131,137,138)* reported on programs offered to workers at increased risk of CRC.

Interventions to Increase Screening Adherence

Fecal Occult Blood Testing

Table 7 summarizes selected information from 18 studies that evaluated different strategies or interventions to increase adherence to FOBT *(27,37,42,43,45,48–50,52,53,56,58,60,87,100,101,104,105,139)*. Two reports *(37,139)* were based on the same sample and were counted as a single study. The study populations were patients in all studies but five *(87,100,101,104,105)*.

Table 6. Adherence to rescreening sigmoidoscopy by type of study population for two definitions of rescreening

Type of study population (ref. No.)	Type of rescreening				
		Coverage*		Compliance†	
	No.	%	Interval, y	%	Interval, y
Work site					
Lewis et al. *(137)*	147			64	3
Neale et al. *(131)*	980			20	1
		34	4	16	3
Tilley et al. *(138)*	7545	79	(3 rounds)	34	(3 rounds)

*Offered more than one sequential opportunity to be screened and participated one or more times. Denominator includes all persons offered a test at baseline who remained eligible, e.g., were alive, remained free of colorectal cancer.

†Offered more than one sequential opportunity to be screened and participated in all of them. Denominator includes all persons offered a test at baseline who remained eligible, e.g., were alive, lived in the geographic area, remained free of colorectal cancer.

In the U.K. patient registries from which samples were drawn probably represented the general population in the geographic areas studied. Most studies used random or systematic assignment of individuals, households, medical practices, or other groups to interventions or strategies (Table 7). In some studies, it was unclear how individuals or groups were assigned to interventions *(42,43,56,87,100).* One study *(58)* used a pretest/post-test design.

The most intensive strategies delivered to well-defined populations of eligible persons rarely increased adherence above 50% (Table 7). In studies that delivered minimal or relatively impersonal interventions to the control group, adherence ranged from approximately 10%–30% *(42,48,49,104,139).* In general, adherence was lowest when persons were asked to pick up a test kit or to mail in a reply card in order to receive a kit *(43,50,87,101, 104).* Various strategies ranging from the use of a letter signed by one's own physician and including FOBT kits in the mailout *(37,139)* to intensive follow-up with instructional telephone calls *(48,49)* were effective at increasing adherence, compared with a control group, to approximately 50%. Nichols et al. *(50)* evaluated the inclusion of an educational booklet in conjunction with five different contact strategies and found no effect of the booklet (Table 7). A second mailed follow-up reminder increased adherence in all studies reporting its use *(41–43,54).*

Only five investigators *(48,49,52,60,101,105)* explicitly based interventions on theories or models of behavior change. Of these, only Myers et al. *(48,49)* studied a nonvolunteer population. They found no effect of wording messages in terms of loss versus gain *(48),* although as noted above, they found an intervention effect associated with more intensive contact in both studies *(48,49).* The higher rates observed overall by Thompson et al. *(60)* and by Weinrich et al. *(105)* probably resulted from the fact that both investigators studied volunteers. Thompson et al. found that a simple reminder postcard was as effective as more complex interventions, some of which were based on the Health Belief Model *(60).* Weinrich et al. *(105)* studied elderly, low-income volunteers, 61% of whom were African-American, at a congregate meal site and found that interventions incorporating constructs from Social Cognitive Theory were more effective than those that did not, although the study groups were small and the analysis was difficult to interpret.

Several investigators evaluated the effect on adherence of requiring dietary restrictions before performing the test *(40–42,54,61,104).* Although most investigators found only a modest effect, if any *(40–42,61,104),* Robinson et al. *(54)* reported a substantial effect. Robinson et al. *(54,62)* and Thomas et al. *(59)* evaluated length of testing, i.e., the number of days respondents were asked to collect stool samples. Robinson et al. *(54)* found no effect of 3- versus 6-day testing, but in a follow-up study *(62)* of 1- versus 3-day testing using Hemeselect, respondents were more likely to complete the 1-day test. Thomas et al. *(59)* found a statistically significant effect of 3- versus 6-day testing, but the magnitude of the difference was small (58% and 54% for 3- and 6-day testing, respectively). Type of test, e.g., Hemoccult or Colo-Screen, did not affect adherence *(51,61).*

Only one study examined the effects of an intervention on repeat adherence *(127).* Myers et al. *(127)* offered a second round of screening with FOBT 1 year after the first test to the same study population of members of a health maintenance organization who were still enrollees and who previously received one of four interventions varying in intensity *(48).* In the second round, all persons received a mailed FOBT kit and a reminder letter approximately 2 weeks after the kit was mailed, regardless of treatment group status in round 1 *(127).* Compliance, i.e., completion of all sequential tests or examinations offered to the same people, regardless of prior participation, was 23%. Among persons who completed a test in the first round, 56% completed a second test (i.e., repeat screening). Of particular interest was the finding that second round adherence, regardless of adherence status in the first round, was similar across the four groups that received interventions of different intensity in round 1; the range was 28%–33% and there was no pattern across groups. Surprisingly, when the analysis was limited to persons who completed a test in the first round, completion of a second test was lowest in the group who received the most intense intervention in round 1 *(127).*

Sigmoidoscopy

Four studies *(27,58,134,135)* of clinic patients evaluated different contact strategies to increase completion of sigmoidoscopy. Two studies *(27,135)* used a randomized design. Physicians, including residents, at a family practice clinic were encouraged to deliver educational messages about the benefits of CRC screening and to offer FOBT and sigmoidoscopy during an office visit. During the study period, only half of identified eligible patients were offered either test or procedure. Adherence was approximately 30% among patients offered screening sigmoidoscopy. Although not specifically a study of CRC screening adherence, Selby et al. *(135)* reported adherence rates for sigmoidoscopy in patients participating in a randomized trial of a multiphasic health checkup. During the 16-year follow-up, 30% of patients in the study group who were urged to schedule a multiphasic health checkup completed at least one sigmoidoscopy compared with 25% in the control group who were free to schedule a multiphasic health checkup but who were not contacted and urged to do so. During the checkup, all persons aged 40 years

Table 7. Experimental interventions to increase adherence to fecal occult blood testing (FOBT)

Author(s) (ref. No.)	Location/ date of study	Study population	Intervention groups or methods	Adherence, %	No.	Comments
Bejes and Marvel *(27)*	Midwestern community/?	Clinic patients, >49 y	1) Control group	17	216	M.D.s were randomized but patients were unit of analysis. M.D.s offered tests at office visit; interventions included FOBT and FS. 151 patients (42%) in groups 2 and 3 were not offered the screening tests. No statistical difference between groups 2 and 3 so combined for analysis. Adherence for combined groups was 56%
			2) Patients received information from M.D. on benefits of CRC screening and were offered two tests (FOBT & FS)	44	36	
			3) Same as 2) but a recall letter signed by an M.D. was mailed 2–3 weeks later	59	143	
Elwood et al. *(104)*	U.S. (GA, DE, OH, CO)/?	NRTA–AARP, >54 y	1) Total mail-out: mailed slides and info on test	15	2007	Individuals randomized to groups or "panels" to test five contact methods. A difference of ⩾2% was statistically significant. Also evaluated the effects of: diet N/Y: 21/18 (ss); DRE N/Y: 9.8 (ns); postage N/Y: 18/22 (ss); sponsor ACS/AARP: 8/9 (ns); all methods required mailing in slides for processing
			2) Selective mail-out: sent educational info; slides mailed if requested	13	2032	
			3) Come-in: sent educational info; had to come in and pick up test	9	4100	
			4) Group meeting: slides distributed by ACS volunteers on request at group meetings	29	1751	
			5) At-home: ACS volunteers made home visits and left test if requested	20	1225	
Hardcastle et al. *(37,139)*	U.K. (Nottingham)/ 1981–1984	Patients from GP registers, >45–74 y	1) Letter from health department (1983)	26	1260	In the 1983 study, persons were randomized to method 1 or method 2. Method 2 was more effective. In the 1986 study, method 2 was compared with methods 3 and 4. Both were more effective than 2
			2) Letter from own M.D.	38	9492	
			3) Educational letter sent 2 wks before FOBT was mailed (1986)	47	415	
			4) Interview to discuss test 2 wks before FOBT was mailed (1986)	52	756	
King et al. *(42)*	Australia (Sydney)/1991	GP patients from three practices, 45–75 y	1) Letter and FOBT from own GP and diet restriction	51	185	Three of six general practices chosen at random; patients "were divided" into five groups. Groups 1–4 sent follow-up reminder letter; letter increased adherence in all groups. Return to senders letters removed from denominator. Group 1 versus group 2 evaluated diet restrictions; confidence intervals for these two groups did not overlap
			2) Same as 1) but no diet restriction	60	174	
			3) Same as 2) but with brochure on CRC	49	190	
			4) GP letter but had to request FOBT by phone	32	166	
			5) Letter from non-GP and FOBT were hand-delivered	23	200	
Lallemand et al. *(43)*	U.K./?	Patients from two GP registers, >40 y	1) Practice A patients sent letter and kit and one reminder: before reminder/after reminder	36/44	3361	Patients from two practices invited by their GPs to do FOBTs; each practice used a single contact method; not clear how practices were assigned to methods
			2) Practice B patients sent letter and told to collect kit from GP; if not done, kits were mailed with reminder letter; 2nd reminder sent to B: no reminder/1st reminder/2nd reminder	10/19/37	927?	
Lee *(101)*	U.S. (WA)/1988	Federal employees, >39 y	1) Sent two letters; a) a CRC risk appraisal based on baseline risk factor data (normal, moderate, or high), and b) facts about CRC and availability of FOBT at the worksite clinic	9	139	278 workers were randomized to one of two conditions; both groups had to pick up test at the worksite; No. of eligibles not clear; methodology not clear; 33% of 1455 returned a survey; 278 were >39 y; data on: perceived susceptibility; benefit, knowledge, and intention; also used intention as an outcome
			2) A letter telling of availability of FOBT at the worksite clinic	4	139	
Lee *(100)*	U.K./?	Employees at two factories, 40–65 y	1) Factory A: Screening offered at annual examination by nurses (face-to-face). Kits mailed in	45	989	Two versions of a program not described in detail offered to two nonrandomized groups
			2) Factory B: Written invitation in paychecks; kits had to be picked up from medical department and mailed in	22	1431	

Table 7—Continued. Experimental interventions to increase adherence to fecal occult blood testing (FOBT)

Author(s) (ref. No.)	Location/ date of study	Study population	Intervention groups or methods	Adherence, %	No.	Comments
Mant et al. *(45)*	U.K. (Oxford)/?	Patients from GP registers, >45–64 y	1) Mailed FOBT, no invitation for health check	26	404	Patients from six practices who had not had a health check were randomized by household to 1 of 3 groups; No adherence rates reported for group 4 because they were not offered FOBT; each practice used each method for 3 months; the order varied across practices
			2) Mailed FOBT and invitation for health check	32	397	
			3) Invitation for health check stating FOBT would be offered at the health check	21	402	
			4) Invitation for health check only			
Myers et al. *(48)*	U.S. (PA)/1989	HMO patients, 50–74 y	1) Advance letter; kit; 15-day reminder letter	27	165	Patients randomly assigned to 1 of 4 groups; women were more responsive than men to the minimal prompt (group 1); interventions included self-help booklets, telephone reminders, and messages framed in gain versus loss terms
			2) Same as 1) plus 30-day reminder call	37	167	
			3) Same as 2) plus educational booklet with kit	37	168	
			4) Same as 3) plus instructional call 10 days after mail-out	48	337	
Myers et al. *(49)*	U.S. (PA)/?	HMO patients, 50–74 y	1) Advance letter; kit; 15-day reminder letter	29	251	Patients randomized to 1 of 2 groups; Analysis stratified by sex and group status. Interventions similar to (1991) study but message framing not used. Used constructs from HBM, TRA, and SLT to create a predictive framework, the preventive health model
			2) Same as 1) plus educational booklet and 10-min. instructional phone call	50	250	
Nichols et al. *(50)*	U.K. (Farnborough, Basingstoke, N. Hampshire)/ 1982	Patients from GP registers, >40–70 y	1) Letter from GP and FOBT	38/38	8136	Patients from 14 practices randomized by household to 1 of 5 groups; the effect of an educational booklet also was evaluated for each contact method: no educational booklet/educational booklet; if no. of eligibles used, overall compliance was 32%
			2) Letter from GP and specific appt time	48/50	3698	
			3) Letter from GP and request to make an appt	26/29	2142	
			4) Letter from GP and request to pick up test	19/15	421	
			5) Routine consultation	57/58	3427	
Plaskon and Fadden *(52)*	U.S. (MD?)/?	Clinic patients, 50–70 y	1) Envelope with educational materials about CRC	0	47	An M.D. discussed with all patients who volunteered for the study the risks and benefits of CRC screening. Talk based on HBM constructs. Patients also told they could ask for free FOBT at the front desk. As they left, they were randomly assigned to receive 1 of 2 envelopes. Adherence was measured by self-report
			2) Envelope with educational material and a free FOBT	51	34	
Pye et al. *(53)*	U.K. (Nottingham)/?	Patients from GP registers, >50–74 y	1) Letter from GP and FOBT	55	385	Patients from two practices randomized by household to 1 of 5 groups
			2) Letter from GP and FOBT and educational leaflet	46	385	
			3) Letter from GP and FOBT and bowel symptoms Q	48	387	
			4) Educational leaflet 2 weeks before GP letter and FOBT	51	388	
			5) Bowel symptoms Q 2 weeks before GP letter	48	385	
Slater et al. *(87)*	Israel (Jerusalem)/?	Community, >39 y	1) Mailed offer to insured persons in community; had to return stamped card to receive FOBT	19	2640	Study was conducted in two neighborhoods. All persons in a given neighborhood got the same method
			2) Recruited through clinic; M.D.s distributed letter and return postcard during office visit; had to request mail-out of FOBT	42	324	
Sontag et al. *(56)*	U.S. (IL)/?	Patients at a VA hospital, >39 y	1) Outpatient clinics: tests explained by nurses	30	2650	Not clear if patients randomly assigned to groups; all patients were advised to prepare slides on the last 3 days of a 5-day meat-free high-fiber diet
			2) Admitting area: no explanation; clerk handed out kits	18	8497	
			3) Admitting area: M.D. explained tests	27	2375	
			4) Nurse practitioner clinic: 1 NP gave instructions on how to prepare kits	93	75	
			5) VA organizations: kits distributed at group meetings of various Vet org. Importance emphasized by group officers	43	3400	

Table 7—Continued. Experimental interventions to increase adherence to fecal occult blood testing (FOBT)

Author(s) (ref. No.)	Location/ date of study	Study population	Intervention groups or methods	Adherence, %	No.	Comments
Struewing et al. *(58)*	U.S. (MD)/?	Clinic patients, >40 y	FOBTs distributed to patients by nursing staff; education of M.D. clinic staff encouraged them to recommend CRC screening (with FS?); reminder cards attached to patient charts	60 63	159 169	Not a randomized design; pre/post test; methods unclear with few quality controls Included sigmoidoscopy
Thompson et al. *(60)*	U.S. (WA)/?	HMO patients, >44 y	1) Control group: FOBT and printed instructions	68	56	Randomized individuals to 1 of 10 groups. All received FOBT and printed instructions with diet restrictions. Some interventions based on Health Belief Model. Persons with appointment for routine examination invited to participate in a health promotion disease prevention study; high response rates may be due to health motivation of persons scheduling physical examination and willing to participate in health promotion studies; only groups 4 and 9 were not significantly different from the control group ($P<.05$)
			2) Follow-up call at 10 days if test not returned	84	55	
			3) Mail reminder card 2 days after FOBT ordered	93	55	
			4) 3–5 minute talk based on the HBM by M.D. on purpose, importance, and procedure of FOBT	81 93	52 45	
			5) 2 and 3	92	48	
			6) 2 and 4	85	48	
			7) 3 and 4	94	54	
			8) 2 and 3 and 4	75	51	
			9) 3–5 minute talk by nurse on purpose, importance, and procedure of FOBT	93	43	
Weinrich et al. *(105)*	U.S. (SC)/1990–1991	Persons attending a congregate meal site, >49 y	1) Traditional method: ACS slide/tape and hand-out	56	41	Randomized 11 sites but analyzed individuals; 75% volunteered to participate; statistical analysis unclear; no 2-way comparisons of groups were made. overall; 4) was more effective than the combined effects of 2 and 3; interventions based on theories of behavior change
			2) Elderly educator method: 1) but used elderly persons as teachers; based on Social Cognitive Theory (observational learning and role models)	61	59	
			3) Adaptation for Aging Changes method: 1) adapted for changes associated with aging	43	42	
			4) Combination of 2 and 3	93	29	

and over were offered screening sigmoidoscopy, regardless of study group status. Kelly and Shank *(134)* used a pretest/post-test design to evaluate three approaches that involved having physicians in a family practice residency program encourage patients to have sigmoidoscopy. Similar to Bejes and Marvel *(27)*, only about half of the eligible patients were offered the procedure, and approximately 30% in each of the three groups completed it. Struewing et al. *(58)* used a pretest/post-test design to evaluate the effectiveness of attaching reminder cards to patients' medical records when they attended a primary care clinic at a Veterans Administration hospital. Approximately 5% of the patients had completed sigmoidoscopy at post-test follow-up.

Madlon-Kay *(140)* studied interest in scheduling sigmoidoscopy using four different approaches and found that 55% of the patients who were sent a letter by their personal physician returned a postcard indicating interest. Two other approaches, including a physician-signed letter asking patients to call the clinic to discuss scheduling an appointment and displaying an informational hand-out with a reply card, yielded responses of approximately 25%.

Whether or not a high percentage of persons would undergo screening colonoscopy if offered the opportunity is not known. One study *(141)* that did not provide a precise denominator mailed invitations for free colonoscopy to more than 17 000 physicians, nurses, and their spouses, but only 959 persons responded to the invitation.

Factors Associated With Screening Adherence

Fecal Occult Blood Testing

Demographic and medical history variables. Patterns of prospective adherence by age or sex or both were reported in a number of programs that offered FOBT to patients *(26,28,29,33, 38,39,44,92)*, to persons in the community *(63,69,71,74,118, 119,123)*, to workers *(97,102)*, or to other groups *(107,111,115, 117)*. Prospective adherence by age or sex also was reported for some of the experimental interventions to increase adherence *(27,42,43,45,48,50,104,139)*. As well, age and sex patterns were described in a number of community surveys of self-reports of past adherence *(16,24,25,91–94,96)*. Age categories differed across studies making comparisons difficult, and most studies did not test for statistical significance. In FOBT programs for patient or community populations that measured prospective behavior, adherence was lowest among persons 70 years of age and older *(26,32,33,69,74,92,123)*. This pattern was not uniformly observed in a program offered to relatives of CRC case patients and control subjects *(115)* or in community surveys of recent self-reported past behavior where this comparison was made *(25,93)*. In the experimental interventions to increase adherence, there also was no consistent relationship between age and completion of FOBT. Some studies found that completion was higher in younger age groups *(43,104,139)*, others found no

consistent pattern *(45,48,58),* and one found that older persons were more likely to complete the test *(50).*

In programs reporting prospective adherence by sex, women were more likely to complete FOBT in 13 studies *(26,28,38,39, 69,71,74,92,97,102,107,118,123),* and men had higher completion rates in two *(33,117).* In most experimental interventions, women also were more likely than men to complete FOBT, although the differences were not pronounced and, when tested, were not always statistically significant *(27,42,43,45,48–50,58, 87,104,139).* Data from other studies *(115,119),* including national surveys of recent past behavior, showed inconsistent patterns by sex *(16,25,93).*

Associations between adherence and socioeconomic status indicators including education, income, and occupation were less frequently reported; however, with one exception *(111),* both prospective and retrospective studies found a positive association between higher education and completion of FOBT *(16,24,29,93,94,115).* Likewise, most studies found a positive association with income *(16,24,93,94,97);* in the two studies *(47,110)* reporting no association, the range of income was truncated.

Only a few studies *(16,24,93)* reported associations between race or ethnicity and adherence. Data from national surveys of self-reported past screening behavior showed minimal or no differences between whites and African-Americans, as did data from other studies *(47,110,115,142).* Likewise, very few studies reported the associations between marital status and adherence. The results of these studies were inconsistent with some reporting that married persons were more likely to complete FOBT *(83,111,115,119)* and others reporting no association *(24,47,142).* Too few studies examined other demographic or medical history variables, including family history, to comment on patterns of association.

Knowledge, attitudes, beliefs, and health-related behaviors. Table 8 summarizes the univariate associations reported in studies examining FOBT adherence and measures of knowledge, attitudes, beliefs, and health-related behaviors. Most of the surveys were based on constructs from the Health Belief Model *(60).* Three studies were retrospective surveys of samples of participants and nonparticipants *(29,143,144),* three were cross-sectional surveys in which self-reported past CRC screening was measured concurrently with the independent variables *(24,36,95,96),* and five measured attitudes and beliefs prior to offering CRC screening *(33,44,49,110,115).* Three reports *(113–115)* are based on the same study population and are summarized as one study here. One group of investigators used survey data to predict both retrospective and prospective adherence *(47).* Very few investigators performed multivariable analyses *(24,47,49,110).* Most studies did not include the same set of attitude or belief measures; however, even when studies used the same variables or constructs, e.g., perceived susceptibility, the way in which they were measured differed across studies. As shown on Table 8, health motivation or preventive health orientation, e.g., engaging in other health-promoting behaviors such as regular medical or dental check-ups, showed the most consistent positive association with FOBT completion. This factor also differentiated persistent compliers (i.e., persons who reported completing five consecutive FOBTs) from persistent refusers (i.e., persons who refused three consecutive FOBTs) *(142).* Knowledge about cancer and knowing someone with CRC also were positively associated with adherence. Other variables were examined in only a few studies, or there was less consistent evidence for the pattern of association (Table 8).

Sigmoidoscopy

Demographic and medical history variables. There were too few prospective studies of screening sigmoidoscopy that reported on age or sex to generalize about patterns of adherence *(111,128,131,138).* In community surveys of past behavior, men were more likely to report having had sigmoidoscopy than women, regardless of the time period *(16,24,91,93,94).* With one exception *(111),* education and income were positively associ-

Table 8. Correlates of adherence to fecal occult blood testing (FOBT) and to sigmoidoscopy (ref. No.)

Variable and type of test	Association		
	Positive	Negative	None
FOBT			
Perceived susceptibility	*(33, 95)*		*(29, 36, 44, 49, 115, 143)*
Perceived severity	*(44, 49, 95)*	*(36)*	*(29, 143)*
Perceived barriers		*(44, 95, 143)*	*(29, 96)*
Perceived benefits	*(33, 47, 49, 144)*	*(36)*	*(44, 95, 143)*
Health motivation/prevention orientation	*(29, 33, 36, 44, 47, 49, 96)*		*(24, 142)*
Self-efficacy	*(49, 114, 143)*		
Fatalism		*(33, 110, 143)*	
Internal locus of control		*(47)*	
Physician advice/ability	*(33, 47, 143)*		*(49)*
Social support			*(49)*
Knowledge of cancer risk factors	*(24, 33, 47)*		*(29)*
Knows someone with CRC	*(33, 47, 95, 144)*		
Sigmoidoscopy			
Perceived susceptibility	*(95, 134, 136)*		
Perceived severity	*(95)*	*(136)*	*(134)*
Perceived barriers		*(134, 136)*	*(95)*
Perceived benefits	*(136)*		*(95, 134)*
Preventive orientation	*(134)*		*(24)*
Knowledge about cancer	*(24, 95)*		
M.D. advice/ability	*(134, 136)*		

ated with completion of sigmoidoscopy. Of the studies that included race or ethnicity, two *(24,136)* found that whites were more likely than African-Americans to report past sigmoidoscopy, but Hispanics were not *(24)*. More recent data from the NHIS *(16)* found no difference in self-reports of past behavior between whites and African-Americans. Too few studies reported on other demographic or medical history variables to comment on patterns of association.

Knowledge, attitudes, beliefs, and health-related behaviors. Only four studies, three cross-sectional surveys of past behavior *(24,134,136)* and one retrospective survey following an intervention *(134)*, reported associations for knowledge and belief measures associated with sigmoidoscopy (Table 8). Perceived susceptibility was positively associated with sigmoidoscopy in the three studies that measured it *(95,134,136)*. There was no consistent pattern for the other variables measured in more than one study.

Reasons for Nonparticipation in Colorectal Cancer Screening

Fecal Occult Blood Testing

Fifteen studies surveyed samples of nonparticipants about their reasons for not completing the test *(27,28,42,48,55,63,97, 102,120,122,124,143–146)*. Practical reasons, such as conflicts with work or family, inconvenience, being too busy, being out of town, lack of interest, and cost, ranked first in seven of the 12 studies that inquired about these reasons *(27,28,42,48,63,97, 102,120,122,124,143–146)*. Not having any current health problems or symptoms of CRC ranked first or second in five of 11 studies that included these reasons *(42,48,97,102,120)*. Other reasons that ranked high were that the test was embarrassing or unpleasant *(28,55,97,102,120,144)* and that the respondent didn't want to know about health problems or was anxious about finding out test results *(97,120,146)*.

Sigmoidoscopy

Five studies asked samples of nonparticipants about their reasons for not completing sigmoidoscopy *(27,131,133,147, 148)*. Reasons that were endorsed most frequently were absence of current health problems or symptoms *(131,133,147,148)*, practical reasons (e.g., conflicts with work or family, inconvenience, being too busy, being out of town, lack of interest, and cost) *(131,133,147,148)*, worried about pain, discomfort, or injury associated with the examination *(27,131,133,147,148)*, and didn't want to know about health problems *(131,147,148)*.

Discussion

A number of investigators have emphasized that adherence to CRC screening guidelines is needed to ensure effectiveness in both health and economic terms *(149–152)*. Lieberman *(150)* compared the cost-effectiveness of five screening programs for CRC and concluded that compliance was the most important determinant of program effectiveness in all five programs. (The assumption was made that Lieberman defined compliance as completion of all recommended tests or procedures.) It is noteworthy that, in his model, compliance had differential effects on efficacy across programs when efficacy was measured by the percentage of cancers and of deaths prevented *(150)*. Although annual FOBT alone was the most cost-effective method, it prevented the fewest CRC cancer deaths, and the cost-effectiveness of FOBT alone was sensitive to variation in several factors, including compliance, the cancer detection rate, and the costs of cancer care and of colonoscopy. For FOBT alone to be the most cost-effective method, compliance must be 80% to equal the mortality reduction achieved with one-time colonoscopy at 50% compliance or with annual FOBT plus periodic sigmoidoscopy at 60% compliance *(150)*. If compliance with annual FOBT is less than 50%, it is no longer cost-effective compared with annual FOBT plus periodic sigmoidoscopy or with one-time colonoscopy. One-time colonoscopy in the sixth decade of life was estimated to have the greatest impact on the percentage of cancers and of deaths prevented at all levels of compliance compared with the other methods. A recent cost-effectiveness analysis of four methods of CRC screening concluded that no strategy could be ruled out on the basis of cost-effectiveness; however, the effect of varying rates of compliance was not assessed *(153)*. It can be argued from a public health perspective that the selection of a method for screening should go beyond considerations of cost-effectiveness. Although FOBT is the most cost-effective method, its programmatic effectiveness rests on the ability of the test to detect CRC cancer at an early stage when it can be cured. FOBT does not hold the potential for prevention of the disease that is possible with sigmoidoscopy or colonoscopy *(18,21)*.

Rates of adherence to FOBT varied by type of study population, e.g., patient or community, and depending on the type of study population, the median adherence rate was 40%–50% (Table 3). A salient issue for FOBT screening is whether or not the behavior will be sustained over time. The data on FOBT rescreening shown in Table 4 indicate that it will be difficult to achieve an annual FOBT compliance of more than 50% in the general population. The data from CRC screening programs that offered multiple opportunities for sigmoidoscopy show limited support for the view that compliance with sigmoidoscopy, sufficient to impact morbidity and mortality, can be achieved *(150)*, even in groups identified as being at increased risk (Table 6).

There are data to suggest that once someone has undergone a more invasive procedure such as sigmoidoscopy, the experience may moderate their perception and willingness to repeat the behavior. In five studies *(154–158)*, patients who had various procedures for screening or diagnosis, including sigmoidoscopy, colonoscopy, or double-contrast barium enema, were asked to rate discomfort associated with the procedures. In two studies that offered screening sigmoidoscopy *(154,157)*, the majority of patients reported willingness to have the procedure again *(154,157)*. In three studies of patients undergoing diagnostic evaluation *(155,156,158)*, two found that colonoscopy was as or more acceptable than barium enema *(155,156)*. In a study of first-degree relatives of patients who had undergone colonoscopy *(159)*, relatives were randomized to sigmoidoscopy or to colonoscopy, after agreeing to participate in the study; completion was approximately 75% in both groups.

Collectively, these findings indicate that important considerations in selecting a method for CRC screening are the success of the initial contact strategy in getting individuals to do the behavior and the likelihood that they can be persuaded to repeat

it at specified intervals. Intensive efforts appear to be warranted in the initial offer for CRC screening, particularly when the procedure is invasive. In addition, studies of duration of effects for different kinds of interventions are needed to provide data to guide the selection of different CRC screening modalities. Feinleib *(160)* noted an interesting paradox in the data from two of the cardiovascular risk reduction trials *(161,162)*: the control communities continued to show improvement while the intervention communities showed adverse or level trends. These findings are consistent with those from the study by Myers et al. *(127)* discussed above. An implication of these findings is that, once initiated, intensive efforts must be sustained to maintain a health-promoting behavior.

To date, attempts to promote CRC screening have used both a public health model that targets entire communities, e.g., mass media campaigns, and a medical model that targets individuals, e.g., general practice patients. Most of these efforts, however, did not include systematic evaluation of strategies to increase adherence and very few explicitly based strategies to promote screening on behavioral science theories or models. Research efforts in this area could perhaps benefit from considering the experiences reported from the cardiovascular risk reduction trials as well as from the recent intervention studies to increase mammography screening. Experiences from community-based interventions to change cardiovascular risk factors in the general population *(160,163–165)* and from recent experimental interventions to increase mammography screening *(166–173)* indicate that we should not underestimate the salutary effect of public education on secular trends in health behaviors, such as smoking *(162,174–176)* and breast cancer screening *(16,177)*. The preponderantly null results of these carefully designed studies should be viewed in a larger social context in which cardiovascular risk reduction and breast cancer screening have received considerable publicity over the past decade, in part through the advocacy efforts of social groups who supported these issues. As noted by Susser *(164)*, broad social movements are needed to stimulate and sustain change in health behavior at the population level. Experimental interventions at the individual or community level are only part of a social movement, and we currently know very little about methods for bringing about social change *(164)*. These experiences and caveats should be the foundation for developing health promotion efforts to increase CRC screening.

In fact, CRC mortality is beginning to decline *(178,179)*. Although CRC screening shows only a modest increase from 1987 through 1992 *(16)*, it is likely to accelerate as the public becomes more aware of the effectiveness of CRC screening. In designing experimental interventions to increase CRC screening, these trends must be considered when estimating effect size. As well, the cost-effectiveness analyses for CRC screening conducted by Lieberman *(150)* indicate that we need to set specific targets for compliance with different CRC screening methods. In the mammography intervention studies, only one study of asymptomatic women at average risk *(172)* reported a completion rate of more than 60% in response to an intervention, indicating the need to understand ceiling effects for different health behaviors.

Recent commentaries on the lack of success of community-based interventions also emphasize the need to identify and target special population subgroups for health promotion interventions *(160,163,165)*. There is some indication from the data reviewed here that women are more receptive to prospective offers of FOBT than men and that predictors differ by sex *(49)* and age *(143);* however, these findings need confirmation in studies explicitly designed to assess sex differences in response to different types or intensity of interventions to increase CRC screening and in predictors of adherence. Other related issues, such as sex differences in delay in seeking diagnosis for symptoms *(180)*, patient preference for male or female health professionals, and sex differences in physician behavior in recommending CRC screening, also require systematic investigation.

Although data on adherence for different racial/ethnic groups are sparse, we can surmise from the literature in other areas of cancer prevention and control that special efforts will be needed to ensure participation of minorities in CRC screening *(181)*. We know from national data *(2)* that African-Americans are at increased risk for the occurrence of and mortality from CRC. A recent study *(182)* found that women, African-Americans, and persons living in geographic areas characterized by indicators of low socioeconomic status (SES) were at increased risk for late-stage CRC diagnosis. Stratified analysis showed that the most important predictor of late-stage diagnosis was living in a low SES area for all age, race, sex, and source or care groups *(182)*. This finding is consistent with that of Brenner et al. *(183)* who reported decreased CRC survival for persons living in low versus high SES areas. There is some evidence *(184)* that adverse differences in stage at diagnosis for African-Americans compared with whites may be compounded by treatment differences, with African-Americans more likely to be hospitalized for severe conditions related to a diagnosis of CRC and to receive less aggressive treatment, although stage at diagnosis was not controlled in the analysis. Mayberry et al. *(185)* analyzed factors associated with the black/white difference in survival and found that stage at diagnosis accounted for more than 50% of the excess mortality observed in African-Americans; poverty and patterns of treatment did not further explain the survival disadvantage. Dayal et al. *(186)* also found that African-Americans were at increased risk of death from CRC and that this disadvantage persisted across categories of stage at diagnosis, sex, age, and SES; differences were most pronounced for localized disease. Collectively, these findings underscore the need to continue our efforts to evaluate the separate effects of race and SES in relation to a number of CRC-related outcomes, including screening adherence.

Attention to methodologic issues also is essential. Although Gordon et al. *(187)* found reasonably good agreement between self-reports of colorectal cancer screening and medical records among members of a health maintenance organization, findings from two community surveys sound a cautionary note about the validity of self-reports of past screening behavior *(95,116)*. Lipkus et al. *(116)* surveyed a population that was predominantly African-American and found low concordance between self-reports of past FOBT and medical records. Price *(95)* surveyed a low SES population and found that approximately 40% of the respondents did not know if they had had an FOBT or sigmoidoscopic examination.

Although there are trade-offs in terms of morbidity and mortality reductions for different methods of CRC screening, the

option of multiple methods offers potential advantages for population screening. The approach to recommendations for CRC screening taken by the Guidelines Panel *(21)* and by the American Cancer Society *(18)* outlines options that can be implemented in various contexts using different approaches for different target populations. The type and frequency of screening and the target population, in turn, have implications for the kinds of health promotion efforts that are likely to be effective in motivating individuals to undergo screening. Studies are needed in various target populations that evaluate adherence to different methods of CRC screening in the context of expectations about the type, frequency, and efficacy of the procedures. For example, it may prove easier to motivate some individuals to undergo more costly and invasive procedures less often than to engage in frequent but less costly screening tests *(150)*. Alternatively, embedding testing in the context of routine medical care has been an effective way to increase the prevalence of recent Pap testing and of clinical breast examinations, particularly among low SES and minority women *(188–192)*. We know from the literature on breast cancer screening that one of the most important reasons women give for obtaining mammography is that it was recommended by a physician *(193–196)*. There also is empiric evidence that those who have a regular source of care are more likely to receive preventive health services *(197,198)*. Although FOBT currently does not enjoy the acceptance either by patients or by physicians of Pap testing, clinical breast examination, or digital rectal examination, it is no more complicated to perform and no more invasive than those procedures. If the test characteristics of FOBT were improved, perhaps more primary care physicians would administer it during a routine office visit.

Researchers in the area of CRC screening have called attention to the need to develop better screening methods that can identify persons at increased risk for developing CRC *(199–202)*. Genetic testing currently offers the potential to identify persons at increased risk for developing certain types of CRC, e.g., hereditary nonpolyposis colon cancer, and testing for these and other genetic mutations may soon be available for population screening, thus permitting more precise risk stratification *(199)* and risk targeting *(160)*. However, at the present time the use of genetic testing outside a research context raises many ethical, legal, social, and public health issues that have yet to be resolved *(203–211)*.

There are still unanswered questions about the efficacy and effectiveness of some methods or combinations of methods for CRC screening, all of which have implications for what screening procedures are recommended, the frequency with which they are recommended, and to whom they are recommended. While some *(199,201)* are unequivocal in recommending that we begin CRC screening, others *(212,213)* remain cautious. One concern is that we lack sufficient information on the potential detrimental consequences of CRC screening, such as adverse psychologic effects that impact not just the individual being screened but also their family and friends, adverse social repercussions associated with labelling susceptible individuals (e.g., insurance loss), and the possibility that individuals will rely on medical technology and abdicate responsibility for self-initiated health promoting behaviors and self-care *(212,213)*. In the U.K., the National Health Service Research and Development Programme is approaching these issues by calling for research that attempts to measure broad sociologic effects of screening on self-care and health-related behavior in contrast to individual psychologic effects *(212)*. These issues are particularly relevant for CRC cancer, where epidemiologic research shows that dietary behavior and physical activity may be protective. Ultimately, screening may be just one of the options for prevention of this disease.

While behavioral scientists approach the study of determinants of health-related behaviors from a theoretic perspective, it has recently been argued that epidemiologic research on the determinants of health outcomes also would benefit from adopting a theory-based approach *(214)*. The integration of theoretic perspectives across disciplines could only serve to enhance interdisciplinary collaborations to conduct translational research on CRC cancer prevention and control.

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