Longitudinal adherence to Immunochemical fecal occult blood testing vs guaiac-based FOBT in an organized colorectal cancer screening program

Llucia Benito[1,2], Noemie Travier[2,3], Gemma Binefa[2,3], Carmen Vidal[2,3], Jose Espinosa[2,3,] Núria Milà[2,3,4], Montse Garcia[2,3]

1 School of Nursing. University of Barcelona. Fundamental Care and Medical-Surgical Nursing Department. Hospitalet de Llobregat (Barcelona). Spain

2 IDIBELL, Institute of Biomedical Research. Hospitalet de Llobregat (Barcelona), Spain

3 Catalan Institute of Oncology, Cancer Prevention and Control Program. Hospitalet de Llobregat (Barcelona), Spain

4 Consortium for Biomedical Research in Epidemiology and Public Health (CIBERESP), Spain.

Key words: colorectal cancer, population-based screening, longitudinal adherence

Financial support: This study was partially cofounded by ISCIII-Subdirección General de Evaluación and by FEDER funds/European Regional Development Fund (ERDF)—a way to build Europe (PI12/00992, PI16/00588) and by the Department of Universities and Research (2017 SGR 1283) of the Government of Catalonia.

Conflicts of interest: All authors have no conflicts of interest.

Corresponding author:
Montse García
Catalan Institute of Oncology (Barcelona)
Cancer Prevention and Control Program.
Av. Gran Via, 199-203.
08908 Hospitalet de Llobregat (Barcelona), Spain
Phone: +34 932607959
e-mail: mgarcia@iconcologia.net

Word count: 2,992
Figure and Table count: 5 (5 tables)
Reference count: 37

ABSTRACT

Longitudinal adherence is a critical component of the efficacy of stool-based screening programs because they should be repeated every 1-2 years. Few data have been published on the uptake in multiple rounds of fecal occult blood test-based (FOBT) colorectal cancer (CRC) screening.

We calculated two measures of longitudinal adherence to biennial FOBT (guaiac fecal occult blood test:gFOBT or fecal immunochemical test:FIT) to better understand its impact on the programmatic effectiveness of a population-based CRC screening program (2000-2017).

Ongoing population-based CRC program of men and women aged 50-69 years (n=131,862). *Variables:* Age at first CRC screening invitation, sex, number of screening invitations, number of screens, deprivation score, and uptake rate. Logistic regression models were used to assess the independent effect of sex, age at first invitation, deprivation and the type of screening test offered on adherence.

The uptake rate for gFOBT was 23.9% and for the FIT 37.4%. The overall rate of consistently screened invitees after seven rounds of screening was 14.2%, being 20.6% for those individuals who used FIT and 14.3% for those who used gFOBT. Factors associated with continued participation (consistent vs inconsistent screenees) showed that longitudinal adherence was associated with age, screening test used, and number of invitations. Continued participation was lower in individuals who were screened using FIT than among those screened using gFOBT (OR: 0.68;95%CI:0.57-0.81).

The overall rate of consistently screened invitees for CRC screening was higher with FIT than gFOBT. Studying the rate of individuals being current for screening may help to anticipate potential benefits before long-term outcome data are available.

INTRODUCTION

Colorectal cancer (CRC) screening is a simple and effective public health intervention that prevents and minimizes the impact of CRC on the community. There is convincing evidence supporting the fecal occult blood test (FOBT), sigmoidoscopy and colonoscopy as screening tools (1-9).

Uptake is a key indicator of the potential effectiveness of any screening intervention because it reflects the degree to which a population is exposed to the intervention. Bulliard et al. (10) published a review of cancer screening uptake definitions and measures, focusing primarily on uptake in a single round of screening and noted that measures of uptake across multiple rounds of screening are complex. Several indicators measure adherence; the choice of the indicator depends on the objective. Determining who is eligible to be studied depends on the question of interest, and there are three possibilities: the entire population (studies focused on the proportion of the population in need of screening), people meeting eligibility criteria for screening (relevant considerations for screening eligibility include those related to the risk level; invitation to screen; prior cancer, symptoms, or tests; and screening ascertainment), and people who have been previously screened (measure of the time to rescreening) (10, 11).

Longitudinal adherence is a critical component of stool-based screening programs for screening efficacy because screens should be repeated every 1-2 years, and the attrition rate has important implications for the long-term effectiveness of the screening program (12, 13,~~)~~. The effectiveness of an FOBT screening program is highly dependent on uptake in multiple rounds (14). Ideally, eligible invitees accept the invitation to be screened in every screening round (12, 15). The best indicator to study the effectiveness is to calculate the percentage of consistently screened individuals among all invitees.

Few data have been published on the uptake in multiple rounds of FOBT-based CRC screenings in a large population-based open cohort. To compare the published data, the measure used to calculate longitudinal adherence, especially the screening eligibility criteria and the length of the study period, needs to be considered. The longitudinal adherence of individuals eligible for colorectal cancer screenings using the guaiac fecal occult blood test (gFOBT) ranges from 38.1% to 47.2% (4, 6, 16, 17). Between 14.3% and 44.4% of invitees were consistently screened for CRC using the gFOBT (12,15,18-20). Screening programs using the fecal immunochemical test (FIT) reported 38.3%-53.6% rates of consistently screened invitees (21-24). In all these studies, the number of rounds studied was at most three or four.

European guidelines for quality assurance in colorectal cancer screening and diagnosis have defined a standard for uptake; however, the desirable target would be to achieve an uptake rate of

65% (25). These guidelines recommend minimal uptake, but there is no recommendation for longitudinal adherence.

In the context of an intervention or program, studying longitudinal adherence may help to anticipate the potential benefits before long-term outcome data are available. Measuring longitudinal adherence may also help identify opportunities to develop interventions and programs that reduce disparities.

In 2000, Catalonia was the first region to launch a population-based CRC screening program using FOBT in Hospitalet de Llobregat (26). The first two screening rounds were part of the pilot study. Over time, the screening program was strategically modified to attain quality indicators and to make it more accessible to the population (26,27). Nowadays, several regions of Spain have active CRC screening programs (28,29).

We calculated two measures of longitudinal adherence to biennial FOBT (gFOBT or FIT) to better understand its impact on the programmatic effectiveness of a population-based CRC screening program from 2000 to 2017.

METHODS

Seven rounds of the Catalan CRC biennial screening program were performed from February 2000 to June 2017 (first round from 2000 to 2002; second round from 2003 to 2005; third round from 2006 to 2008; fourth round from 2008 to 2010; fifth round from 2010 to 2012; sixth round from 2012 to 2014; and seventh round from 2014 to 2017).

Study Population: The target population included 131,862 men and women aged 50–69 years who were residents in the screening area, Hospitalet de Llobregat, a municipality to the immediate southwest of Barcelona. The analysis evaluating screening adherence was restricted to subjects invited to participate at least twice between 2000 and 2017 (n=103,122).

To analyze the effect of the type of screening test used on longitudinal adherence, we compared subjects who were invited at least twice for gFOBT-based screenings irrespective of further invitations for FIT-based screenings with subjects who were invited at least twice for FIT-based screenings and had never been invited for gFOBT-based screenings (n=93,107).

Screening Procedure: This study was performed within our ongoing, population-based CRC screening program. The study design has been previously described (26, 27, 30). Briefly, a biennial population-based screening program for CCR using the FOBT was launched in Hospitalet de Llobregat, an industrial city of 260,288 inhabitants. Participants with positive screening results were referred for a colonoscopy. Participants with no lesions found during the colonoscopy were invited

for another screening after 10 years if eligible. The program was free to the public and included men and women aged 50 to 69 years.

Exclusion Criteria: Subjects were excluded if they had any of the following: a personal history of CRC or adenomas, familial CRC cancer, inflammatory bowel disease, a colonoscopy in the previous 5 years or FOBT in the previous 2 years, or a terminal disease or a severe disabling condition. Subjects with an invalid mailing address and removals from the screening area registry were also excluded because they could not be invited to a screening.

Screening Test: The gFOBT was the only test used in the first three screening rounds (Hema-screen™; Immunostics, Inc New Jersey, USA). In the fourth round, the FIT (OC Sensorμ, Palex) was partially introduced and offered to 12,727 individuals to assess its feasibility and acceptability (eligible population assigned to two Basic Health Areas randomly selected). The gFOBT was offered to the remaining target population (n=50,199) (eligible population assigned to 10 Basic Health Areas).

Based on the favorable results obtained with the FIT, the Catalan Cancer Strategy decided that the FIT would be used throughout Catalonia. Thus, in the fifth, sixth, and seventh rounds of CRC screenings, the FIT was the only test used.

Variables: Data on age at first invitation, sex, number of screening invitations and number of screens were retrieved from the program database. Since no individual information on socioeconomic status (SES) was available, a deprivation score, elaborated by the Catalan Agency for Quality and Health Technology Assessment and calculated for basic healthcare areas of the Catalan territory, was used (31). This score combined several pieces of contextual data, such as income deprivation, employment deprivation, health deprivation and average education, into a single deprivation score for a basic healthcare area [score: 0-100]. Higher scores on this index represent greater socioeconomic deprivation.

The uptake rate was calculated as the number of participants (persons with a FOBT performed properly) relative to all eligible invitees. Uptake rates were calculated for each screening round.

We have used two measures to calculate the longitudinal adherence. The first measure is the continued participation, which answers the research question: what is the prevalence of receiving regular screening? This measure gives information about long-term satisfaction with the screening program (10). Participants are studied and analyzed if they continue over time with screening. The denominator of this indicator is the number of individuals who have participated.

The second measure is the percentage of invited individuals with a consistent screening behavior, which answers the research question: who could potentially benefit most from cancer screening?

What proportion of invitees participates in all screening rounds? In this case, the denominator is the individuals invited to the cancer screening program and the numerator the individuals that have been tested as many time as invited. The measure gives information about the percentage of eligible population that can benefit from the program, the effectiveness of the screening program. Thus, this could be an intermediate indicator of mortality, which is a very expensive indicator and requires a lot of time to calculate it. Nevertheless, this measure depends on the individuals who enhance uptake in screening and those who continued being screened over time.

To classify individuals according to their screening behavior we considered three categories: never screened individuals (no uptake in any round of the screening), inconsistent screenees (attending at least one round of screening but less than the total eligible number of screenings), and consistent screenees (attending all rounds of screenings when eligible). We have examined the proportion of individuals who participated in the screening after two or more invitations (late adopters) and those who discontinued screening (quitters) in the next round.

Statistical Analyses: A descriptive analysis was performed to identify invitees with a consistent screening behavior over seven screening rounds and by type of test. The Joinpoint Regression Program (Version 4.5.0.1, Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute, Bethesda, MD, USA) was used to analyze uptake trends for the whole population and to detect where a significant change in the trend occurred.

Multivariate logistic regression models were used to assess the independent effects of sex, age at first invitation (5-year category), deprivation (10-point category) and type of screening test offered, on screening adherence. All the models were further adjusted for the number of invitations and average uptake after the first screening invitation. These models provided odds ratios (ORs) and 95% confidence intervals (CIs) that allowed us to compare: 1: consistent vs inconsistent screenees, 2: inconsistent screenees vs never screened individuals and 3: screenees (both consistent and inconsistent screenees) vs never screened individuals.

Ethics: Our CRC screening program, similar to all Spanish population-based screening programs, followed public health laws and the Organic Law on Data Protection. The study protocol was approved by the ethics committee of the University Hospital of Bellvitge (PR261/17).

RESULTS

Uptake: Over the seven screening rounds, the uptake rates increased significantly from 17.2% to 38.0%. Of the 131,862 individuals eligible for the seven screening rounds, 62.8% were ‘never participants’, and 37.2% participated at least once (Table 1, Supplementary figure 1).

Consistently screened invitees: The number of times that invitees participated during the seven screening rounds displayed for the number of times that invitees were eligible is summarized in Table 2. The overall screening rate after seven rounds of screening was 14.2% (18,681/131,862). According to the number of invitations it ranged from 16.03% to 12.51% (Table 2).The overall screening rate according to the type of test is shown in table 3, 14.3 for Guaiac test and 20.6 in FIT (Table 3).

Inconsistent screenees: Inconsistent screenees can be classified in two main groups: those who changed screening behavior over time (late adopters and quitters) and those with an erratic behavior regarding screening. Table 4 shows the proportion of individuals who participated in the screening after two or more invitations (late adopters) and those who stopped being screened (quitters) (Table 4).

Late Adopters: Individuals who enhanced uptake after being invited one time in the previous round and not having participated was 11.2% for the gFOBT and 12.6% for the FIT (Supplementary tables 2 and 4).

Quitters: The proportion of quitters for both tests was approximately 25% after their first screen. The percentage of participants who withdrew after two rounds of screenings and after three rounds of screenings was greater for the FIT than for the gFOBT and for three rounds (FIT:13.8% and 8.7% and gFOBT: 7.1% and 5.4%, respectively; Supplementary tables 2 and 4).

Continued participation: Table 5 provides the results of the multivariate logistic regression analysis examining predictors of longitudinal adherence in CRC screenings. Model 1, that analysed factors associated with continued participation (consistent vs inconsistent screenees), longitudinal adherence was associated with age, screening test used (gFOBT or FIT), and number of invitations. Continued participation was lower among individuals who used the FIT than among those who used the gFOBT (OR: 0.68; 95% CI: 0.57-0.81).

No differences in sex or deprivation index were observed. The age at first invitation (5-year change) was associated with adherence to CRC screenings. Elderly individuals were more likely to be adherent than were their younger counterparts.

The model that compared inconsistent screenees versus never screened individuals (Model 2) revealed that screening uptake was associated with sex, deprivation index and test type. The ORs showed that women participated more than men, especially those with a lower deprivation index and those who were invited to participate in screenings using the FIT. Similar findings were found with the model that compared those never screened with screenees (both consistent and inconsistent screenees) (Model 3); women, those with a lower deprivation index and who used FIT were more likely to have been screened at least once (Table 5).

DISCUSSION

This population-based study calculated two longitudinal adherence indicators to CRC screening with FOBT. The results showed a longitudinal decrease in adherence over 7 screening rounds. In addition, it was observed that the overall rate of consistently screened invitees for CRC screening was higher with FIT than guaiac test despite lower continued participation. Factors associated with initial uptake were quite different from those relating to adherence in subsequent rounds of screenings. Continued participation was associated with age, screening test used (gFOBT or FIT), and number of invitations.

Monitoring longitudinal screening adherence is important (22, 24, 32), especially for FOBT, because individuals are more likely to adhere to screening options that require fewer screenings over time (33). There is little information on uptake patterns in any screening program that is predicated on repeated invitations at regular intervals (15, 18, 19, 21-24) (Supplementary table 3). To the best of our knowledge, no study has compared the longitudinal adherence (neither continued participation among screenees nor proportion of consistently screened invitees) of both tests (gFOBT and FIT)

Given the scarcity of information on the impact of repeated FIT or gFOBT screenings, such data are of major importance for countries considering or planning the implementation of population-based FIT or gFOBT screening programs. The replacement of the gFOBT with quantitative FIT screenings should increase uptake. When comparing the FIT and the Guaiac, in terms of continued participation, in our screening program is lower in the FIT, but instead, the number of people who join the screening program was greater in FIT than in the Guaiac and therefore, the percentage of consistently screened invitees was still greater with the FIT. The latter measure gives information about how many individuals could potentially benefit most from cancer screening (some individuals who have been screened sporadically may also get some benefit from being screened) (14).

The longitudinal decrease in adherence may be partially explained by screening fatigue. Invitees lose the motivation to participate because of a false perception of decreased CRC risk after several negative test outcomes (34). Screening fatigue considerably reduces screening effectiveness and is a potential threat for FOBT screening programs because repeated testing is important to achieve reasonable sensitivity for detecting advanced neoplasia. Furthermore, CRC risk increases with age, stressing the importance of uptake among older individuals (35).

Late adopters (individuals who participate in CRC screenings after several invitations) contributed to overall uptake. Here, previous non-attenders were re-invited every 2 years, irrespective of whether they had previously responded, because this practice improves uptake (36). Increased awareness of CRC screening and sufficient information on CRC and FIT screenings may enhance the uptake in successive rounds because the target population is screening-naïve when first approached (36). It is important to keep inviting to the previous nonparticipants because, in our study, up to 8.4% of

the population participated after three invitations, regardless of the type of test (gFOBT or FIT). In cancer screening programs where uptake is less than 45%, any intervention is important to increase uptake, especially when the intervention mainly involves sending an invitation letter and a reminder.

In addition, it is important to consider the percentage of quitters, especially when uptake is <45%. Almost 25% of the participants do not participate again in the next round. Primary care professionals should be closely involved in interventions designed to improve longitudinal adherence. The general practitioner role is pivotal not only to increase uptake in FOBT screenings but also to ensure adherence with repeat testing for people with negative FOBT results (18). General practitioners could increase their involvement in CRC screening if they had more involvement with patient information at different stages of the screening process. Their privileged mode of communication remains face-to-face consultation with the patient (37).

The strengths of our study include access to a large cohort of an average-risk population composed of participants of the age ranges that are typically invited for CRC screening programs worldwide. Our study also had several limitations. First, SES could only be assigned by postal code, as a proxy for individual level SES. Second, 17 years have passed since the screening program was implemented, and many organizational changes have occurred. These changes may have contributed to uptake modification and longitudinal adherence; however, these changes have not been monitored and therefore cannot be identified as confounding factors. Third, the first two rounds of screenings were pilot rounds with uptake values of 17.2% and 22.3%, respectively, which conditioned full adherence. When we excluded these two rounds, the full adherence over five rounds of screenings improved by six percentage points (from 14.2% to 20.6%).

To improve the comparability of longitudinal adherence indicators in cancer screening interventions, the definitions and associated terminology need to be explicit, standard terms should be favored and the use of the same term for different meanings needs to be avoided (10).

In summary, there are differences in the longitudinal adherence of FIT and gFOBT screening; the FIT increased overall uptake but decreased continued participation. In programs with an overall uptake of less than 45%, it is considered appropriate to focus on interventions that improve initial uptake. When the uptake is 45% or higher, then it is important to design specific interventions focused on maintaining adherence. Identifying the proportion of consistently screened individuals is important in order to anticipate the population benefits of screening before having mortality data available.

REFERENCES

1. Atkin WS, Edwards R, Kralj-Hans I, Wooldrage K, Hart AR, Northover JM, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. Lancet (2010) 375:1624-33.

2. Brenner H, Stock C, Hoffmeister M. Effect of screening sigmoidoscopy and screening colonoscopy on colorectal cancer incidence and mortality: systematic review and meta-analysis of randomised controlled trials and observational studies. BMJ (2014) 348:g2467.

3. Brenner H, Chang-Claude J, Jansen L, Knebel P, Stock C, Hoffmeister M. Reduced risk of colorectal cancer up to 10 years after screening, surveillance, or diagnostic colonoscopy. Gastroenterology (2014) 146:709-17.

4. Hardcastle JD, Chamberlain JO, Robinson MH, Moss SM, Amar SS, Balfour TW, et al. Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. Lancet (1996) 348:1472-7.

5. Hewitson P, Glasziou P, Watson E, Towler B, Irwig L. Cochrane systematic review of colorectal cancer screening using the fecal occult blood test (hemoccult): an update. Am J Gastroenterol (2008) 103:1541-9.

6. Kronborg O, Fenger C, Olsen J, Jorgensen OD, Sondergaard O. Randomised study of screening for colorectal cancer with faecal-occult-blood test. Lancet (1996) 348:1467-71.

7. Mandel JS, Church TR, Bond JH, Ederer F, Geisser MS, Mongin SJ, et al. The effect of fecal occult-blood screening on the incidence of colorectal cancer. N Engl J Med (2000) 343:1603-7.

8. Schoen RE, Pinsky PF, Weissfeld JL, Yokochi LA, Church T, Laiyemo AO, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. N Engl J Med (2012) 366:2345-57.

9. Segnan N, Armaroli P, Bonelli L, Risio M, Sciallero S, Zappa M, et al. Once-only sigmoidoscopy in colorectal cancer screening: follow-up findings of the Italian randomized controlled trial--SCORE. J Natl Cancer Inst (2011) 103:1310-22.

10. Bulliard JL, Garcia M, Blom J, Senore C, Mai V, Klabunde C. Sorting out measures and definitions of screening participation to improve comparability: the example of colorectal cancer. Eur J Cancer (2014) 50:434-46.

11. Chubak J, Hubbard R. Defining and measuring adherence to cancer screening. J Med Screen (2016) 23:179-85.

12. Gellad ZF, Stechuchak KM, Fisher DA, Olsen MK, McDuffie JR, Ostbye T, et al. Longitudinal adherence to fecal occult blood testing impacts colorectal cancer screening quality. Am J Gastroenterol (2011) 106:1125-34.

13. Liang PS, Wheat CL, Abhat A, Brenner AT, Fagerlin A, Hayward RA, et al. Adherence to competing strategies for colorectal cancer screening over 3 years. Am J Gastroenterol (2016) 111:105-14.

14. Ponti, A., A. Anttila, and G. Ronco. "Report on the implementation of the council recommendation on cancer screening." *Luxembourg: European Commission* (2017).

15. Steele RJ, McClements PL, Libby G, Carey FA, Fraser CG. Patterns of uptake in a biennial faecal occult blood test screening programme for colorectal cancer. Colorectal Dis (2013) 16:28-32.

16. Lindholm E, Brevinge H, Haglind E. Survival benefit in a randomized clinical trial of faecal occult blood screening for colorectal cancer. Br J Surg (2008) 95:1029-36.

17. Mandel JS, Bond JH, Church TR, Snover DC, Bradley GM, Schuman LM, et al. Reducing mortality from colorectal cancer by screening for fecal occult blood. Minnesota colon cancer control study. N Engl J Med (1993) 328:1365-71.

18. Denis B, Gendre I, Perrin P. Participation in four rounds of a French colorectal cancer screening programme with guaiac faecal occult blood test: a population-based open cohort study. J Med Screen (2015) 22:76-82.

19. Lo SH, Halloran S, Snowball J, Seaman H, Wardle J, von Wagner C. Predictors of repeat participation in the NHS bowel cancer screening programme. Br J Cancer (2015) 112:199-206.

20. Mila N, Garcia M, Binefa G, Borras JM, Espinas JA, Moreno V. Adherence to a population-based colorectal cancer screening program in Catalonia (Spain), 2000-2008. Gac Sanit (2012) 26:217-22.

21. Crotta S, Segnan N, Paganin S, Dagnes B, Rosset R, Senore C. High rate of advanced adenoma detection in 4 rounds of colorectal cancer screening with the fecal immunochemical test. Clin Gastroenterol Hepatol (2012) 10:633-8.

22. Kapidzic A, Grobbee EJ, Hol L, van Roon AH, van Vuuren AJ, Spijker W, et al. Attendance and yield over three rounds of population-based fecal immunochemical test screening. Am J Gastroenterol (2014) 109:1257-64.

23. Osborne JM, Wilson C, Duncan A, Cole SR, Flight I, Turnbull D, et al. Patterns of participation over four rounds of annual fecal immunochemical test-based screening for colorectal cancer: what predicts rescreening? BMC Public Health (2018) 18:81.

24. van der Vlugt M, Grobbee EJ, Bossuyt PM, Bongers E, Spijker W, Kuipers EJ, et al. Adherence to colorectal cancer screening: four rounds of faecal immunochemical test-based screening. Br J Cancer (2017) 116:44-9.

25. Segnan N, Patnick J, von Karsa L. European Guidelines for Quality Assurance in Colorectal Cancer Screening and Diagnosis. Luxembourg: European Comission, Office for Official Publications of the European Union (2010).

26. Peris M, Espinas JA, Munoz L, Navarro M, Binefa G, Borras JM. Lessons learnt from a population-based pilot programme for colorectal cancer screening in Catalonia (Spain). J Med Screen (2007) 14:81-6.

27. Binefa G, Garcia M, Milà N, Fernández E, Rodríguez-Moranta F, Gonzalo N, et al. Colorectal cancer screening programme in Spain: results of key performance indicators after five rounds (2000–2012). Sci Rep (2016) 6:19532.

28. Ascunce N, Salas D, Zubizarreta R, Almazan R, Ibanez J, Ederra M. Cancer screening in Spain. Ann Oncol (2010) 21:iii43-51.

29. Cancer Screening Programmes Network. Situation of colorectal cancer screening programmes in Spain. (2017) http://www.cribadocancer.org.

30. Garcia M, Borras JM, Binefa G, Mila N, Espinas JA, Moreno V. Repeated screening for colorectal cancer with fecal occult blood test in Catalonia, Spain. Eur J Cancer Prev (2012) 21:42-5.

31. Observatory of the Catalan Health System. New socioeconomic indicator for the financing of the basic health areas 2014. (2017) http://observatorisalut.gencat.cat/ca/observatori-sobre-els-efectes-de-crisi-en-salut/indicador_socioeconomic_2015/#bloc3.

32. Jensen CD, Corley DA, Quinn VP, Doubeni CA, Zauber AG, Lee JK, et al. Fecal immunochemical test program performance over 4 rounds of annual screening: a retrospective cohort study. Ann Intern Med (2016) 164:456-63.

33. Cyhaniuk A, Coombes ME. Longitudinal adherence to colorectal cancer screening guidelines. Am J Manag Care (2016) 22:105-11.

34. Marteau TM, Kinmonth AL, Thompson S, Pyke S. The psychological impact of cardiovascular screening and intervention in primary care: a problem of false reassurance? British family heart study group. Br J Gen Pract (1996) 46:577-82.

35. Greuter MJ, Berkhof J, Canfell K, Lew JB, Dekker E, Coupe VM. Resilience of a FIT screening programme against screening fatigue: a modelling study. BMC Public Health (2016) 16:1009.

36. Steele RJ, McClements PL, Libby G, Black R, Morton C, Birrell J, et al. Results from the first three rounds of the Scottish demonstration pilot of FOBT screening for colorectal cancer. Gut (2009) 58:530-5.

37. Papin-Lefebvre F, Guillaume E, Moutel G, Launoy G, Berchi C. General practitioners' preferences with regard to colorectal cancer screening organisation colon cancer screening medico-legal aspects. Health Policy (2017) 121:1079-84.

Table 1. Colorectal cancer screening uptake per rounds.

Screening round number	Screening test	Number of BHA involved	Target population	Uptake†		Rescreening‡
				n	%	%
1 (Pilot)	**Guaiac**	11	63,872	11,005	17.2	
2 (Pilot)	**Guaiac**	12	66,519	14,816	22.3	73.2
3	**Guaiac**	12	65,142	17,742	27.2	87.0
4	**Guaiac**	10	50,199	15,135	30.2	87.3
	FIT	2	12,727	4,625	36.3	
5	**FIT**	12	63,824	22,981	36.0	89.7
6	**FIT**	12	60,906	23,325	38.3	88.7
7	**FIT**	12	61,428	23,366	38.0	81.2
Overall	**FIT or Guaiac**	12	131,862	48,974	37.2	83.7

BHA: Basic Healthcare Area (There are 12 BHA in L'Hospitalet); FIT: fecal immunochemical testing †Uptake: total number of people who have used and returned a screening test irrespective of result. This includes individuals with inadequate/incomplete results. ‡ Rescreening (Refers to two consecutive rounds): total number of people invited for screening in Round n and Round n -1 who participated in both rounds.

Uptake trend: The percentage change per screening round from 2000 to 2012 was 20.10 and from 2012 to 2017 was 0.98 (derived from Jointpoint regression analysis)

Table 2. Number of times invitees participated in the CRC screening program displayed for the number of times they were eligible.

		Number of Invitation							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Number of Participations	**0**	24,820	18,546	12,257	9,683	7,678	6,004	3,900	82,888
	1	3,920	3,472	2,334	1,797	1,781	1,441	938	15,683
	2		4,205	2,009	1,562	1,340	1,308	774	11,198
	3			2,680	1,748	1,358	1,222	692	7,700
	4				2,356	1,483	1,136	715	5,690
	5					2,200	1,446	769	4,415
	6						2,067	968	3,035
	7							1,253	1,253
Total		28,740	26,223	19,280	17,146	15,840	14,624	10,009	131,862
Consistently screened invitees*			**16.0%**	**13.9%**	**13.7%**	**13.8%**	**14.1%**	**12.5%**	**14.2%****

*Consistently screened invitees: being tested as many times as getting invited.

** When excluding Pilot Screening Rounds (Round 1 and Round 2), the overall percentage of consistently screened invitees is 20.9% (Supplementary table 1)

Table 3 Individuals invited to a CRC screening program by test used and number of invitations

Screening test*	Number of invitations	Individuals invited to screening program					
		Never screened		Inconsistent Screenees		Consistent Screenees	
		N	%	n	%	n	%
Guaiac*	**2**	19740	72.1	3556	13.0	4082	14.9
	3	15690	63.5	5495	22.2	3541	14.3
	4	13106	58.3	6327	28.2	3031	13.5
	All	48536	65.1	15378	20.6	10654	14.3
FIT**	**2**	5892	63.6	1309	14.1	2059	22.2
	3	4514	54.7	2208	26.8	1532	18.6
	4	470	45.9	325	31.7	230	22.4
	All	10876	58.7	3842	20.7	3821	20.6

FIT: faecal immunochemical testing

*Individuals who were offered guaiac were included in the analysis, irrespective of further invitation for FIT-based screened (n=74,568).

** Individuals who were offered FIT as the only screening test of choice (n=18,539)

Table 4. Participation and withdrawal according to the number of previous participations.

Number of previous invitations	Number of previous participations	Participation to the current round				All
		No		Yes		
		N	%	N	%	
		Never screened		Late adopters		
1	**0**	18546	92.4	1525	7.6	20071
2	**0**	12257	93.2	901	6.8	13158
3	**0**	9683	92.7	761	7.3	10444
4	**0**	7678	90.8	782	9.2	8460
5	**0**	6004	90.8	609	9.2	6613
6	**0**	3900	91.5	362	8.5	4262
		Quitters		Consistent Screenees		
1	**1**	1947	31.6	4205	68.4*	6152
2	**2**	503	15.8	2680	84.2	3183
3	**3**	279	10.6	2356	89.4	2635
4	**4**	185	7.8	2200	92.2	2385
5	**5**	174	7.8	2067	92.2	2241
6	**6**	78	5.9	1253	94.1	1331

Late adopters: individuals who enhance participation after ≥ 2 invitations; Quitters; individuals who discontinued screening for the next round; Consistent screenees; individuals who participate every time they get a screening invitation.

* When excluding Pilot Screening Rounds (Round 1 and Round 2), the percentage of consistent screenees after two invitations is 80.0%.

403 **Table 5.** Factors associated with continued participation and uptake in a population-based screening program for CRC.

	Continued participation		Uptake			
	Model 1. Consistent vs. Inconsistent screenees		Model 2. Inconsistent screenees vs. Never screened		Model 3. Screenees† vs. Never screened	
Independent variables	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Sex (ref men)	1.00		1.00		1.00	
Women	1.01	[0.97-1.06]	1.20	[1.16-1.24]	1.21	[1.17-1.24]
Age at first invitation (5-year change)	1.04	[1.01-1.07]	0.98	[0.96-1.00]	1.00	[0.99-1.02]
Deprivation index (10-point change)	0.98	[0.96-1.01]	0.88	[0.87-0.90]	0.87	[0.86-0.88]
Invitations number (ref 2)	1.00		1.00		1.00	
3 invitations	0.58	[0.54-0.61]	1.96	[1.87-2.05]	1.51	[1.46-1.57]
4 invitations	0.48	[0.45-0.52]	2.52	[2.38-2.67]	1.84	[1.76-1.93]
Type of test (ref Guaiac)	1.00		1.00		1.00	
FIT	0.68	[0.57-0.81]	1.68	[1.47-1.91]	1.38	[1.25-1.53]
Average participation at first invitation (1-percent change)	1.04	[1.03-1.05]	0.99	[0.98-1.00]	1.01	[1.00-1.01]

404 FIT: fecal immunochemical testing; OR: Odds Ratio; CI: Confidence interval. † Screenees includes both consistent and inconsistent screenees.

AACR American Association for Cancer Research

Cancer Prevention Research

Longitudinal adherence to Immunochemical fecal occult blood testing vs guaiac-based FOBT in an organized colorectal cancer screening program

Llúcia Benito, Noemie Travier, Gemma Binefa, et al.

Cancer Prev Res Published OnlineFirst March 19, 2019.