available at www.sciencedirect.com

ScienceDirect

journal homepage: www.ejconline.com

Screening for colorectal cancer: Comparison of perceived test burden of guaiac-based faecal occult blood test, faecal immunochemical test and flexible sigmoidoscopy

L. Hol [a,], V. de Jonge [a], M.E. van Leerdam [a], M. van Ballegooijen [b], C.W.N. Looman [b], A.J. van Vuuren [a], J.C.I.Y. Reijerink [d], J.D.F. Habbema [b], M.L. Essink-Bot [b,c], E.J. Kuipers [a,e]*

[a] *Department of Gastroenterology and Hepatology, Erasmus University Medical Centre, Rotterdam, The Netherlands*
[b] *Department of Public Health, Erasmus University Medical Centre, Rotterdam, The Netherlands*
[c] *Department of Social Medicine, Academic Medical Centre, Amsterdam, The Netherlands*
[d] *Cancer Screening Organisation for Southwest Netherlands, Vlaardingen, The Netherlands*
[e] *Department of Internal Medicine, Erasmus University Medical Centre, Rotterdam, The Netherlands*

ARTICLE INFO

Article history:
Received 30 September 2009
Received in revised form 15 March 2010
Accepted 22 March 2010
Available online 4 June 2010

Keywords:
Colorectal cancer
Population-based screening
Faecal immunochemical test
Guaiac-based faecal occult blood test
Flexible sigmoidoscopy
Burden

ABSTRACT

Background: Perceived burden of colorectal cancer (CRC) screening is an important determinant of participation in subsequent screening rounds and therefore crucial for the effectiveness of a screening programme. This study determined differences in perceived burden and willingness to return for a second screening round among participants of a randomised population-based trial comparing a guaiac-based faecal occult blood test (gFOBT), a faecal immunochemical test (FIT) and flexible sigmoidoscopy (FS) screening.

Methods: A representative sample of the Dutch population (aged 50–74 years) was randomised to be invited for gFOBT, FIT and FS screening. A random sample of participants of each group was asked to complete a questionnaire about test burden and willingness to return for CRC screening.

Results: In total 402/481 (84%) gFOBT, 530/659 (80%) FIT and 852/1124 (76%) FS screenees returned the questionnaire. The test was reported as burdensome by 2.5% of gFOBT, 1.4% of FIT and 12.9% of FS screenees (comparing gFOBT versus FIT $p = 0.05$; versus FS $p < 0.001$). In total 94.1% of gFOBT, 94.0% of FIT and 83.8% of FS screenees were willing to attend successive screening rounds (comparing gFOBT versus FIT $p = 0.84$; versus FS $p < 0.001$). Women reported more burden during FS screening than men (18.2% versus 7.7%; $p < 0.001$).

Conclusions: FIT slightly outperforms gFOBT with a lower level of reported discomfort and overall burden. Both FOBTs are better accepted than FS screening. All three tests have a high level of acceptance, which may affect uptake of subsequent screening rounds and should be taken into consideration before implementing a CRC screening programme.

* *Corresponding author*: Address: Department of Gastroenterology and Hepatology, Erasmus MC, University Medical Centre Rotterdam, 's-Gravendijkwal 230, 3015 CE Rotterdam, The Netherlands. Tel.: +31 10 7032983; fax: +31 10 7034682.
E-mail address: l.hol.1@erasmusmc.nl (L. Hol).
0959-8049/$ - see front matter
doi:10.1016/j.ejca.2010.03.022

1. Introduction

Colorectal cancer (CRC) is the second most common cause of cancer-related death in Europe.[1] Randomised controlled trials (RCTs) provided compelling evidence to support screening of average-risk individuals with faecal occult blood testing (FOBT).[2] One RCT on flexible sigmoidoscopy (FS) screening with 7 years of follow-up showed a 59% reduction in CRC-related mortality.[3] Nation-wide screening programmes are currently being implemented in several countries in Europe. In the Netherlands, guaiac-based FOBT (gFOBT), faecal immunochemical test (FIT) and FS are considered as potential screening tests for a nation-wide call–recall screening programme to start in the near future.

Uptake of screening is of considerable importance for the effectiveness of CRC screening programmes. The attendance rate of initial and successive screening rounds has remained low in many countries.[4] Important reasons for non-participation in CRC screening are related to the anticipated burden of a screening test, such as anticipated embarrassment, pain and discomfort.[4,5]

Experience with a screening test may affect the willingness to attend successive screening rounds. Given the need for repeated testing at regular intervals (e.g. FS at 5- or 10-yearly periods) to achieve effective screening and the relatively short screening interval of FOBT (annual or biennial) screening, it is of particular importance to determine screening experiences among participants. Additionally, experience with CRC screening may be communicated to other potential screenees, which may also affect uptake of CRC screening programmes in successive cohorts.

A few studies have reported on the test burden of gFOBT and FIT screening.[6–8] Although the perceived test burden of FS screening has been more widely studied,[9–12] trials comparing the burden of gFOBT, FIT and FS screening are lacking.

Therefore, this study assessed differences in perceived burden and willingness to return for a second screening round among participants of a randomised population-based trial comparing gFOBT, FIT and FS screening.

2. Methods

As part of a Dutch population-based randomised screening trial,[13] we evaluated the perceived burden and willingness to return for a successive screening test of various CRC screening tests among participants of gFOBT, FIT and FS screening by means of a questionnaire survey. The trial protocol and data on attendance and diagnostic yield of the different screening methods have been described elsewhere.[13] Recruitment took place between November 2006 and May 2008. The Dutch Ministry of Health approved the study protocol (2006/02WBO). The study questionnaire was approved by the Institutional Review Board of the Erasmus MC (MEC-2005-264).

2.1. *Subjects*

A random sample of the Dutch population aged 50–74 years was asked to participate in a randomised screening trial.[13] A total of 2375 (uptake: 50%) persons attended gFOBT screening, 2979 (uptake: 62%) persons FIT screening, and 2432 (uptake: 31%) FS screening. A random sample of screenees (481 gFOBT participants, 659 FIT participants and 1124 FS participants) was asked to participate in the questionnaire study on acceptance and burden of the screening test they underwent (Fig. 1). For both FOBTs 20–22% of all screenees were selected to participate in this study. For FS a larger proportion of screenees was selected, because power analysis indicated that at least 800 respondents were needed to allow a comparative analysis of the prevalence of physical symptoms before and after the FS.

2.2. *Questionnaires and measurements*

gFOBT and FIT screenees were asked to complete a single questionnaire 1 week after the test was received at the laboratory, but before the screenee received the test result. FS participants were asked to complete a questionnaire in the waiting area of the endoscopy unit prior to their procedure

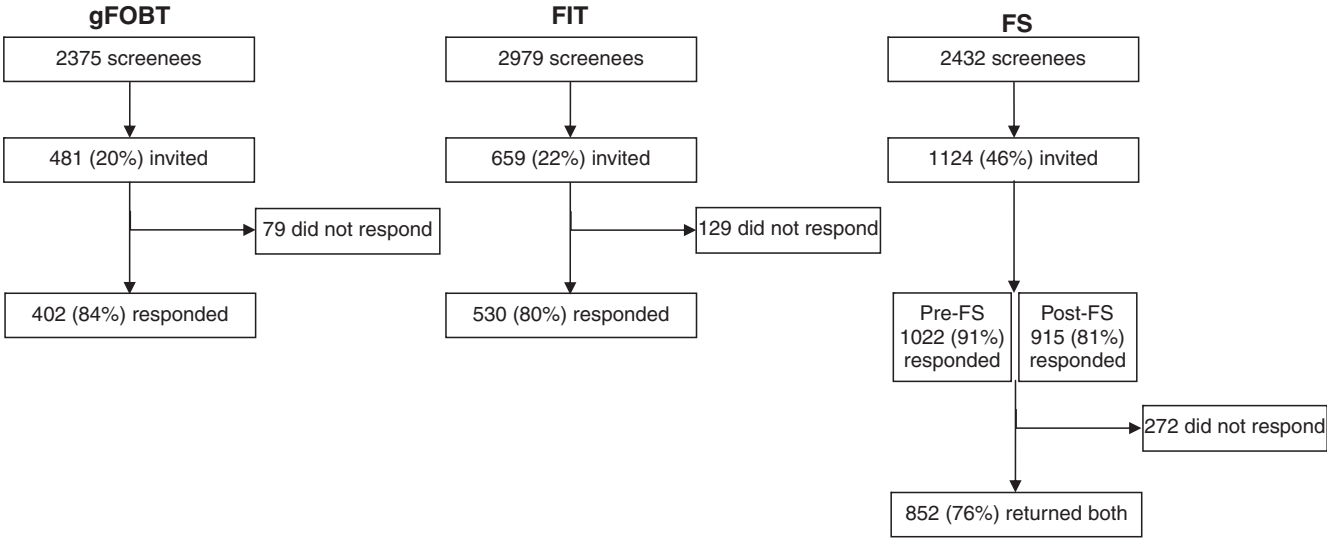

Fig. 1 – Trial profile.

and a second questionnaire 1 week after the procedure at home. The different components of the questionnaire are discussed below.

2.2.1. *Embarrassment, discomfort and pain*

Embarrassment and discomfort resulting from FOBT were measured by three separate items that were adapted from earlier studies and related to three stages of the procedure (collecting faeces, performance of the test and returning the test to the laboratory), each with three response options (not, quite or very embarrassing/unpleasant).[14,15]

Pain, embarrassment and discomfort before, during and after the FS were measured 1 week after the screening test. The four stages of the procedure, i.e. preparation, digital rectal examination (DRE), FS itself, and the period directly after the FS, with three response options (not, quite or very painful, embarrassing or unpleasant) were assessed separately.

We estimated the overall embarrassment, pain and discomfort for FOBT and FS after combining the items into summary scores, by adding the item responses (not = 0, quite = 1, very = 2) per stage of the procedure divided by the number of stages measured.

2.2.2. *Overall acceptance*

Overall acceptability of the screening method was examined by three items. For each of the three screening tests 5-point Likert scales was used to elicit subjects' perceptions of overall burden of the entire screening procedure ('very burdensome'–'not burdensome at all'), willingness to return for a successive screening round, and whether the participant would recommend friends/family members to undergo the same screening test ('certainly' – 'certainly not'). For overall burden, Likert scores of 1–2 were used to indicate burdensome. Likert scores of 1–2 were used to indicate willingness to return for a successive screening round, as well as a positive recommendation to friends/family members to undergo the same screening test, whereas scores of 4–5 were used to indicate not willing to return and a negative recommendation.

2.2.3. *Symptoms before and after FS*

To detect whether the FS caused physical symptoms, we compared the occurrence of eight symptoms in the week before the test and 1 week afterwards: rectal blood loss, diarrhoea, constipation, nausea or vomiting, flatulence or feeling bloated, faecal incontinence, anal pain and abdominal pain. Questions were composed analogous to those of previous studies.[14,15]

2.2.4. *Perceived risk of developing colorectal cancer*

We also assessed patients' subjective evaluation of their risk of developing CRC as a potential determinant of the perceived burden, using seven response options (very small, small, quite small, intermediate, quite substantial, substantial and very substantial).[16]

2.2.5. *Subject characteristics*

Demographic data were collected, including patients' classification of own health using the EQ-5D classification.[17]

2.3. *Statistical analyses*

Statistical analysis was performed using the SPSS statistical package, version 15.0.1. Analysis was performed using the χ^2 test or Student's *t*-test when appropriate, for nominal and ordinal data. Symptoms before and after FS were compared using McNemar's test. A two-sided *p*-value of <0.05 was considered significant. Differences between the summary scores of embarrassment, discomfort or pain were calculated using the independent-samples *t*-test (Cronbach's alphas gFOBT/FIT: $\alpha = 0.79$; FS: $\alpha = 0.81$). The data from the EuroQol-5D (EQ-5D) classification of own health were transformed into an EQ-5D index score using the algorithm described by Dolan.[18] Univariate ordinal regression analyses were performed to compare overall burden, recommendation to friends/family to attend screening and willingness to return for screening between the three screening tests. To study associations between determinants (screenees age, gender, EQ5D-index score, perceived risk and for FS arm only; previous endoscopy experience, gender of endoscopist) and overall burden, recommendation to friends/family to attend screening and willingness to return we used univariate and multivariate ordinal regression analyses (stepwise inclusion $p < 0.1$). For the subgroup analyses to determine the effect of same-sex endoscopist among women on embarrassment, discomfort and pain during the FS itself a Bonferroni correction was used to compensate for multi-comparison. Spearman's rank correlation was performed to determine the correlation between overall burden and recommendation to friends/family to attend screening and the willingness to return for screening.

3. Results

3.1. *Response and respondent characteristics*

In total 402/481 (84%) gFOBT and 530/659 (80%) FIT screenees returned their questionnaire (Fig. 1). Of the FS screenees 1022/1124 (91%) completed the questionnaire prior to the FS and 915/1124 (81%) returned the second questionnaire after the procedure. In total 852/1124 (76%) of FS screenees returned both questionnaires. The respondents' characteristics are shown in Table 1. Characteristics of responding screenees to both FOBT programmes were similar. FS screenees reported a marginally better general health status as measured by the EQ-5D index score than both FIT and gFOBT screenees ($p < 0.001$), and were slightly older than FIT screenees ($p = 0.008$). All other characteristics including gender, ethnicity, marital status, employment status, level of education, endoscopy experience and perceived risk on CRC were equally distributed between the three screening arms.

3.2. *Embarrassment, discomfort, and pain*

Screenees rated overall embarrassment during gFOBT and FIT equally (0.07 versus 0.06; $p = 0.30$) (Table 2). A larger proportion of gFOBT than FIT screenees described the test as uncomfortable (0.15 versus 0.11; $p = 0.02$), mainly due to more discomfort while collecting faeces and performing the test (Table 2).

Table 1 – Subject characteristics.

	gFOBT	FIT	FS
Total included screenees (*n*)	402	530	852
Mean age in years (SD)	60.8 (6.3)	61.6 (6.3)	60.7 (6.4)
Gender (% male)	45.3	50.6	50.7
Ethnicity (% Caucasian)	95.2	95.1	94.5
Marital status (%)			
Married/living with partner	88.7	87.3	88.6
Employment status (%)			
Pensioner/early retirement	35.0	38.9	35.0
In paid work	40.6	38.3	46.9
Unemployed	4.3	4.6	4.3
Education (%)			
Elementary	10.7	12.8	9.3
Secondary	71.8	63.3	64.1
Tertiary and postgraduate	17.6	23.9	26.9
General health, EuroQol-5D (EQ-5D) index score: mean (SD)	0.90 (0.13)	0.91 (0.13)	0.93 (0.11)
Endoscopy experience (%)			
Colonoscopy	14.0	15.5	17.1
Sigmoidoscopy	0.5	0.6	1.3
Perceived risk (%)			
Very small –small	43.9	54.1	45.8
Quite substantial – substantial	1.7	3.8	4.0

Table 2 – Embarrassment and discomfort per stage of gFOBT and FIT screening.

	gFOBT				FIT				
	Not%	Quite%	Very%	Mean summary Score (SEM)	Not%	Quite%	Very%	Mean summary Score (SEM)	*p*-value
Embarrassment				0.07 (0.01)				0.06 (0.01)	0.30
Collecting faeces	90.7	8.1	1.3		93.7	6.1	0.2		0.06
Performing the test	94.0	5.8	0.3		95.2	4.8	0.0		0.45
Returning the test	95.7	4.0	0.3		94.6	5.2	0.2		0.14
Discomfort				0.15 (0.01)				0.11 (0.01)	**0.02**
Collecting faeces	77.1	20.6	2.3		85.1	13.6	1.3		**0.00**
Performing the test	83.6	15.4	1.0		90.4	8.4	1.1		**0.00**
Returning the test	96.7	3.3	0.0		96.2	2.9	1.0		0.63

Overall score for embarrassment, discomfort and pain during FS was 0.18, 0.42, and 0.27, respectively. FS screenees reported embarrassment most frequently during the DRE (quite/very: 24.0%). In total 13.4%, 19.3% and 11.0% of screenees reported to have been quite/very embarrassed during the preparation, the endoscopy itself and the period after the FS, respectively. Pain and discomfort were mainly reported during the endoscopy (quite/very: 55.0% and 53.9%). In total, 17.4% and 15.4% of the screenees experienced the procedure as very painful or uncomfortable (Table 3). The mean overall embarrassment and discomfort were significantly higher for FS than for gFOBT and FIT screening ($p < 0.001$).

3.3. *Symptoms before and after FS*

Undergoing FS screening was not significantly associated with the occurrence of diarrhoea (reported prevalence 1 week before and 1 week after FS screening being: 7.4 versus 6.4%), constipation (4.7 versus 6.1%), anal pain (5.8 versus 4.5%), faecal incontinence (1.0 versus 1.1%), nausea and vomiting (2.6 versus 2.4%), or rectal blood loss (1.4 versus 2.8%). Screenees significantly more often reported abdominal pain (9.2 versus 15.8%; $p < 0.001$), and flatulence or feeling bloated (23.6 versus 33.4%; $p < 0.001$) 1 week after than before the FS.

3.4. *Overall acceptance*

Significantly less FIT than gFOBT described the test as burdensome ($p = 0.05$), whereas FS was more often reported to be burdensome than gFOBT ($p < 0.001$) and FIT ($p < 0.001$) (Fig. 2a). Significantly more women than men reported burden during FS screening (18.2% versus 7.7%; $p < 0.001$). Younger screenees (<60 years) were more likely to experience test burden during FIT and FS screening than older screenees ($\geqslant$60 years) (FIT 2.2% versus 0.7%; $p = 0.002$; FS 15.5% versus 10.5%; $p = 0.002$), whereas age was not associated with

Table 3 – Embarrassment, discomfort and pain per stage sigmoidoscopy screening.

	Sigmoidoscopy			
	Not%	Quite%	Very%	Mean summary Score (SEM)
Embarrassment				0.18 (0.01)
Preparation	86.7	12.4	1.0	
Digital rectal examination	76.0	22.1	1.9	
Sigmoidoscopy	80.7	16.9	2.4	
Directly afterwards	89.0	9.8	1.2	
Discomfort				0.42 (0.01)
Preparation	68.6	28.3	3.1	
Digital rectal examination	75.9	22.5	1.7	
Sigmoidoscopy	46.1	38.4	15.4	
Directly afterwards	69.1	25.0	5.9	
Pain				0.27 (0.01)
Preparation	95.5	4.3	0.2	
Digital rectal examination	90.3	8.8	0.8	
Sigmoidoscopy	45.0	37.6	17.4	
Directly afterwards	81.5	15.4	3.1	

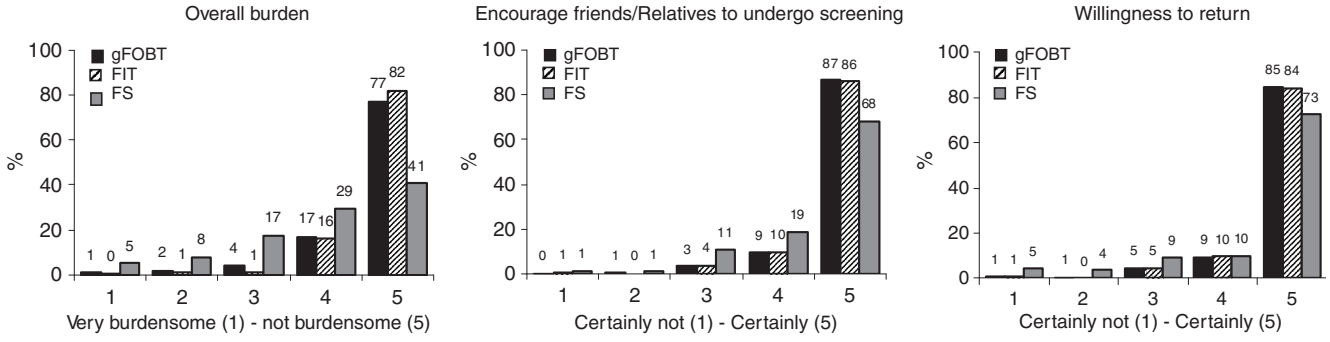

Fig. 2 – Using a 5-point Likert scale: scores on overall burden, the advice subjects would give to others to participate in screening, and willingness of screenees to return for successive screening rounds.

reported burden of gFOBT screening (3.2% versus 2.0%; $p = 0.22$). Reported burden was higher among screenees with a low compared with a high level of education in all screening arms (gFOBT 8.7% versus 0.0%; FIT 4.9% versus 0.0%; FS 11.6% versus 6.8%; p-values < 0.001).

Female screenees reported less burden when the FS was performed by a same-sex endoscopist (22.8% versus 15.5%; $p = 0.019$), while in male screenees no such association was found (8.0% versus 7.5%; $p = 0.20$). Women less often described the FS itself as embarrassing if the FS was performed by a female instead of a male endoscopist (quite/very: 18.4% versus 34.4%; $p < 0.001$), whereas no differences in pain or discomfort was found. In men no such association was found.

The vast majority of FOBT screenees would encourage friends and/or relatives to attend FOBT screening (gFOBT: 96.0%, FIT: 95.8%; $p = 0.76$) and was willing to attend a successive screening round (gFOBT 94.1%; FIT 94.0%; $p = 0.84$). A significantly smaller proportion of FS screenees was willing to attend another round of FS screening (83.8%, p-values < 0.001) or would encourage friend and/or relatives (FS: 87.1%, p-values < 0.001) to undergo FS screening compared to both FOBTs (Fig. 2b and c). There was a significant correlation between perceived burden and willingness to attend another round (gFOBT ρ –0.38; FIT ρ –0.52; FS ρ –0.50; all p-values < 0.001) and a positive recommendation to friends and/or relatives (gFOBT ρ –0.41; FIT ρ –0.40; FS ρ –0.53; all p-values < 0.001).

Men who underwent a FS were more willing to attend a successive screening round than women (86.4% versus 78.8%; $p = 0.014$). EQ5D-index score, perceived risk on CRC and previous endoscopy experience were not significantly associated with experienced burden, recommendation to friends and/or relatives, or with willingness to return for a successive screening round.

4. Discussion

Population-based screening needs to be well accepted in order to achieve an adequate uptake in first and successive screening rounds. This is the first population-based study comparing perceived test burden and willingness to return for a successive screening round between gFOBT, FIT and FS in an average-risk population. All three screening tests were well accepted among participants, given the large proportion of screenees willing to return for successive screening rounds and the positive recommendation for screening that most subjects intended to give their family and/or friends. FIT

was perceived as slightly less burdensome than gFOBT screening due to less reported discomfort during faecal collection and test performance. The number of faecal samples required may explain the difference in discomfort during faecal collection, as the gFOBT had to be performed on three consecutive bowel movements and FIT was a one-sample test. This is further underlined by an Australian study that showed similar acceptability of FIT and gFOBT when a two-sample FIT was used.[8] The difference in faecal sampling method between gFOBT (card) and FIT (swab) might also clarify the difference in discomfort, as reported by a British study showing that potential screenees preferred a sterile transport swab to a smear card.[7] The higher acceptability of FIT is in line with results of two RCTs, both demonstrating a higher uptake of FIT compared to gFOBT.[13,19] The higher acceptability is an important argument for choosing FIT in preference to gFOBT as the screening method for a nation-wide screening programme, apart from additional arguments regarding test performance characteristics.[13,19–30] Therefore, the Dutch Health Council recently recommended to introduce a nation-wide FIT-based CRC screening programme.[31]

FS is clearly more burdensome than both FOBTs, as 55% of screenees reported some kind of discomfort or pain. However, in agreement with previous studies only a small proportion of screenees reported severe embarrassment, discomfort or pain during the procedure.[9,12,22–24] In this and other studies all FS were performed without conscious sedation,[9,23] which seems acceptable for FS screenees.

Perceived burden of FS screening varied by gender. Our observations reflect those of other studies reporting that women were more likely to experience burden during FS,[25,26] and were therefore less willing to return for successive screening rounds. This contributes to the reported lower uptake among women for a first FS screening round.[9,13,23] A lower uptake in first and successive screening rounds will limit the effectiveness of FS as a screening modality in women. Therefore, endoscopists should be even more aware of potential burden in women, and should consider steps to minimise burden and thereby improve uptake for successive screening rounds (e.g. using sedation or a more flexible, smaller-calibre endoscope).

Several studies have shown a preference for a female endoscopist among women.[27,28] Nickelson and colleagues revealed embarrassment as the most important reason for preferring a same-sex endoscopist. The present study shows that the expectation reflects the actual experience, as women reported more embarrassment during the FS itself when performed by a female compared to a male endoscopist. A nation-wide screening programme might therefore be more effective when women are offered a choice between a male or female endoscopist.

Our study has shown that preparation with a single enema self-administered at home was well accepted by screenees. A few screenees reported significant embarrassment (1.0%), discomfort (3.1%) or pain (0.2%) during preparation. Furthermore, as described previously, a high proportion of screenees was willing to perform the bowel preparation at home (85%).[13,29]

The present study shows that the willingness to undergo successive screening rounds was significantly lower for FS screenees than for both FOBTs. Nevertheless, only a small minority of screenees were not willing to attend successive screening rounds of gFOBT (1.2%), FIT (1.3%) or FS (8.3%) screening, which is in line with previous studies.[6,11,12,22] This finding is essential for an effective screening programme, since screening tests must be repeated at regular intervals to be effective. Furthermore, experience with CRC screening will be communicated to other potential screenees. This may largely affect uptake of successive cohorts, given the low level of awareness of CRC and CRC screening in Europe and especially in the Netherlands.[30] In the present study, the majority of respondents would recommend family/friends to undergo screening with the same test they underwent themselves. This will positively affect uptake of screening resulting in increasing uptake levels in successive screening rounds.

The general practitioners in the region have been involved in this screening programme. They were informed about the study by direct visits of research physicians prior to start of the study and received additional written information. Furthermore, they were responsible for the referral of screenees with a positive screening test to one of the affiliated hospitals for total colonoscopy. The active role of the GP and the level of information provided may have positively affected the uptake and possibly improved the degree of satisfaction of screenees with the screening programme.[4,32]

A drawback of this study is that, because the majority of respondents were of Caucasian ethnicity (95%), our results cannot be extrapolated to a non-Caucasian population. Further studies on test burden in a non-Caucasian population are therefore needed. Furthermore, FS screenees were slightly older than FIT screenees and healthier than both gFOBT and FIT screenees, since those subgroups were more likely to participate in screening.[13] However, these differences in subject characteristics did not affect the interpretation of the results, since these marginal differences are clinically irrelevant. Furthermore, perceived test burden can only be measured in screenees and not in non-participants.

In conclusion, gFOBT, FIT and FS are well accepted screening tests among participants. FIT slightly outperforms gFOBT with a lower level of reported discomfort and overall burden. Both FOBTs were better accepted than FS screening. The high level of acceptance may affect uptake of the subsequent screening rounds and should be taken into consideration before implementing a CRC screening programme. Furthermore, attempts should be made to improve acceptance of FS screening among women if FS is considered to be the test of choice, since women reported significantly more discomfort during FS screening.

Conflict of interest statement

None declared.

Study organisation

M.L. Essink-Bot, E.J. Kuipers, J.D.F. Habbema and M. van Ballegooijen, M. van Leerdam conceived the idea for the study; M.L.

Essink-Bot, E.J. Kuipers, J..D.F Habbema, M. van Ballegooijen and M.E. van Leerdam designed the protocol; E.J. Kuipers and J.D.F. Habbema supervised the execution of the study; M.L. Essink-Bot and L. Hol developed the questionnaires, L. Hol performed the retrieval of the sample; J.C.I.Y. Reijerink was responsible for the retrieval of the target population from the municipal registries and all mailings; A.J. van Vuuren was responsible for the analyses of the FOBTs; M.E. van Leerdam was responsible for the endoscopy programme; J.C.I.Y. Reijerink, M.E. van Leerdam and L. Hol were responsible for the database design; V. de Jonge was responsible for data entry. V. de Jonge and L. Hol drafted the report; L. Hol and C.W.N. Looman performed the statistical analyses; all the collaborators listed above provided comments on the paper and approved the final version.

Trial steering committee: L. Hol, M.E. van Leerdam, M. van Ballegooijen, A.J. van Vuuren, J.C.I.Y. Reijerink, A.C.M. van der Togt, J.D.F. Habbema, E.J. Kuipers.

Trial advisory board: J.W. Coebergh, A. Cats, I.M.A. Joung.

Acknowledgements

This trial was funded by the Dutch Cancer Society (EMCR 2006-3673), and the Dutch Ministry of Health, Health Care Prevention Program–Implementation (ZonMw 2006-5877). The authors thank the members of the advisory board, all general practitioners in the region, gastroenterologists and surgeons of Erasmus MC, IJsselland Hospital, St Fransicus Gasthuis Hospital, Vlietland Hospital, Haven Hospital, Ikazia Hospital, Medical Centre Rijnmond-South and Albert Schweitzer Hospital, residents, secretaries, nurses and all participants of the trial.

REFERENCES

1. Karim-Kos HE, de VE, Soerjomataram I, et al. Recent trends of cancer in Europe: a combined approach of incidence, survival and mortality for 17 cancer sites since the 1990s. *Eur J Cancer* 2008;**44**(10):1345–89.
2. Hewitson P, Glasziou P, Watson E, et al. Cochrane systematic review of colorectal cancer screening using the fecal occult blood test (hemoccult): an update. *Am J Gastroenterol* 2008;**103**(6):1541–9.
3. Hoff G, Grotmol T, Skovlund E, et al. Risk of colorectal cancer seven years after flexible sigmoidoscopy screening: randomised controlled trial. *BMJ* 2009;**338**:b1846.
4. Vernon SW. Participation in colorectal cancer screening: a review. *J Natl Cancer Inst* 1997;**89**(19):1406–22.
5. Janz NK, Lakhani I, Vijan S, et al. Determinants of colorectal cancer screening use, attempts, and non-use. *Prev Med* 2007;**44**(5):452–8.
6. Multicentre Australian Colorectal-Neoplasia (MASC) Group. A comparison of colorectal neoplasia screening tests: a multicentre community-based study of the impact of consumer choice. Med J Aust 2006; 184(11):546–50.
7. Ellis RJ, Wilson S, Holder RL, et al. Different faecal sampling methods alter the acceptability of faecal occult blood testing: a cross sectional community survey. *Eur J Cancer* 2007;**43**(9):1437–44.
8. Worthley DL, Cole SR, Mehaffey S, et al. Participant satisfaction with fecal occult blood test screening for colorectal cancer. *J Gastroenterol Hepatol* 2007;**22**(1):142–3.
9. UK Flexible Sigmoidoscopy Screening Trial Investigators. Single flexible sigmoidoscopy screening to prevent colorectal cancer: baseline findings of a UK multicentre randomised trial. Lancet 2002; 359(9314):1291–300.
10. Segnan N, Senore C, Andreoni B, et al. Baseline findings of the Italian multicenter randomized controlled trial of "once-only sigmoidoscopy"–SCORE. *J Natl Cancer Inst* 2002;**94**(23):1763–72.
11. Nicholson FB, Korman MG. Acceptance of flexible sigmoidoscopy and colonoscopy for screening and surveillance in colorectal cancer prevention. *J Med Screen* 2005;**12**(2):89–95.
12. Zubarik R, Ganguly E, Benway D, et al. Procedure-related abdominal discomfort in patients undergoing colorectal cancer screening: a comparison of colonoscopy and flexible sigmoidoscopy. *Am J Gastroenterol* 2002;**97**(12):3056–61.
13. Hol L, van Leerdam ME, van BM, et al. Screening for colorectal cancer; randomised trial comparing guaiac-based and immunochemical faecal occult blood testing and flexible sigmoidoscopy. *Gut* 2010;**59**(1):62–8.
14. Kruijshaar ME, Kerkhof M, Siersema PD, et al. The burden of upper gastrointestinal endoscopy in patients with Barrett's esophagus. *Endoscopy* 2006;**38**(9):873–8.
15. Essink-Bot ML, Rijnsburger AJ, van DS, et al. Women's acceptance of MRI in breast cancer surveillance because of a familial or genetic predisposition. *Breast* 2006;**15**(5):673–6.
16. Kruijshaar ME, Siersema PD, Janssens AC, et al. Patients with Barrett's esophagus perceive their risk of developing esophageal adenocarcinoma as low. *Gastrointest Endosc* 2007;**65**(1):26–30.
17. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. *Ann Med* 2001;**33**(5):337–43.
18. Dolan P. Modeling valuations for EuroQol health states. *Med Care* 1997;**35**(11):1095–108.
19. van Rossum LG, Van Rijn AF, Laheij RJ, et al. Random comparison of guaiac and immunochemical fecal occult blood tests for colorectal cancer in a screening population. *Gastroenterology* 2008;**135**(1):82–90.
20. Hol L, Wilschut JA, van BM, et al. Screening for colorectal cancer: random comparison of guaiac and immunochemical faecal occult blood testing at different cut-off levels. *Br J Cancer* 2009;**100**(7):1103–10.
21. Dancourt V, Lejeune C, Lepage C, et al. Immunochemical faecal occult blood tests are superior to guaiac-based tests for the detection of colorectal neoplasms. *Eur J Cancer* 2008;**44**(15):2254–8.
22. Schoen RE, Weissfeld JL, Bowen NJ, et al. Patient satisfaction with screening flexible sigmoidoscopy. *Arch Intern Med* 2000;**160**(12):1790–6.
23. Segnan N, Senore C, Andreoni B, et al. Baseline findings of the Italian multicenter randomized controlled trial of "once-only sigmoidoscopy"–SCORE. *J Natl Cancer Inst* 2002;**94**(23):1763–72.
24. Taylor T, Williamson S, Wardle J, et al. Acceptability of flexible sigmoidoscopy screening in older adults in the United Kingdom. *J Med Screen* 2000;**7**(1):38–45.
25. Doria-Rose VP, Newcomb PA, Levin TR. Incomplete screening flexible sigmoidoscopy associated with female sex, age, and increased risk of colorectal cancer. *Gut* 2005;**54**(9):1273–8.
26. Eloubeidi MA, Wallace MB, Desmond R, et al. Female gender and other factors predictive of a limited screening flexible sigmoidoscopy examination for colorectal cancer. *Am J Gastroenterol* 2003;**98**(7):1634–9.
27. Farraye FA, Wong M, Hurwitz S, et al. Barriers to endoscopic colorectal cancer screening: are women different from men? *Am J Gastroenterol* 2004;**99**(2):341–9.

28. Schneider A, Kanagarajan N, Anjelly D, et al. Importance of gender, socioeconomic status, and history of abuse on patient preference for endoscopist. *Am J Gastroenterol* 2009;**104**(2):340–8.
29. Atkin WS, Hart A, Edwards R, et al. Single blind, randomised trial of efficacy and acceptability of oral picolax versus self administered phosphate enema in bowel preparation for flexible sigmoidoscopy screening. *BMJ* 2000;**320**(7248):1504–8.
30. Keighley MR, O'Morain C, Giacosa A, et al. Public awareness of risk factors and screening for colorectal cancer in Europe. *Eur J Cancer Prev* 2004;**13**(4):257–62.
31. Gezondheidsraad. Bevolkingsonderzoek naar darmkanker. Den Haag: Gezondheidsraad; 2009 [publicatienr. 2009/13].
32. Senore C, Armaroli P, Silvani M, et al. Comparing different strategies for colorectal cancer screening in Italy: predictors of patients' participation. *Am J Gastroenterol* 2010;**150**(1):188–98.