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Flexible Sigmoidoscopy and CT Colonography Screening: Patients' Experience with and Factors for Undergoing Screening—Insight from the Proteus Colon Trial[1]

Carlo Senore, MD, MSc
Loredana Correale, PhD
Daniele Regge, MD
Cesare Hassan, MD
Gabriella Iussich, MD
Marco Silvani, MD
Arrigo Arrigoni, MD
Lia Morra, PhD
Nereo Segnan, MD, MPH

Purpose: To compare the acceptability of computed tomographic (CT) colonography and flexible sigmoidoscopy (FS) screening and the factors predicting CT colonographic screening participation, targeting participants in a randomized screening trial.

Materials and Methods: Eligible individuals aged 58 years (n = 1984) living in Turin, Italy, were randomly assigned to be invited to screening for colorectal cancer with FS or CT colonography. After individuals who had died or moved away (n = 28) were excluded, 264 of 976 (27.0%) underwent screening with FS and 298 of 980 (30.4%) underwent CT colonography. All attendees and a sample of CT colonography nonattendees (n = 299) were contacted for a telephone interview 3–6 months after invitation for screening, and screening experience and factors affecting participation were investigated. Odds ratios (ORs) were computed by means of multivariable logistic regression.

Results: For the telephone interviews, 239 of 264 (90.6%) FS attendees, 237 of 298 (79.5%) CT colonography attendees, and 182 of 299 (60.9%) CT colonography nonattendees responded. The percentage of attendees who would recommend the test to friends or relatives was 99.1% among FS and 93.3% among CT colonography attendees. Discomfort associated with bowel preparation was higher among CT colonography than FS attendees (OR, 2.77; 95% confidence interval [CI]: 1.47, 5.24). CT colonography nonattendees were less likely to be men (OR, 0.36; 95% CI: 0.18, 0.71), retired (OR, 0.31; 95% CI: 0.13, 0.75), to report regular physical activity (OR, 0.37; 95% CI: 0.20, 0.70), or to have read the information leaflet (OR, 0.18; 95% CI: 0.08, 0.41). They were more likely to mention screening-related anxiety (mild: OR, 6.30; 95% CI: 2.48, 15.97; moderate or severe: OR, 3.63; 95% CI: 1.87, 7.04), erroneous beliefs about screening (OR, 32.15; 95% CI: 6.26, 165.19), or having undergone a recent fecal occult blood test (OR, 13.69; 95% CI: 3.66, 51.29).

Conclusion: CT colonography and FS screening are well accepted, but further reducing the discomfort from bowel preparation may increase CT colonography screening acceptability. Negative attitudes, erroneous beliefs about screening, and organizational barriers are limiting screening uptake; all these factors are modifiable and therefore potentially susceptible to interventions.

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[1] From the Azienda Ospedaliero Universitaria Città della Salute e della Scienza Centro per l'Epidemiologia e la Prevenzione Oncologica in Piemonte, Piemonte, Turin, Italy (C.S., M.S., N.S.); im3D Medical Imaging Laboratory, via Lessolo 5, Turin 10153, Italy (L.C., L.M.); Candiolo Cancer Institute-Fondazione del Piemonte per l'Oncologia, Istituto di Ricovero e Cura a Carattere Scientifico, Candiolo, Italy (D.R.); Endoscopy Unit, Nuovo Regina Margherita Hospital, Rome, Italy (C.H.); Clinica Sant'Anna, Lugano-Sorengo, Switzerland (G.I.); and Screening Unit, Azienda Sanitaria Locale, Novara, Italy (A.A.). Received February 16, 2017; revision requested April 10; revision received June 5; accepted June 19; final version accepted August 14. **Address correspondence to** L.C. (e-mail: *loredana.correale@i-m3d.com*).

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Once-only flexible sigmoidoscopy (FS), offered only once, when a patient is 55–60 years old, is currently recommended as one of the tests for colorectal cancer (CRC) screening (1–3). Computed tomographic (CT) colonography has been proposed as an alternative screening test (4). Recently, the randomized controlled trial known as the Proteus colon trial (5,6) was performed to compare the participation and detection rates with CT colonography with those of FS in a population-based screening program. In that trial, CT colonography showed equivalent diagnostic performance and participation to those of FS (6). To design effective screening programs, however, it is important to fully understand factors affecting acceptability of the test and the barriers to participation for subjects. Thus, screening experience and participation factors must be considered along with health outcomes.

To our knowledge, so far only one survey (7) in the Dutch screening trial (8) has included questions to assess patient satisfaction with and perception of CT colonography versus colonoscopy. However, due to different study protocols and target populations, the generalizability of previous findings is uncertain. Furthermore, a direct comparison in the same population of the acceptability of CT colonography versus that of FS or the fecal immunochemical test, which are the screening strategies currently adopted by most population programs, is lacking.

Models of behavior change (9) propose that decisions to engage in health-promoting behaviors are influenced by psychologic factors such as self-efficacy, perceived susceptibility to and perceived severity of the disease, and perceived barriers of the preventative health behavior. Research (10–14) has established that many of these factors influence the decision to undergo screening for CRC. However, the specific factors influencing participation in CT colonography screening are still unknown.

In this article, we present the results of a survey comparing the acceptability of CT colonography versus FS screening and the factors that allow prediction of patient participation in CT colonographic screening, targeting participants in the Proteus colon trial (5,6).

Advances in Knowledge

- In the context of a screening trial, most of the interviewees gave practical reasons (27.5%, work and family constraints or illness) and fear of embarrassment (18.7%) for nonparticipation in CT colonography screening.
- Erroneous beliefs about screening (odds ratio [OR], 32.1), high level of anxiety (OR, 3.6), sex-related preferences (reference = male; OR, 2.8), lack of physical activity (OR, 2.8) are also barriers to CT colonography screening.
- Most frequently reported reasons for participation in the future were onset of symptoms (63% of interviewees) and having a preconsultation with the general practitioner (43%).
- Although the experience of CT colonography screening was not problematic for the majority of participants, lower satisfaction scores were reported with CT colonography than with flexible sigmoidoscopy, due to a more burdensome bowel preparation (OR, 2.77; 95% CI: 1.47, 5.24).
- The proportion of participants who would not recommend the test to friends or relatives, or who would not repeat the test in a future round, was low in both arms, although lower in flexible sigmoidoscopy arm (0.9% vs 6.7% and 1.3% vs 7.2%).

Implications for Patient Care

- Measures to improve participation in CT colonography screening must not only address organizational barriers, but also sex-specific barriers and people's beliefs and attitudes toward screening, to help invitees to make informed decisions.
- Among participants, bowel preparation was identified as the most unpleasant aspect of the CT colonography screening procedure; this result suggests the importance of further optimizing CT colonographic bowel preparation in a screening setting.

Materials and Methods

This research was funded by the Piedmont Region Department of Health and Department of Technical Innovation and by im3D, Turin, Italy. L.C. and L.M. are employees of im3d. Authors who were not employees or consultants of im3D (C.H., C.S., N.S., D.R. and S.M.) had control of all data and information that might present a conflict of interest for the authors who were employees of or consultants for im3D. The local ethics review committees had approved the RCT protocol, including the survey of nonrespondents.

Study Population

Data were collected in the Proteus colon trial, a randomized controlled trial in which the efficacy of CT colonography

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Abbreviations:
CI = confidence interval
CRC = colorectal cancer
FS = flexible sigmoidoscopy
OR = odds ratio

Author contributions:
Guarantors of integrity of entire study, C.S., D.R., C.H.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; agrees to ensure any questions related to the work are appropriately resolved, all authors; literature research, C.S., L.C., D.R., A.A.; clinical studies, D.R., C.H., G.I., A.A.; experimental studies, G.I., N.S.; statistical analysis, C.S., L.C., N.S.; and manuscript editing, C.S., L.C., C.H., M.S., A.A., L.M.

Conflicts of interest are listed at the end of this article.

See also the editorial by Taylor and von Wagner in this issue.

versus that of FS was studied in the context of a population-based screening program (5,6). The present analysis, aimed to measure patient satisfaction with the screening tests and determinants of participation in CT colonography screening, included all subjects who participated in screening with either FS or CT colonography (n = 562) and those who did not respond to the invitation to undergo CT colonography (n = 399) in the second enrollment period of the trial (January 2013).

The trial protocol has been described in detail elsewhere (5). All individuals aged 58 years old living in Turin, Italy, were eligible for screening during the months of September 2012 and January 2013 and were randomly allocated (1:1) to be invited to undergo CT colonography or FS screening (Appendix E1 [online]). Eligible subjects (n = 1984) were mailed a personal letter, signed by their general practitioner, offering a prefixed test date. The letter included a leaflet describing the screening procedure and its possible side effects. Subjects were asked to call the screening center to confirm, modify, or cancel their appointment. A reminder letter was mailed to all subjects who did not respond to the initial invitation within 45 days. Screening and related assessments were offered free of charge to all subjects who attended the screening. All attendees gave written consent for the study procedures.

Bowel preparation for FS consisted of a single enema (133 mL of 22% sodium phosphate) self-administered at home 2 hours before the test, without dietary restrictions. The examination was performed in the reference Endoscopy Unit of the Turin screening program by experienced endoscopists. In the FS arm, subjects were not required to reach the center before the scheduled time of their appointment. In the CT colonography arm, a reduced preparation procedure was self-administered (5,15), consisting of a low-residue diet for 3 days and a sachet of stool softener (diluted in one glass of water) at the three main meals starting 3 days before CT colonography. Unlike the FS participants, CT colonography participants were required to reach the radiology center 2 hours before the examination to receive the oral iodine solution (50 mL) for fecal tagging. For colon insufflation, carbon dioxide was used. The examinations were performed in three radiology units and were then transferred through a regional information and communication technology network to a centralized reading center to be interpreted by a pool of experienced radiologists (Appendix E1 [online]).

Interview

For the purposes of this survey, two groups of subjects were targeted for a phone interview, all attendees in both CT colonography and FS arms (n = 562) and all nonattendees (n = 399) in the CT colonography arm invited for screening in January 2013 (comprising 50% of nonattendees, assuming a similar participation rate throughout the two invitation periods). Subjects who phoned the screening center to decline the invitation were excluded. Interviews were carried out 3–6 months after screening invitations were sent by trained interviewers who were not blinded to randomization arm, attendance status, and screening results; therefore, interviewers could check the responses of subjects who had been referred for colonoscopy to be sure that they were reporting on the screening experience (Appendix E1 [online]).

Subjects who did not respond to five calls at different times and days (at least one call between 7 PM and 8 PM) were considered untraceable. When the subject was temporarily unavailable, the interviewer fixed an appointment for a second call: After three missed appointments, the subject was considered to have refused screening. Subjects who gave their consent to the telephone interview were administered a questionnaire regarding the subject's experience with FS and CT colonography, as well as factors influencing CT colonography attendance.

Content of the Interview Questionnaire

Attendees were asked to report adverse effects associated with both bowel preparation and test procedures and to grade their intensity (none, mild, moderate, or severe). They were also requested to rate anxiety, embarrassment, and pain associated with the examination on a five-point Likert scale (1 = none, 5 = severe). The questionnaire was set according to factors in the Precede-Proceed model (9).

Predisposing factors included beliefs about screening benefits and efficacy, attitude toward undergoing regular medical checkups (completely or moderately reassured or moderately or severely worried), perception of CRC risk, adoption of health-protective behaviors (eg, physical activity, no smoking habits), and self-reported health status (good, fair, poor, or very poor), along with several sociodemographic factors including sex, age, education, and occupation. Enabling factors included use of media (eg, newspapers, television, the Internet) and information conveyed with the invitation (letter and information leaflet) and adoption of other preventive practices (Papanicolau test and mammography for women, prostate-specific antigen test for men). Reinforcing factors included seeking medical advice, knowing a close relative or friend with CRC, having undergone a previous test for early CRC detection. Nonattendees were also asked the main reason for declining screening, and they were then required to indicate whether a number of factors identified in previous studies (9,13) had influenced their decision making and what factors could induce them to accept future screening invitations.

Sample Size Calculation

Assuming a 25%–30% response rate in both arms, we expected 250–300 attendees for both FS and CT colonography. We planned to interview all of them and a 50% sample of CT colonography nonattendees to achieve a one-to-one ratio of attendees to nonattendees in this group. The planned size ensured 80% power (at a 5% level of significance) to detect absolute differences greater than or equal to 8% in the prevalence of screening-related adverse effects in the comparison of CT colonography and FS attendees,

Table 1

Respondents' Baseline Characteristics

Characteristic	FS Attendees	CT Colonography Attendees	CT Colonography Nonattendees	*P* Value*	*P* Value†
Invitees targeted for the interview	264	298	299	. . .	. . .
No. of women invited	143 (54.2)	130 (44.8)	145 (48.5)	. . .	. . .
No. of respondents	239 (90.5)	237 (79.5)	182 (60.9)	<.001	<.001
Sex				.007	.002
Female	132 (55.2)	101 (42.6)	105 (57.7)		
Male	107 (44.8)	136 (57.4)	77 (42.3)		
Education‡				.0205	.154
Primary school or intermediate degree	125 (53.2)	98 (42.2)	83 (49.7)		
High school or university	110 (46.8)	134 (57.8)	84 (50.3)		
Family risk of CRC‡§	28 (11.7)	25 (10.5)	7 (2.9)	.773	.024
Prior endoscopy experience‡	47 (19.8)	46 (19.8)	18 (10.0)	>.999	.009

Note.—Unless otherwise indicated, data are number of subjects, with percentage in parentheses.

* Comparison of FS vs CT colonography attendees

† Comparison of CT colonography nonattendees vs CT colonography attendees

‡ Because not all respondents answered the questions on their family risk, education, and prior endoscopy experience, percentages for these items are not based on the total number of respondents, but on the total number of respondents who answered those questions.

§ First-degree relative with CRC.

given their expected frequency (6,8,16,17), as well as absolute differences of approximately 7%–15% in the distribution of putative predictors of participation in the comparison of CT colonography attendees and nonattendees on the basis of their expected (6,10,14) distribution, ranging from 9% (those with a positive family history) to 45% (the proportion of participants who read the leaflet).

Data Analysis

Descriptive statistics were used to characterize the study population. Respondents, nonrespondents, and the full target sample were compared on the basis of sex. χ^2 statistics were used to test for statistically significant differences. Within each group of attendees, we calculated the proportion of adverse effects (reported in the interview) associated with the preparation or the test procedure. Identical items on perceived burden associated with the procedure were compared between CT colonography and FS attendees by using χ^2 statistics. Because interviews were performed 3–6 months after the invitation, we also conducted a sensitivity analysis to assess whether self-reported experience of the tests could have been affected by survey timing. Predictors of screening participation were evaluated with univariate and multivariate logistic regression analyses. We analyzed separate models: the first was focused on factors associated with nonattendance among subjects invited for CT colonography, and the second was focused on factors associated with participation in FS compared with that in CT colonography screening among subjects. Odds ratios (ORs) and 95% confidence intervals (CIs) were used as measures of association. Secondary analyses were performed to address the problem of differential recall bias among attendees and nonattendees (Appendix E1 [online]). All statistical tests were two sided, and differences were considered statistically significant at a *P* value of .05.

Results

Of the 976 individuals invited to undergo FS screening, 264 (27%) participated, and of the 980 invited to undergo CT colonography, 298 (30.4%) participated. Among FS attendees, 238 of 264 (90.5%) responded to the interview, 10 of 264 (3.8%) refused, and 15 of 264 (5.7%) could not be traced. Among the 298 CT colonography attendees, 237 (79.5%) responded to the telephone interview, 34 of 298 (11.4%) refused, and 27 of 298 (9.1%) could not be traced.

After excluding subjects who called the screening center to refuse screening ($n = 14$), those who reported undergoing a recent fecal occult blood test or conventional colonoscopy ($n = 21$) and those who met other exclusion criteria ($n = 5$), 299 CT colonography nonattendees were eligible for the interview: 182 (60.9%) responded, 16 (5.3%) refused, 101 (33.8%) people were excluded because they could not be traced ($n = 93$) or were ill at the time of the interview ($n = 8$). There was not a bias in response according to sex for the survey of both FS attendees and CT colonography attendees ($P = .300$) and CT colonography nonattendees ($P = .382$) (Appendix E1 [online]). For the CT colonography nonattendees survey, the respondents group included a larger percentage of women than did the full target sample, which also included nonrespondents ($P < .001$) (Appendix E1 [online]). Demographic and clinical characteristics of the responders for each survey are described in Table 1.

Table 2

Patients' Experience with the Screening Test by Screening Modality and Sex

	FS Screening			CT Colonography Screening		
Patient Response	Women	Men	Total	Women	Men	Total
Discomfort of bowel preparation*	130	103	233	99	136	235
None	108 (83.1)	79 (76.7)	187 (80.3)	71 (71.7)	100 (73.5)	171 (72.8)
Mild	12 (9.2)	17 (16.5)	29 (12.4)	5 (5.1)	17 (12.5)	22 (9.2)
Moderate or severe	10 (7.7)	7 (6.8)	17 (7.3)	23 (23.2)	19 (14.0)	42 (17.9)
Embarrassment†	130	103	223	100	136	236
1	111 (85.4)	82 (79.5)	193 (82.3)	69 (69.0)	105 (77.2)	174 (73.7)
2	11 (8.5)	11 (10.6)	22 (9.4)	17 (17.0)	18 (13.2)	35 (14.8)
>2	8 (6.2)	10 (9.7)	18 (7.7)	14 (14.0)	13 (9.6)	27 (11.4)
Anxiety†	130	103	233	100	137	236
1	99 (76.2)	93 (90.3)	192 (82.4)	75 (75.0)	105 (76.1)	180 (76.0)
2	19 (14.6)	9 (8.7)	28 (12.0)	14 (14.0)	26 (18.9)	40 (16.9)
>2	12 (9.2)	1 (1.0)	13 (5.6)	11 (11.0)	6 (4.3)	17 (7.1)
Pain†	130	103	233	101	137	236
1	84 (64.6)	83 (80.6)	167 (71.7)	62 (61.4)	91 (66.4)	152 (64.3)
2	20 (15.4)	10 (9.7)	30 (12.9)	15 (15.0)	30 (21.9)	45 (18.9)
>2	26 (20.0)	10 (9.7)	36 (15.4)	24 (24.0)	16 (11.7)	40 (16.8)

Note.—Data are number of patients who responded, with percentage in parentheses.

* Rated on a scale of 1–4 (1, none or tolerable; 2, mild; 3, moderate; 4, severe).

† Rated on a scale of 1–5 (1, none; 5, severe).

Acceptability and Patient Experience with the Screening Tests

The percentage of attendees who would not recommend the test to friends or relatives (FS, 0.9%; CT colonography, 6.7%; OR, 0.12; 95% CI: 0.13, 0.51) and who would not repeat the test in the future if invited (FS, 1.3%; CT colonography, 7.2%; OR, 0.16; 95% CI: 0.03, 5.8) was low in both arms, although it was significantly lower in the FS arm.

Table 2 shows the perceived embarrassment, pain, and burden of bowel preparation and screening procedures. Discomfort from the bowel preparation was more often rated as "moderate or severe" by those who underwent CT colonography (17.9%) than by those who underwent FS (7.3%; OR, 2.77; 95% CI: 1.47, 5.24), while self-reported moderate to severe pain (OR, 1.11; 95% CI: 0.68, 1.82), embarrassment (OR, 1.55; 95% CI: 0.83, 2.95), and anxiety (OR, 1.31; 95% CI: 0.62, 2.88) did not differ according to arm. Bowel preparation and the examination itself were scored as the most burdensome aspects of the entire screening procedure by 59 of 237 (24.9%) and 86 of 237 (36.3%) CT colonography participants, respectively, and by 42 of 239 (17.6%; OR, 0.66; 95% CI: 0.41, 1.05) and 83 of 239 (34.7%; OR, 0.95; 95% CI: 0.65, 1.42) of FS participants, respectively.

The percentage of attendees who experienced postprocedure symptoms was 24.9% for CT colonography and 19.7% for FS (Table 3). A higher number of CT colonography attendees had multiple symptoms (25 attendees of CT colonography and 10 of FS; OR, 2.69; 95% CI: 1.26, 5.83) and scored these symptoms as moderate to severe (18 CT colonography and four FS; OR, 4.81; 95% CI: 1.60, 14.4). Bowel distension and abdominal pain, either alone or in combination, were the most common complaints in both groups, distension being more often rated as moderate to severe in the CT colonography group (OR, 2.73; 95% CI: 1.24, 6.04). In this latter group, 22 (9.3%) subjects reported fecal incontinence after the test, and 16 (72.7%) subjects rated this discomfort as moderate to severe; the corresponding figures for the FS group were three (1.3%) subjects, with three (100.0%) reporting moderate to severe discomfort. The reported symptoms occurred on the same day of the test in more than 90% of the patients and were generally self-limited, lasting no more than 6 hours in approximately 67% of the patients. Only three subjects (one in FS and two CT colonography group) asked for their general practitioner's advice, while none reported having been admitted to the hospital or referred to an emergency department. The screening procedure (including the travel time to the screening center) was completed within 2 hours for 87.9% of subjects who underwent FS, while it required 3–4 hours for 79.2% of those who underwent CT colonography (who were required to drink the iodine solution for fecal tagging at the screening center 2 hours before the test).

Factors Predicting CT Colonography Participation

Tables 4 and 5 show results of logistic regression analyses. People who considered screening to be ineffective (OR, 32.15; 95% CI: 6.26, 165.19), who

Table 3

Self-reported Symptoms after Examination

	Symptoms (Any Score)			Symptoms (Moderate or Severe)		
Symptom	FS (n = 239)	CT Colonography (n = 237)	OR*	FS (n = 239)	CT Colonography (n = 237)	OR*
Abdominal pain	30 (12.6)	33 (13.9)	...	17 (7.1)	18 (7.6)	...
Bowel distension	23 (9.6)	35 (14.8)	...	9 (3.8)	23 (9.7)	...
Anal irritation	1 (0.4)	6 (2.5)	...	1 (0.4)	2 (0.8)	...
Bleeding	0 (0)	1 (0.4)	...	0 (0)	1 (0.4)	...
Nausea or vomiting	0 (0)	7 (3.0)	...	0 (0)	5 (2.1)	...
Incontinence	3 (1.3)	22 (9.3)	8.05 (2.38, 27.28)	3 (1.3)	16 (6.8)	...
At least one symptom	47 (19.7)	59 (24.9)	...	26 (10.9)	37 (15.6)	...
More than one symptom	10 (4.2)	25 (10.5)	2.69 (1.26, 5.83)	4 (1.8)	18 (7.6)	4.81 (1.60,14.40)

Note.—Unless otherwise indicated, data are number of patients, with percentage in parentheses.

* Data in parentheses are 95% CIs.

reported higher levels of screening-related anxiety (reference, no anxiety; mild: OR, 6.30; 95% CI: 2.48, 15.97; moderate or severe: OR, 3.63; 95% CI: 1.87, 7.04), who reported greater perceived CRC risk (> 15%; OR, 2.83; 95% CI: 1.08, 7.41), and those who reported a recent fecal occult blood test (OR, 13.69; 95% CI: 3.66, 51.29) were more likely to refuse a CT colonography invitation. Men (OR, 0.36; 95% CI: 0.18, 0.71), subjects who read the mailed information (OR, 0.18; 95% CI: 0.08, 0.41), those who were retired (OR, 0.31; 95% CI: 0.13, 0.75), those who reported regular physical activity (OR, 0.37; 95% CI: 0.20, 0.70), and those with friends or neighbors with CRC (OR, 0.15; 95% CI: 0.05, 0.49) were less likely to decline the invitation. There was not a statistically significant association between regular screening practice and CT colonography screening participation (OR, 1.24;[95% CI: 0.46, 1.32). The observed associations between risk perception, screening beliefs, screening-related anxiety, and CT colonography participation remained significant even after attendees who had been referred for colonoscopy were excluded (Appendix E1 [online]).

The main reasons for refusing CT colonography screening were work or family constraints or current illness, mentioned by 50 (27.5%) of the 182 nonattendees; test-related embarrassment, by 34 (18.7%); and absence of symptoms, by 24 (13.2%) nonattendees. Test-related risks or fear of the examination were mentioned by eight (4.4%) nonattendees. Onset of gastrointestinal symptoms, physician's advice, the offer of an interview with a health professional (eg, nurse) or the offer of a noninvasive test mentioned, respectively, by 115 (63.2%), 78 (42.9%), and 52 (28.6%) respondents, were the most common reasons stated as potential triggers for accepting screening in the future.

Compared with CT colonography attendees, FS attendees (Table 5) were less likely to be men (OR, 0.50; 95% CI: 0.31, 0.80), to report higher levels of screening-related anxiety (moderate or severe vs no anxiety: OR, 0.44; 95% CI: 0.25, 0.77), and to mention having read the information leaflet (OR, 0.16; 95% CI: 0.08, 0.30), while they were more likely to report a higher educational level (OR, 1.76; 95% CI: 1.13, 2.74), lower level of physical activity (OR, 0.65; 95% CI: 0.42, 1.00), and regular participation in other screening programs (OR, 2.50; 95% CI: 1.06, 5.88). In addition, among attendees who were able to indicate a figure for the estimated CRC mortality reduction with screening, those who rated it high were more likely to belong in the FS than in the CT colonography attendees group (OR, 2.57; 95% CI: 1.46, 4.51). No difference in the reported trends for predictors of participation was observed in the comparison of subjects who had their interviews at different intervals since the invitation. Also, no difference in the perceived burden was observed among FS and CT colonography screenees interviewed at different time intervals since the examination (Appendix E1 [online]).

Discussion

We found that both FS and CT colonography are well-tolerated screening tests. The most relevant difference is related to bowel preparation, which required longer time and was perceived as more burdensome in the CT colonography arm. Although the reduced preparation adopted in our study had been rated by patients as less unpleasant (5,15,18–21) and was associated with higher participation in CT colonography screening (22) than that of full cathartic preparation, it is apparently still more burdensome than the single self-administered enema required for FS. Bowel preparation was, however, also perceived as the most burdensome aspect of CT colonography screening in trials (7,23) in which a noncathartic protocol was adopted. These results emphasize the importance of further optimizing CT colonography bowel preparation in a screening setting, where screenees' satisfaction is an important feature of successful programs.

Abdominal pain and distension were the most important components of the self-reported postprocedural distress in both screening arms, distension

Table 4

Comparison of CT Colonography Attendees versus Nonattendees and FS Attendees at Univariate Analysis

Characteristic	No. of CT Colonography Attendees	Nonattendees CT Colonography		FS Attendees	
		No. of Nonattendees	*P* Value*	No. of Attendees	*P* Value*
Sex			.002		.006
Female	101 (42.6)	105 (57.7)		132 (55.2)	
Male	136 (57.4)	77 (42.3)		107 (44.8)	
Education			.516		.020
Primary school or intermediate degree	124 (53.0)	83 (49.7)		98 (42.2)	
High school or university	110 (47.0)	84 (50.3)		134 (57.8)	
Physical activity			<.001		.086
No or occasional physical activity	119 (52.0)	128 (74.9)		139 (59.9)	
At least once a month	110 (48.0)	43 (25.1)		93 (40.1)	
Employment status			<.001		.187
Employed	86 (36.9)	81 (49.4)		99 (43.2)	
Retired	67 (28.8)	20 (12.2)		50 (21.8)	
Unemployed	80 (34.3)	63 (38.4)		80 (34.9)	
Attitude toward regular screening			<.001		.010
No anxiety	152 (67.3)	50 (30.5)		184 (79.3)	
Mild anxiety	18 (8.0)	29 (17.7)		15 (6.5)	
Moderate or severe anxiety	56 (24.8)	85 (51.8)		33 (14.2)	
Perceived risk of CRC			.010		.007
Risk unknown	126 (54.5)	97 (54.5)		110 (47.2)	
<10% over 10 years	65 (28.1)	32 (18.0)		54 (23.2)	
>15% over 10 years	40 (17.3)	49 (27.5)		69 (29.6)	
Expected CRC mortality reduction with screening			.183		<.001
Did not know†	132 (56.4)	112 (62.9)		89 (38.2)	
High or very high	102 (43.6)	66 (37.1)		144 (61.8)	
Reading information material			<.001		<.001
Did not read leaflet	21 (9.1)	63 (35.4)		70 (30.0)	
Read leaflet	211 (90.9)	115 (64.6)		163 (70.0)	
Known relatives, friends, or neighbors with CRC			<.001		.712
None	160 (68.4)	154 (57.2)		150 (64.4)	
Relatives	18 (7.7)	29 (10.8)		49 (21.0)	
Friends or neighbors	56 (23.9)	86 (32.0)		34 (14.6)	
General practitioner's advice			<.001		.872
Did not seek advice	174 (75.3)	162 (91.0)		177 (76.0)	
Asked for advice	57 (24.7)	16 (9.0)		56 (24.0)	
Self-reported health status			<.152		.027
Good	141 (60.0)	84 (49.4)		133 (57.3)	
Fair	77 (32.8)	74 (43.5)		94 (40.5)	
Poor or very poor	17 (7.2)	12 (7.1)		5 (2.2)	
Reads newspapers			.141		.751
Daily	67 (28.8)	61 (35.7)		64 (27.5)	
Two or three times a week	98 (42.1)	56 (32.7)		106 (45.5)	
Never or occasionally	68 (29.2)	54 (31.6)		63 (27.0)	
Opinion about screening effectiveness			<.001		.156
Allows for detection of early stage curable disease	231 (99.1)	126 (71.2)		233 (100.0)	
Not useful or useful only when symptoms are present	2 (0.9)	51 (28.8)		0 (0.0)	
Self-reported practice of preventive tests for other cancer sites			.051		.002
None	201 (85.9)	135 (78.5)		220 (94.4)	
Mammography and Papanicolau test or prostate-specific antigen test	33 (14.1)	37 (21.5)		13 (5.6)	

Table 4 *(continues)*

Table 4 (continued)

Comparison of CT Colonography Attendees versus Nonattendees and FS Attendees at Univariate Analysis

Characteristic	No. of CT Colonography Attendees	Nonattendees CT Colonography		FS Attendees	
		No. of Nonattendees	*P* Value*	No. of Attendees	*P* Value*
Recent CRC screening tests			<.001		.484
None	185 (78.7)	128 (71.9)		192 (82.4)	
Recent fecal occult blood test within past 2 years	4 (1.7)	32 (18.0)		5 (2.1)	
Colonoscopy or FS within past 5 years	46 (19.6)	18 (10.1)		36 (15.5)	
Smoking habits			.183		.512
Never smoker	146 (62.7)	117 (70.5)		156 (67.5)	
Former smoker	50 (21.5)	32 (19.3)		41 (17.7)	
Smoker	37 (15.9)	17 (10.2)		34 (14.7)	

Note.—Unless otherwise indicated, data are number of patients, with percentage in parentheses.

* Reference was CT colonography attendees.

† Among CT colonography attendees, three described the reduction in mortality with screening as low and 29 did not know the reduction in mortality; among CT colonography nonattendees, 10 described it as low and 102 did not know; and among FS attendees, three described it as low and 86 did not know.

being perceived as more burdensome in the CT colonography arm. Although carbon dioxide was used for obtaining pneumocolon for CT colonography examination and air was used for distention during FS, the documented positive effect (24) of carbon dioxide in reducing patient discomfort was likely offset by the much larger gas volume needed to explore the entire colon with CT colonography. The proportion of CT colonography attendees reporting postprocedural abdominal complaints was lower in our cohort than in the Dutch trial (7), which might be explained by the lower iodine dose in our protocol.

The positive correlation between CT colonography screening and male sex reflects the higher participation of men in CT colonography than in FS screening in the Proteus Colon randomized controlled trial (6). Our findings are also suggestive of a social gradient, because CT colonography attendees were more likely to have a lower education level than were FS attendees. Findings concerning adoption of health-protective behaviors were not consistent. Previous practice of other screening tests was not associated with participation in CT colonography screening, while FS attendees were more likely to report having undergone the Papanicolau test, mammography, or prostate-specific antigen test. CT colonography attendees were more likely to report a regular practice of physical activity compared with nonattendees, which was consistent with findings from studies in which other CRC screening strategies were evaluated (25–27), but they were also more active than FS attendees. Thus the offer of CT colonography screening may reach subjects showing a positive attitude toward health protective behaviors who are not yet familiar with preventive tests.

Less than 50% of CT colonography nonattendees and attendees in both screening arms were able to quantify the expected mortality reduction with screening, with CT colonography attendees being more likely than FS attendees to mention a realistic estimate of their 10-year CRC risk. Also, although results of previous reports (10,26,27) suggested that individuals who perceive themselves to be at higher risk for CRC are more likely to attend, a significantly higher proportion of CT colonography nonattendees overestimated their personal CRC risk in our study. A possible explanation of these findings is that perceived susceptibility does not influence participation in CT colonography screening, but it is important to orienting the decision of people invited for more invasive tests such as FS or colonoscopy, as has already been reported (10).

FS attendees were less likely to report high levels of anxiety associated with regular repetition of screening tests compared with CT colonography attendees, while among CT colonography invitees, even mild levels of anxiety were associated with a reduced likelihood of participation. Subjects who are less confident in the protective effect of screening may prefer a less invasive test, while lower level of confidence and an overestimate of personal CRC risk may result in higher anxiety and in fatalistic beliefs about cancer, which represent a strong barrier to participation. Only 4% of CT colonography nonattendees mentioned fear of the examination or related risks (including radiation exposure) as barriers to attendance, while fear of test-related pain, discomfort, or injury had been reported previously as a major barrier to FS screening (10). This suggests that CT colonography may be perceived as less painful and invasive than FS. Concerns about embarrassment during the examination, mentioned by 20% of nonparticipants as a major barrier, may limit CT colonography screening uptake.

Screening was perceived as useful only when symptoms were present by 29% of CT colonography nonattendees, with most indicating the onset of symptoms as the main reason for future participation in CRC screening. Almost all participants in both screening arms were instead well convinced of the importance of early CRC detection

Table 5

Multivariate Logistic Regression Model Comparing CT Colonography Attendees versus CT Colonography Nonattendees and FS Attendees

	CT Colonography Nonattendees		FS Attendees	
Variable	No. of Subjects*	OR	No. of Subjects†	OR
Sex				
Female	173	1	214	1
Male	188	0.36 (0.18, 0.71)	220	0.50 (0.31, 0.80)
Education				
Primary school or intermediate degree	189	1	209	1
High school or university	172	1.27 (0.70, 2.31)	225	1.76 (1.13, 2.74)
Employment status				
Employed	149	1	173	1
Retired	130	0.31 (0.13, 0.75)	150	0.76 (0.45, 1.27)
Unemployed	82	0.55 (0.28, 1.08)	111	0.78 (0.45, 1.35)
Attitude toward screening				
No anxiety	186	1	318	1
Mild anxiety	45	6.30 (2.48, 15.97)	32	0.76 (0.34, 1.73)
Moderate or severe anxiety	130	3.63 (1.87, 7.04)	84	0.44 (0.25, 0.77)
Physical activity				
No or occasional physical activity	218	1	242	1
At least once a month	143	0.37 (0.20, 0.70)*	192	(0.42, 1.00)
Reading information material				
Did not read leaflet	69	1	82	1
Read leaflet	292	0.18 (0.08, 0.41)	352	0.16 (0.08, 0.30)
Perceived CRC risk				
Risk unknown	191	1	218	1
<10% over 10 years	88	1.15 (0.47, 2.80)	114	0.50 (0.26, 0.93)
>15% over 10 years	82	2.83 (1.08, 7.41)	102	0.99 (0.51, 1.90)
Self-reported practice of other screening tests				
None	58	1	43	1
Mammography and Papanicolau test or prostate-specific antigen test	303	1.24 (0.46, 1.32)	391	2.50 (1.06, 0.5.88)
Expected mortality reduction with CRC screening				
Unknown	207	1	201	1
High or very high	164	0.86 (0.38, 1.98)	233	2.57 (1.46, 4.51)
General practitioner's advice				
Did not seek advice	295	1	. . .	. . .
Asked for advice	66	0.52 (0.23, 1.17)	. . .	. . .
Opinion about screening effectiveness				
Screening allows detection of early stage curable disease	320	1	. . .	. . .
Not useful or useful only when symptoms are present	42	32.15 (6.26, 165.19)	. . .	. . .
CRC screening tests within the past years				
None	276	1	. . .	. . .
Recent fecal occult blood test	53	13.69 (3.66, 51.29)	. . .	. . .
Colonoscopy or FS	32	0.86 (0.38, 1.91)	. . .	. . .
Known relatives, friends, or neighbors with CRC				
None	271	1	. . .	. . .
Relatives	51	0.73 (0.33, 1.65)	. . .	. . .
Friends or neighbors	39	0.15 (0.05, 0.49)	. . .	. . .

Note.—In the first model, an OR greater than 1 suggests that the likelihood of not attending to CT colonography screening is higher among subjects who present with a certain characteristic compared with those who do not show that characteristic; in the second model, an OR greater than 1 suggests that attendees with a certain characteristic would have a higher likelihood to undergo screening with FS compared with CT colonography than those without that characteristic. Data in parentheses are 95% CIs.

* Number of subjects included in the model in each category (CT colonography attendees plus CT colonography nonattendees).

† Number of subjects included in the model in each category (CT colonography attendees plus FS attendees).

‡ $P = .049$.

enabled by screening. Because misconceptions about screening are major barriers to attendance also for other CRC screening tests (10,15,25–27), efficient educational interventions on these beliefs are warranted to improve participation.

Organizational barriers were important to choices about screening. Employed subjects showed a significantly lower uptake and higher difficulty in coping with screening-related procedures than did retired or unemployed people. Many CT colonography nonattendees reported work or family constraints as the main reason for declining the invitation. Similar results have been reported in the Dutch trial (14), as well as for other screening strategies (10). The study design, which did not allow invitees to switch between FS and CT colonography, and the high response rate among both attendees and nonattendees compared with those other similar surveys (7,10,14,16) represent strengths of the study.

Our study had limitations. Data were self-reported and the interviews were performed 3–6 months after the invitation, which may have introduced recall bias and reporting error. However, no difference in the reported trends was observed when comparing predictors of compliance with screening invitation or self-reported ratings of screening experience. We did not exclude subjects referred for colonoscopy. However, the study interviewers were not blinded to the screening results, and they were instructed to check subjects' responses to discriminate experiences with the screening and not the assessment test results. Therefore, inaccurate recall was limited among attendees, thus reducing differential recall bias. In a sensitivity analysis, we found our results to be robust even after excluding subjects referred for colonoscopy.

We conducted the survey in the context of a randomized controlled trial, and therefore, the experimental setting could have limited the generalizability of our findings, even if this was not mentioned as a major concern by nonattendees responding to the interview. Also, the FS participation was the same in the trial as it was in the regional screening program (3,17), and CT colonography uptake was comparable with those in other studies (7,22), which would suggest that responders are representative of the attendees in our program. Only subjects aged 58 who were eligible for inclusion in an established FS program were enrolled in this study, and therefore, our findings may not extend to screening programs targeting a wider age range.

In spite of these limitations, our findings complement and extend those from previous work (7,14) and provide additional useful information to identify factors that influence patients' experience and preferences for different tests and to develop targeted interventions. In conclusion, CT colonography and FS screening are well accepted. Further reducing the discomfort from bowel preparation may increase CT colonography acceptability. Negative attitudes, erroneous beliefs about screening, and organizational barriers limit screening uptake. All of these factors are modifiable, and therefore, susceptible to interventions.

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