

1 Predictors of Intention Translation in Flexible Sigmoidoscopy Screening For Colorectal
2 Cancer

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28 **Objective**

29 This prospective study aimed to identify predictors of intention and subsequent attendance of
30 flexible sigmoidoscopy screening using constructs derived from the Health Belief Model
31 (HBM).

32 **Method**

33 4,330 people aged 54 and registered at one of 83 participating English General Practices
34 were sent a pre-invitation questionnaire to assess socio-demographics, HBM variables
35 including perceived benefits, barriers, seriousness, health motivation and external cues to
36 action) as well a range of other constructs and personal characteristics known to relate to
37 cancer screening.

38 **Results**

39 Of the 1,578 (36.4%) respondents, 1,555 (98.5%) answered the intention question: 52.9%
40 stated 'definitely yes', 38.1% 'probably yes', 6.8% 'probably not' and 2.2% 'definitely not'.
41 Intentions were positively associated with a higher score on a scale of benefits (Odds Ratio
42 [OR]: 4.62; 95% Confidence Intervals [CI]: 3.24-6.59) and health motivation, i.e. interest in
43 other ways of preventing CRC (OR: 2.61; 95% CI: 1.62-4.22), while a higher score on
44 perceived barriers (OR: 0.19; 95% CI: 0.12-0.31) and currently following recommended
45 healthy lifestyle behaviours (OR: 0.31; 95% CI: 0.16-0.59) were negatively associated.
46 Attendance was verified for 922 (65.2%) intenders of whom 737 (79.9%) attended.
47 Attendance was predicted by health motivation (OR: 1.75; 95% CI: 1.07-2.86), perceived
48 benefits (OR: 1.82; 95% CI: 1.37-2.43), perceived barriers (OR: 0.47; 95% CI: 0.32-0.69),
49 individual-level deprivation (OR: 0.26; 95% CI: 0.14-0.50) and having diabetes (OR: 0.48;
50 95% CI: 0.25-0.94).

51 **Conclusion**

52 This study supported the usefulness of the HBM in predicting cancer screening and was
53 further enhanced by adding non-HBM variables such as individual socioeconomic
54 deprivation and co-morbidities.

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56 **Keywords:** Cancer screening, flexible sigmoidoscopy, prospective questionnaire, intentions,
57 attendance, Health Belief Model

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64 In 2010, shortly after the publication of the 10-year follow-up data from the UK
65 Flexible Sigmoidoscopy Screening Trial (UKFSST), the English government announced the
66 introduction of flexible sigmoidoscopy screening as part of the existing NHS Bowel Cancer
67 (Colorectal, CRC) Screening Programme (BCSP). Following a pathfinder study in 2013
68 (Bevan, Rubin, Sofianopoulo, Patnick & Rees, 2014), FS screening began to roll out, known
69 as bowel scope screening (BSS). BSS is a one off FS screening test offered to adults aged 55
70 who are registered with a primary care practitioner. No further bowel screening invitations
71 are then offered until the age of 60 when they are then transferred into the guaiac faecal
72 occult blood test part of the English BCSP (biennial invitations). The swiftness with which
73 FS was adopted reflected the dramatic potential public health benefits documented by Atkin
74 and colleagues (Atkin et al., 2010), which has been further supported by more recent follow-
75 up data at 17 years (Atkin et al., 2017), as well as several other trials in other countries (e.g.
76 US, Italy and Norway; Schoen et al., 2012; Segnan et al., 2011; Hoff, Grotmol, Skovlund &
77 Bretthauer, 2009).

78 Despite the fact that a once only FS screening test was found to halve CRC mortality
79 and even reduce incidence by 32%, uptake has been low (Elmunzer et al., 2012). Within the
80 first 14 months of the launch of BSS, uptake was 43% (McGregor et al., 2016a) thus making
81 it the only organised NHS screening programme with less than 50% participation. By
82 comparison recent uptake of cervical and breast screening in England has been reported to be
83 around 70% (Public Health England 2017; Health and Social Care Information Centre, 2018).
84 International data on uptake from trials of FS screening range between 32% in the
85 Netherlands (Hol et al., 2010) to 65% in Norway (Hoff et al., 2009).

86 Low uptake is further compounded by social inequalities including a socioeconomic
87 gradient, with uptake ranging from 33-53% in the most and least deprived quintile in England
88 respectively (McGregor et al., 2016a). This finding was consistent with a socioeconomic

89 gradient which has consistently been observed in uptake of the FOB test (von Wagner et al.
90 2011; Hirst et al., 2018). There is also a substantial difference between areas with the
91 highest level of ethnic diversity compared with less diverse areas (39 vs 41-47%), and a
92 significant gender difference, with men being more likely to attend than women (45% vs.
93 42%) (McGregor et al., 2016a).

94 The significance of low uptake cannot be underestimated. Low uptake substantially
95 reduces the potential public health benefit associated with the test (Geurts, Massat & Duffy,
96 2015) and undermines its cost-effectiveness. It is therefore not surprising that there has been
97 considerable effort at trying to understand factors associated with uptake of BSS (Hall et al.,
98 2016), and attempts to improve uptake (Kerrison et al., 2017; Kerrison et al., 2018;
99 McGregor et al., 2016b).

100 In terms of identifying determinants of uptake, the UKFSST identified several factors
101 associated with intention to participate in FS screening, including the lack of immediate
102 benefits, negative consequences of participation (e.g. anticipated pain and embarrassment)
103 and cancer fear and fatalism (Power et al., 2008). Attendance in the UKFSST (which was
104 limited to those with high intention) related more strongly to deprivation and stress (Power et
105 al., 2008).

106 In a recent review of the literature concerning factors associated with FS use as a
107 screening test worldwide, factors most commonly found to have a positive association with
108 uptake included low deprivation, male gender, and a family history of CRC, in addition to
109 perceiving there to be low barriers and high benefits to doing the test (Kerrison et al., 2019).

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111 Furthermore, a qualitative study into BSS attendance has identified a perceived or
112 actual lack of need to have the test, a lack of understanding of the benefits and harms of the

113 test, and more practical barriers such as the inability to make appointments (Hall et al., 2016).
114 Yet current quantitative evidence is limited to studies of the UKFSST, while the only
115 evidence from the BSS branch of the BSCP so far has been retrospective. For example, a
116 recent survey identified overall pain and embarrassment to be the most commonly cited
117 barriers to BSS participation among those who never responded to their invitation, and
118 practical and appointment related reasons among those who had initially confirmed their
119 appointment but subsequently failed to attend (von Wagner et al., 2018). While informative,
120 retrospective research suffers from fundamental flaws, most prominently the possibility that
121 reported barriers are post-hoc rationalisations rather than genuine reasons for non-attendance
122 (Waller, Bartoszek, Marlow & Wardle, 2009).

123 The present study used a large prospective survey with adults who were soon to be
124 invited for screening. Of the relatively few studies that have explored psychological
125 determinants from a theoretical perspective, most have used the Health Belief Model (HBM;
126 Becker, Haefner and Maiman, 1977). The HBM is a behaviour change model which
127 stipulates that engagement in health actions is influenced by people's beliefs about the
128 underlying illness or health problem (i.e. perceived susceptibility to, and severity of, the
129 health threat), and behaviour specific cognitions and perceptions (i.e. perceived benefits and
130 barriers). In addition, the model was subsequently extended by adding non-core constructs
131 including internal and external prompts which act as 'cues to action' and a person's general
132 motivation to look after their health was a later addition to the model (Becker, Haefner and
133 Maiman, 1977; Abraham and Scheeran, 2015). Constructs such as perceived benefits and
134 barriers have been found to explain a large proportion of variance in people's motivation (or
135 intention) to participate in cancer screening (Kiviniemi, Bennett, Zaiter & Marshall, 2011).
136 As a result we used items to assess the components of the HBM in relation to colorectal
137 cancer screening as the core of our survey.

138 In addition, the survey aimed to assess selected non HBM constructs which have been
139 previously shown to influence behaviour, specifically fatalistic beliefs and knowledge of risk
140 factors and external circumstances including both individual level and area level deprivation,
141 and overall health, which have been identified as being directly associated with people's
142 ability to translate their intention into action (Power et al., 2008). Socioeconomic deprivation
143 (i.e. the absence or lack of basic material benefits and resources considered necessary to
144 function normally in society) has been repeatedly associated with health behaviours. In brief,
145 being more deprived makes people more likely to engage in unhealthy behaviours while the
146 opposite is the case for healthy behaviours (Pampel, Krueger, Denney, 2010). The latter has
147 been clearly demonstrated in the case of colorectal cancer screening where (as described
148 above) there is a strong link between socioeconomic status with screening attendance,
149 including the NHS Bowel Scope Screening programme (von Wagner et al., 2011; McGregor
150 et al., 2016). The importance of documenting socioeconomic inequalities has also been well
151 documented as socioeconomic differences in uptake will widen socioeconomic inequalities in
152 colorectal cancer outcomes (Haggard & Boushey, 2009; von Wagner et al, 2011).

153 We also explored the role of two specific chronic illnesses as there is emerging evidence of
154 the complex role of chronic illness on cancer screening and symptomatic help seeking (Renzi,
155 Kaushal, Hamilton ...Lyratzopoulos, in press). While respondents with an inflammatory
156 bowel disease such as Crohn's disease were excluded from the study because they would
157 have been ineligible for BSS screening, we were keen to ascertain whether a self-disclosed
158 diagnosis of irritable bowel syndrome would affect BSS attendance. In addition, we wanted
159 to explore the role of diabetes. Having diabetes has been found to be a significant risk factor
160 for colorectal cancer, yet can also be a significant barrier to screening attendance (Bell,
161 Shelton & Paskett, 2001; McBean & Yu, 2007; Zhao et al., 2009; Porter et al., 2016) As
162 evidence for this is currently not consistent (Porter et al 2016; Wilkinson & Culpetter, 2011)

184 **Procedures and Materials**

185 Overall 4,330 eligible patients were assigned unique study IDs to keep the
186 questionnaires anonymous and sent study invitation packs, which contained a GP cover letter,
187 an 8-page questionnaire booklet, and a freepost return envelope addressed to the researchers.
188 Docmail Ltd, a hybrid online mailing company, was employed for the printing, assembling
189 and delivery of the study invitation packs.

190 The GP cover letter contained a short explanation of the study and encouraged
191 recipients to return the questionnaire, either completed or not, using the freepost return
192 envelope. All participants were informed that by returning a completed questionnaire they
193 were providing consent for their data to be used in this study. A reminder letter was sent at
194 two (with new copy of questionnaire) and four (letter only) weeks to individuals who did not
195 return a questionnaire. Such individuals were identified by each practice through elimination
196 of study ID numbers on returned questionnaires. Completed questionnaires were returned for
197 analysis between June 2015 and July 2016. In line with the stipulation by our funding body
198 (see funding statement), we did not provide any incentive or compensation for questionnaire
199 completion.

200 **Questionnaire**

201 ***Outcome variables.*** A participant's intention to attend screening when invited was
202 assessed during questionnaire completion with a single question: 'Do you think you will take
203 up the offer when invited to have the test (bowel scope screening)?' with the following
204 response options: '*definitely not*', '*probably not*', '*yes probably*' and '*yes definitely*'

205 Hypothesis 1 (*H1*). A recent retrospective study of BSS attendance demonstrated that
206 initial interest in bowel scope screening was 95% (von Wagner et al., 2018) so we

207 hypothesised that a majority of survey respondents would initially intend to take part in
208 Bowel Scope Screening.

209 While intention is often used as a proxy for behaviour, we were able to subsequently
210 and objectively measure behaviour, i.e. screening attendance, for a number of participants...
211 Screening attendance information was requested from the Bowel Cancer Screening System
212 for participants who noted their permission for this on their returned questionnaire. In
213 addition to permission, personal information i.e. full name, date of birth and postcode was
214 also required from the participant to fulfil this task. Attendance was then dichotomised into
215 'yes' and 'no'.

216 ***Core HBM variables.*** Fifteen items derived from the existing literature (Champion,
217 1984; Wolf et al., 2001; McCaffery et al., 2001) were included in the survey. The items
218 reflected attitudes towards CRC and screening and were influenced by constructs of the
219 HBM:-barriers/costs to screening (e.g. 'I think the test would be painful'); benefits of the
220 screening test (e.g. 'I think that the test would reduce my chances of getting bowel cancer');
221 perceived susceptibility to cancer (e.g. I am at risk of getting bowel cancer in the future);
222 perceived severity of bowel cancer (i.e. bowel cancer has serious consequences). Each item
223 had five response options: '*strongly disagree*', '*disagree*', '*not sure*', '*agree*', '*strongly*
224 *agree*'.

225 Using an iterated principle factor analysis with varimax rotation (accepting factor
226 loadings of more than 0.300), we merged twelve of the fifteen items into three factors: 1)
227 perceived benefits of the test (five items, Cronbach $\alpha=0.71$; e.g., 'test would be important'),
228 2) perceived barriers (four items, Cronbach $\alpha=0.64$; e.g., 'test would be painful') and 3)
229 perceived susceptibility to bowel cancer (three items, Cronbach $\alpha=0.63$; e.g., 'I am at risk of
230 getting bowel cancer'). Perceived seriousness did not fall within the factor structure but was

231 measured by a single item ('I believe that bowel cancer has serious consequences'). A mean
232 score was calculated for each of the three multi-item factors and scores for all four factors
233 were used as continuous variables for the regression analysis.

234 ***Non-core HBM variables.*** We also measured two non-core HBM constructs that did
235 not form part of the original Health Belief Model, namely 'health motivation', and 'cues to
236 action' with single items. Both were treated as dichotomous variables for the analysis.

237 *Health motivation.* This was measured with the question, 'How interested are you in
238 getting information about other, non-screening, ways in which you could reduce your risk of
239 getting bowel cancer?'. Responses were given on a 4-point Likert scale: '*not at all*',
240 '*somewhat*', '*moderately*', '*very*'.

241 *Cues to action.* For a measure of external 'cues to action', we asked respondents to
242 indicate if they knew somebody who has ever had bowel cancer with 6 options provided:
243 *partner, close friend, other friend, family member (blood relative), family member (non-blood*
244 *relative) or unsure.* Responses were divided into 'Family history of bowel cancer' (blood
245 relatives vs no blood relatives or unsure) and 'Friend/non-blood relative with history of
246 bowel cancer' (friends and non-blood relatives vs no friend/relative with history of bowel
247 cancer or unsure) so as to distinguish cues as either a potential hereditary link to bowel cancer
248 compared to knowledge of another's personal experience.

249 *H2:* In accordance with the HBM, we hypothesised that screening attendance would
250 be predicted by higher perceived benefits, perceived susceptibility, perceived seriousness,
251 and health motivation. In addition, knowing someone with the disease ('cue to action') would
252 also be predictive of screening attendance. Conversely, we predicted that higher perceived
253 barriers would be negatively associated with attendance.

254 ***Non-HBM variables.*** We added questions to measure theoretical constructs not
255 linked to the HBM i.e. fatalism and knowledge.

256 *H3.* We hypothesised that better knowledge of risk factors would be positively
257 associated with bowel cancer screening attendance and that stronger fatalistic beliefs would
258 be negatively associated with attendance.

259 *Fatalism.* The items ‘Getting bowel cancer is like a death sentence’ and ‘There is
260 nothing I can do to stop myself getting bowel cancer’ where both treated as representing
261 different aspects of fatalistic beliefs about colorectal cancer. Responses for both items were
262 provided on a 5 point scale from ‘*Strongly disagree*’ to ‘*Strongly agree*’. Each one was
263 entered individually as a continuous variable for the analysis.

264 *H4:* We hypothesised that higher scores on fatalism would be negatively associated
265 with screening attendance.

266 *Knowledge of risk factors.* We calculated a knowledge score using 13 identified risk
267 factors for bowel cancer (e.g. being overweight, having a diet high in red and processed meat)
268 (Hagggar & Boushey, 2013; Peeters, Bazelier, Leufkens, de Vries, & De Bruin, 2015). Each
269 item had three response options: increases the risk; makes no difference; decreases the risk.
270 Individuals were given a point for every correct answer. Scores ranged from 0 to 13, with
271 high scores indicating better knowledge of CRC risk factors.

272 *H5:* We hypothesised that higher knowledge scores would be positively associated
273 with Bowel Scope Screening attendance.

274 ***Health and lifestyle variables***

275 *Health behaviours.* We assessed if individuals reporting eating at least 5 portions of
276 fruit/vegetables per day (7 point scale; ‘Less than 1 per week’ to ‘3 or more per day’ for fruit

277 and vegetables separately) and how often they partake in at least 30 minutes of exercise of
278 moderate activity (5 point scale; 'Never/Cannot exercise' to 'Everyday). We additionally
279 included a question on current smoking habits (never smoked; ex-smoker; smoker; reversed
280 scored). Individuals were considered to be following recommendations if they indicated they
281 ate 5 or more pieces of fruit/veg per day, exercised for a minimum of 30 minutes at least 5
282 days a week, and were a non-smoker.

283 *H6:* We hypothesised that those who followed all recommendations would be more
284 likely to attend bowel cancer screening, in view that bowel cancer screening is a
285 'recommendation' from the NHS.

286 ***External/circumstantial variables.***

287 *Sociodemographic items.* This included gender (*male; female*), marital status (*single;*
288 *married; cohabiting/ living with partner; divorced/ separated; widowed*), ethnicity (*White*
289 *British; other*), and employment status (*employed full-time; employed part-time; self-*
290 *employed; unemployed; full-time homemaker; retired; student; disabled or too ill to work*).
291 Age (*in years*) was requested as an open response.

292 *Individual-level socioeconomic status.* This was derived from three demographic
293 questions on having a formal education and home and car ownership. Individuals were given
294 a point if their household did not own a car or van, they had no formal qualifications and they
295 did not own their own home. Scores, therefore, ranged from 0 to 3 with high scores indicating
296 higher levels of social deprivation.

297 *Area-level measure of socioeconomic status.* The Index of Multiple Deprivation
298 (IMD), was derived from participants' postcode in order to compare respondents and non-
299 respondents. The IMD is a classification that uses area-based items such as income,
300 employment, health and disability, education, skills and training, barriers to housing and

301 services, crime and living environment (Department for Communities and Local
302 Government, 2011). On the basis of previous evidence we hypothesised a negative
303 association between attendance and individual level markers of deprivation.

304 *Health status.* We assessed self-rated health status with the question ‘Would you say
305 that for someone your age, your health in general is excellent; good; fair; or poor. We
306 anticipated that those who reported excellent or good health would be less likely to attend
307 screening in line with the commonly noted barrier to screening of not feeling it is personally
308 needed (Palmer, Thomas, von Wagner, Raine, 2014).

309 *Co-morbidities.* We asked respondents to report if they had ever been diagnosed with
310 irritable bowel syndrome (IBS) or diabetes. Conversely to feeling healthy, we hypothesised
311 that being diagnosed with IBS would predict screening attendance as the condition is
312 associated with colorectal cancer related symptoms. With regard to diabetes, we anticipated a
313 negative relationship with attendance in line with previous research (Porter et al., 2019).

314 We also asked respondents to indicate if they had had a diagnosis of colorectal cancer,
315 ulcerative colitis, Crohn’s disease and diverticular disease so that we could exclude them
316 from the analysis as they were likely to be receiving care that involves regular colonoscopies
317 and therefore would not be eligible for bowel scope screening.

318

319 **Analysis**

320 We analysed intention and attendance data separately. Using responses to the
321 intention question, we classified respondents as either ‘intenders’ (‘yes definitely’ or ‘yes
322 probably’), or ‘non-intenders’ (‘probably not’ or ‘definitely not’). Owing to the high
323 proportion of intenders among our sample, we focused exclusively on intenders in our
324 prospective analysis of screening attendance. Intenders were further classified as ‘attendees’

325 if they had agreed for their screening records to be checked and the records subsequently
326 confirmed that they had successfully attended BSS. They were classified as ‘non-attenders’ if
327 their records showed that they had not attended. See Figure 1 for a flow diagram of study
328 participation.

329 In the first set of analyses, we examined differences between non-intenders and
330 intenders in a series of Chi-square tests for categorical and ANOVA for continuous variables
331 respectively. Significant predictors were then included in an adjusted logistic regression.

332 In the second set of analyses, we focused on identifying prospective predictors of
333 attendance among intenders only. To this end, we again explored the data for differences
334 between attenders and non-attenders using Chi-square for categorical and ANOVA for
335 continuous variables respectively. We then conducted unadjusted logistic regressions
336 followed by adjusted regression containing significant predictors (at $p \leq 0.05$) at the
337 univariate level. All statistical analysis was conducted with Stata/SE version 15.1 (StataCorp
338 LP, College Station, TX).

339 Results

340 The questionnaire was sent to 4,330 eligible individuals with 1,688 (39.0%) returning
341 a questionnaire that was at least partially completed. Questionnaire respondents were more
342 likely to be female than male (41.4% vs 36.6%, $\chi^2(1, N=4,329) = 10.83, p=0.001$). Those
343 who completed and returned a questionnaire were more likely to live in an area with low
344 deprivation (i.e. in the first quintile 27.8% vs 17.4%, $\chi^2(4, N=4,024) = 128.58, p<0.001$).

345 Among those who returned a completed questionnaire, 110 (6.5%) were removed
346 from the analysis due to the reported age being outside the study eligibility (i.e. below 54 or
347 above 56) or a diagnosis of Ulcerative colitis, Diverticular disease, Crohn’s disease or bowel
348 cancer was noted, rendering the individual ineligible for screening. Of the questionnaire

349 respondents included in the final analysis (N=1,578), the majority were female (53.4%),
350 married or cohabiting (88.4%), white (92.1%) and were living in the least deprived quintile of
351 deprivation (28.0%).

352 **Non-intenders vs intenders**

353 Among the 1,555 (98.5%) respondents for whom intention was recorded, 1,415
354 (91.0%) were classified as intenders and 140 (9.0%) as non-intenders. Tables 2a and 2b show
355 a comparison of non-intenders and intenders. Mean and standard deviations are displayed for
356 continuous attitude items. Variables such as ethnicity, working status and health status were
357 dichotomised due to low frequencies.

358 Variables that were statistically significant in unadjusted logistic regressions were
359 carried forward into in an adjusted model (see Table 3). Intention to do the screening test was
360 positively associated with scoring higher on a scale of perceived benefits (OR: 4.62; 95% CI:
361 3.24-6.58) and health motivation, (OR: 2.61.; 95% CI: 1.62-4.22). Conversely, scoring higher
362 on a scale of perceived test barriers (OR: 0.19; 95% CI: 0.12-0.31) and following
363 recommendations for a healthy lifestyle (OR: 0.31; 95% CI: 0.16-0.59) were negatively
364 associated with intention.

365 **Verification of attendance**

366 1,342 (85.0%) participants gave permission for researchers to access their screening
367 records (using their first and last name, date of birth and postcode) via the NHS Bowel
368 Cancer Screening system: 236 (15.0%) explicitly declined. There were no sociodemographic
369 differences in terms of ethnicity, gender, deprivation or working status between those who
370 did and did not give permission. 922 (72.3%) of those who intended and gave permission
371 could successfully be matched to screening records (screening records were examined in
372 March 2017, 8-21 months post questionnaire completion). There were no relevant statistically

373 significant sociodemographic or intentional differences between those who could be matched
374 or those who could not.

375 **Predictors of attendance among intenders**

376 Of the 922 intenders with verified attendance, 737 (79.9%) successfully completed
377 BSS screening while 185 (20.1%) did not. Tables 4a and 4b show the differences between
378 non-attenders and attenders among intenders. A multivariate analysis of the variables with
379 significant between group differences (see table 5) confirmed that with regard to core HBM
380 variables, scoring lower on a scale of perceived barriers (OR: 0.47; 95%CI: 0.32-0.69) and
381 higher on perceived benefits of the test (OR: 1.82; 95% CI: 1.37-2.43) predicted attendance,
382 as did having high motivation to find out about other non-screening CRC prevention methods
383 (OR: 1.75; 95% CI: 1.07-2.86). This was independent of other predictors including being in
384 the least deprived category of individual deprivation and reporting diabetes.

385 **Discussion**

386 This prospective survey of predictors of attendance at bowel scope (flexible
387 sigmoidoscopy) screening highlights the value of several HBM variables. While our analysis
388 of intention was limited by the large majority of respondents intending to have the test, it was
389 noteworthy that the pattern of results was similar for intention and action. Two core
390 constructs of the HBM, perceived benefits and perceived barriers of the test, emerged as
391 important predictors for not only intention but additionally for action within intenders,
392 suggesting that the reduction of perceived barriers and continued communication of the
393 benefits are needed throughout the screening invitation and appointment process. From
394 previous retrospective work we know that the specific barriers to screening differ for those
395 classified as non-responders to the screening invitation, decliners of the invitation and those
396 who intend to go but then do not attend: from emotive to more practical barriers (von Wagner

397 et al, 2019). However, the benefits of being screened are likely more consistent across the
398 invitation process. Even within intenders there is room to further promote benefits of
399 screening to ensure action/attendance is likely.

400 For the other two core HBM variables, perceived susceptibility and seriousness, a
401 different story emerged. Perceived seriousness was not a predictor for either intention or of
402 subsequent action, perhaps highlighting that the seriousness of CRC is an accepted position
403 for the general public. While a significant difference in 'Perceived susceptibility' was found
404 between intenders and non-intenders (low susceptibility) this disappeared in the adjusted
405 model, suggesting that a heightened perceived personal risk of CRC is already accounted for
406 within another variable, possibly perceived benefits (e.g. feeling the test would reduce
407 chances of getting bowel cancer). Following this, perceived susceptibility was also not a
408 predictor of action.

409 Health motivation is a less well studied aspect of the HBM, but was found to be
410 influential to both screening intentions and behaviour. In this study, interest in finding out
411 more about non-screening ways to prevent CRC was strongly associated with BSS
412 attendance, perhaps suggesting that promoting this specific test should become part of a
413 wider conversation about CRC prevention, and more specifically improving bowel health.
414 This would be as a supplement to encouraging general healthy lifestyle choices such as non-
415 smoking, eating 5 pieces of fruit and vegetables a day, and exercising for at least 30mins for a
416 minimum of 5 days a week. Not following such lifestyle recommendations was found to be a
417 predictor of intention only. As motivation to know more about preventing CRC continued to
418 be a predictor of attendance, more specific education for CRC prevention may be required.

419 Of particular interest is the importance of individual-level deprivation and a diagnosis
420 of diabetes in bridging the gap between intention and attendance at screening. Individual-

421 level deprivation was negatively associated with both intention and attendance and while it
422 was explained by another variable included in our final multivariate models for intention, it
423 was found to be an independent predictor of attendance. This finding maps on to
424 epidemiological studies looking at uptake of BSS (McGregor et al., 2016). However, much
425 less is known about why deprivation is associated with either material or psychological
426 barriers. Our own research has identified that at least some of this relationship can be
427 explained by differences in time perspective and the willingness or ability to ensure short-
428 term costs associated with having the test in return of longer-term gains (Whitaker et al,
429 2011). This is particularly relevant as bowel scope screening is associated with a number of
430 so-called opportunity costs or indirect costs such having to take time off work, travel to the
431 clinic, having to prepare the bowel and the discomfort associated with the procedure.

432 Furthermore, the results support recent interest in people with co-morbidities. Our
433 finding on the role of diabetes as a barrier to attendance was in support of earlier research
434 (e.g. Bell, Shelton & Paskett, 2001) but at odds with current evidence from North America
435 which found that people with diabetes are more likely to undergo colorectal cancer screening
436 and that the relationship is likely to be moderated by how well patients can control their
437 diabetes (Porter et al 2016; Wilkinson & Culpetter, 2011). As such, it is important to better
438 understand the exact role living with diabetes plays. For example, our finding highlights that
439 one should review bowel cancer risk awareness among diabetic patients and the extent to
440 which there are specific barriers that might prevent informed decision making in this group.

441 In contrast to findings reported in a highly cited paper on the intention-behaviour gap
442 in the UK FS trial by Power and colleagues (Power et al., 2008), we found that attendance
443 was predicted by a combination of motivational barriers rather than more upstream and less
444 modifiable barriers such as socioeconomic / area deprivation, and poor health status. Our
445 findings suggest that in this programme even those who intend to do the test would therefore

446 benefit from more education about the benefits of the test and how to overcome anticipated
447 barriers.

448 The finding that following recommendations for healthy behaviours is negatively
449 associated with intention to be screened was counterintuitive as one would expect people
450 with a healthy lifestyle to be more health conscious. However, qualitative literature on
451 reasons for non-attendance has highlighted that people who lead healthy lifestyles often use
452 this as a reason why they do not need to go for cancer screening (McCaffery et al 2001). Our
453 finding suggests that more needs to be done to communicate that screening is for the entire
454 screening-eligible population, regardless of health status and lifestyle. In addition, there is an
455 urgent need to address modifiable barriers. However, it is also important to note that future
456 research should try and identify predictors of attendance in the entire screening eligible
457 population to capture the difference between other sub-groups such as disinclined attenders
458 and disinclined non-attenders.

459 Barriers were grouped together for our analysis, but included perceived
460 embarrassment and pain. Embarrassment, for example, could be addressed by making same-
461 sex practitioners more widely available. Anticipated pain could be addressed by emphasising
462 the option to use Entonox, a pain relief gas, during the procedure.

463 While it is important to emphasise that FS screening is offered for free in England,
464 and employs an organised and population-based process of invitation so theoretically
465 everyone in our sample had equal opportunities to attend, participation still involves indirect
466 costs such as preparation, travel and waiting time.

467 The fact that we could not fully explain uptake with our variables suggests that other
468 factors may be at play (29% and 11% of the variance was explained for intentions and
469 attendance respectively). Previous evidence has suggested consideration of future

470 consequences (CFC) and fatalism (von Wagner, Good, Smith, & Wardle, 2012; Whitaker,
471 Good, Miles, Robb, Wardle & von Wagner 2011). In our study, we did not find fatalistic
472 beliefs to be significant independent predictors of attendance. To better understand the role of
473 SES, alternative measures, specifically geospatial and consumer information could add
474 important insights and provide richer data about contextual determinants of screening uptake.
475 As with diabetes, low SES in itself is associated with an increased risk of developing and
476 dying from bowel cancer (Doubeni et al., 2012) and so deserves further attention when trying
477 to optimise BSS delivery and uptake.

478 Our study had several limitations. Despite the use of two reminders, response to the
479 questionnaire was 39%, which introduced an important selection bias, evident in the
480 proportion of intenders and attenders and low overall SES distribution and lack of ethnic
481 diversity in our sample. As a result our research may have left out some of those at risk of
482 failing to attend screening. This limits our ability to make definitive conclusions about the
483 relative importance of our predictors, and perhaps more importantly means that variables
484 which are associated with BSS attendance did not emerge in our analysis. In our effort to
485 make the questionnaire acceptable we were also unable to include all potential predictors of
486 uptake and to explore their role as potential mediators of socio-demographic patterns
487 observed in FS screening. While we obtained consent from 85% of participants to access
488 personal screening records, we could only verify and match with intention, 73% of them. The
489 remaining 27% either provided inaccurate or ineligible details on full name, date of birth and
490 postcode (which were required to match their NHS records). Furthermore, there was no
491 adequate measure capturing potential attitudes towards FS screening that would have
492 adequately captured the organisation and context of the new BSS programme. While we
493 conducted a factor analysis, we did not have the ability to test the reliability of the structure
494 by testing it on another sample. Finally, our analytical approach focused on identifying direct

495 associations between each possible explanatory and outcome variables. This approach did not
496 account for the relationships between exploratory variables and the indirect effects of
497 variables. Future research using mediation analysis could identify indirect links.

498 Notwithstanding its limitations, this study also had many important strengths. Most
499 importantly, the fact that we were able to capture prospective predictors rather than
500 retrospective correlates of uptake. The benefits of this have been well documented in the
501 literature (Vandenbroucke, 2008) and this study adds important weight to raising awareness
502 of the importance of perceived barriers, which can often be difficult to interpret in the context
503 of non-attenders retrospectively reflecting on the reasons why they did not take up the
504 invitation for screening (Waller, Bartoszek, Marlow & Wardle, 2009). Another strength was
505 our ability to verify uptake rather than relying on self-report.

506 This prospective study provided contrasting findings from the UK FSST, by finding
507 attendance to be predicted by a range of attitudinal and psychosocial factors including
508 perceived importance and test-specific barriers. This suggests more needs to be done to
509 educate the public about the value of the test, and where possible reduce anticipated barriers
510 such as embarrassment.

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Table 1 Classification of the attitudinal variables

Original variable/question	Variable / Construct	Cronbach α
Core HBM variables		
I think the test would be important to do		
I think the test would give me peace of mind		
I think the test would reduce my chances of getting bowel cancer	Perceived benefits	0.71
I think the test would reduce my chances of dying from bowel cancer		
I think the test would be painful		
I think the test would take too much time		
I think the test would be embarrassing	Perceived barriers	0.64
I think the test would be unnecessary if I did not have any symptoms		
I think the enema would be off-putting		
I am at risk of getting bowel cancer in the future		
I am more likely than the average person of my age and gender to get bowel cancer	Perceived susceptibility	0.63
I am worried about getting bowel cancer		
I believe that bowel cancer has serious consequences	Perceived severity	-
Non-Core HBM		
Have any of the following people ever had bowel cancer (blood and non-blood relatives and friends)	Cues to action	
How interested are you in getting information about other ways (not screening) of reducing your chance of getting bowel cancer?	Health motivation	
Non-HBM beliefs		
Getting bowel cancer is like a death sentence	Fatalism (death)	-
There is nothing I can do to stop myself getting bowel cancer	Fatalism (control)	-

Table 2a Difference in knowledge, attitudes and beliefs among non-intenders and intenders (univariate analysis) †

	Non-intenders (N=140)		Intenders (N=1,415)		p-value*
	Mean	(SD)	Mean	(SD)	
Core HBM variables					
Perceived benefit	2.43	(0.67)	3.03	(0.62)	<0.001
Perceived barriers	2.11	(0.52)	1.82	(0.49)	<0.001
Perceived susceptibility	1.90	(0.66)	2.13	(0.68)	0.001
Perceived seriousness	3.32	(0.99)	3.44	(0.86)	0.146
Non HBM variables					
Fatalistic belief (death)	1.82	(1.05)	1.92	(1.04)	0.290
Fatalistic belief (control)	1.22	(0.93)	1.20	(0.88)	0.796
Knowledge of risk factors	9.62	(2.42)	9.61	(2.22)	0.971

*The p-values are derived from ANOVA

† Only eligible sample (i.e. without bowel cancer, ulcerative colitis, diverticular disease or Crohn's disease for whom screening status could be verified).

Table 2b Difference among non-intenders and intenders (univariate analysis) †

	Non-intenders (N=140)		Intenders (N=1,415)		p-value*
	N	(%)	N	(%)	
Non-Core HBM constructs					
Cues to action					
Family history of bowel cancer					
No/unsure	124	(9.78%)	1144	(90.22%)	0.025
Yes	16	(5.57%)	271	(94.43%)	
Friend/non-blood relative with bowel cancer					
No/unsure	110	(9.47%)	1052	(90.53%)	0.272
Yes	30	(7.63%)	363	(92.37%)	
Health motivation					
Interest in non-screening prevention methods					
Not at all/somewhat	49	(21.59%)	178	(78.41%)	<0.001
Moderately/very	87	(6.61%)	1229	(93.39%)	
Health and lifestyle variables					
Health behaviours					
Not following recommendations	115	(13.00%)	1312	(91.94%)	<0.001
Following recommendations	22	(20.37%)	86	(79.63%)	
External/circumstantial variables					
Sociodemographic details					
Self-stated age					
54 years	113	(9.33%)	1098	(90.67%)	0.397
55 years	27	(7.85%)	317	(92.15%)	
Gender					
Male	63	(8.68%)	663	(91.32%)	0.675
Female	77	(9.29%)	752	(90.71%)	
Living condition					
Married/cohabiting	116	(8.45%)	1257	(91.55%)	0.031
Single/divorced/widowed	24	(13.33%)	156	(86.67%)	
Ethnicity					
White	131	(9.21%)	1292	(90.79%)	0.468
Other	9	(7.26%)	115	(92.74%)	
Paid work					
No	31	(13.54%)	198	(86.46%)	0.007
Yes	105	(8.02%)	1204	(91.98%)	
Area level deprivation (IMD quintiles)					
Least deprived	33	(8.07%)	376	(91.93%)	0.089
2 nd	29	(7.99%)	334	(92.01%)	
3 rd	21	(7.32%)	266	(92.68%)	
4 th	22	(9.78%)	203	(90.22%)	
Most deprived	25	(14.29%)	150	(85.71%)	
Individual deprivation markers					
0 (least deprived)	98	(8.51%)	1054	(91.49%)	<0.001
1	19	(7.17%)	246	(92.83%)	
2-3	21	(20.19%)	83	(79.81%)	
Health status					

Poor/fair	43	(10.26%)	376	(89.74%)	0.279
Good/excellent	95	(8.49%)	1024	(91.51%)	
Comorbidities					
Irritable bowel syndrome					
No	119	(8.85%)	1225	(91.15%)	0.604
Yes	21	(9.95%)	190	(90.05%)	
Diabetes					
No	131	(8.91%)	1339	(91.09%)	0.600
Yes	9	(10.59%)	76	(89.41%)	

† Only eligible sample (i.e. without bowel cancer, ulcerative colitis, diverticular disease or Crohn's disease).

*The p-values are derived from Chi-square tests of independence

Note that missing cases are not reported, so that the column frequencies do not always sum up to the total stated at the top of the table.

Table 3 Unadjusted and adjusted logistic regression on intending to do the test

	Unadjusted models		Adjusted model	
	Odds ratio	CI	Odds ratio	CI
Core HBM constructs				
Perceived benefits	3.687	2.783 - 4.886**	4.615	3.237 - 6.581**
Perceived barriers	0.282	0.191 - 0.417**	0.194	0.121 - 0.312**
Perceived susceptibility	1.694	1.297 - 2.213**	1.352	0.954 - 1.917
Non-core HBM variables				
Cues to action				
Family history of bowel cancer				
No	Ref.		Ref.	
Yes	1.836	1.073 - 3.142*	1.187	0.615 - 2.291
Health motivation				
Interest in non-screening prevention methods				
Not at all/somewhat	Ref.		Ref.	
Moderately/very	3.889	2.649 - 5.708**	2.612	1.617 - 4.220**
Health and lifestyle variables				
Health Behaviours				
Not following recommendations	Ref.		Ref.	
Following recommendations	0.343	0.207 - 0.568**	0.311	0.164 - 0.590**
External/circumstantial variables				
Sociodemographic variables				
Living condition				
Married/cohabiting	Ref.		Ref.	
Alone	0.600	0.375 - 0.960*	0.732	0.379 - 1.414
Paid work				
No	Ref.		Ref.	
Yes	1.795	1.170 - 2.754**	1.316	0.724 - 2.395
Individual Deprivation				
0 markers (least deprived)	Ref.		Ref.	
1 marker	1.204	0.723 - 2.006	1.344	0.702 - 2.575
2-3 markers	0.367	0.218 - 0.619**	0.527	0.241 - 1.153
<i>N</i>			1,421	
<i>R</i> ²			0.290	

Left hand side of the table shows the unadjusted logistic regressions for those covariates who had a significant association with attendance. The right hand side shows the adjusted model for these variables. * $p < 0.05$; ** $p < 0.01$

Table 4a. Differences between non-attenders and attenders among intenders (univariate analysis)†

	Non-Attenders (N=185)		Attenders (N=737)		p-value*
	Mean	(SD)	Mean	(SD)	
Core HBM variables					
Perceived benefit	2.88	(0.63)	3.08	(0.61)	<0.001
Perceived barriers	1.93	(0.49)	1.78	(0.48)	<0.001
Perceived susceptibility	2.06	(0.68)	2.14	(0.65)	0.136
Perceived seriousness	3.38	(0.88)	3.46	(0.86)	0.276
Non HBM variables					
Fatalistic beliefs (death)	1.97	(1.04)	1.88	(1.05)	0.262
Fatalistic beliefs (control)	1.29	(0.88)	1.16	(0.89)	0.084
Knowledge of risk factors	9.58	(2.44)	9.73	(2.13)	0.419

*The p-values are derived from ANOVA

† Only eligible sample (i.e. without bowel cancer, ulcerative colitis, diverticular disease or Crohn's disease for whom screening status could be verified).

Table 4b. Differences between non-attenders and attenders among intenders (univariate analysis)†

	Non-Attenders (N=185)		Attenders (N=737)		p-value
	N	(%)	N	(%)	
Non-core HBM variables					
Cues to action					
Family history of bowel cancer					
No	157	(20.91%)	594	(79.09%)	0.182
Yes	28	(16.37%)	143	(83.63%)	
Friend/non-blood relative history of bowel cancer					
No	149	(21.56%)	542	(78.44%)	0.050
Yes	36	(15.58%)	195	(84.42%)	
Health motivation					
Interest in non-screening prevention methods					
Not at all/somewhat	32	(31.37%)	70	(68.63%)	0.003
Moderately/very	153	(18.73%)	664	(81.27%)	
Health and Lifestyle Variables					
Health behaviours					
Not following recommendations	171	(13.00%)	684	(80.00%)	0.947
Following recommendations	11	(20.37%)	43	(79.63%)	
External / circumstantial variables					
Sociodemographic details					
Self-stated age					
54 years	142	(19.75%)	577	(80.25%)	0.653
55 years	43	(21.18%)	160	(78.82%)	
Gender					
Male	85	(20.29%)	334	(79.71%)	0.878
Female	100	(19.88%)	403	(80.12%)	
Living condition					
Married/cohabiting	160	(19.37%)	666	(80.63%)	0.110
Single/divorced/widowed	25	(26.32%)	70	(73.68%)	
Ethnicity					
White	169	(19.81%)	684	(80.19%)	0.526
Other	15	(23.08%)	50	(76.92%)	
Paid work					
No	32	(24.24%)	100	(75.76%)	0.183
Yes	151	(19.24%)	634	(80.76%)	
Individual deprivation					
0 markers (least deprived)	122	(17.35%)	581	(82.65%)	<0.001
1 marker	36	(23.23%)	119	(76.77%)	
2-3 markers	21	(44.68%)	26	(55.32%)	
Area level deprivation (IMD quintiles)					
Least deprived	40	(16.88%)	197	(83.12%)	0.158

2 nd	46	(20.26%)	181	(79.74%)	
3 rd	29	(17.16%)	140	(82.84%)	
4 th	29	(20.86%)	110	(79.14%)	
Most deprived	27	(28.42%)	68	(71.58%)	
Health status					
Poor/fair	59	(24.08%)	186	(75.92%)	0.068
Good/excellent	125	(18.63%)	546	(81.37%)	
Comorbidities					
Irritable bowel syndrome					
No	162	(20.25%)	638	(79.75%)	0.720
Yes	23	(18.85%)	99	(81.15%)	
Diabetes					
No	168	(19.24%)	705	(80.76%)	0.009
Yes	17	(34.69%)	32	(65.31%)	

† Only eligible sample (i.e. without bowel cancer, ulcerative colitis, diverticular disease or Crohn's disease for whom screening status could be verified).

*The p-values are derived from Chi-square tests of independence

Note that missing cases are not reported, so that the column frequencies do not always sum up to the total stated at the top of the table.

Table 5 Unadjusted and adjusted logistic regression models of attendance for intenders

Variable	Unadjusted model		Adjusted model	
	Odds ratio	95% CI	Odds ratio	95% CI
Core HBM variables				
Perceived benefits	1.655	1.276 - 2.146**	1.822	1.368 - 2.425**
Perceived barriers	0.521	0.368 - 0.739**	0.468	0.319 - 0.687**
Non-core HBM variables				
Cues to action				
Friend/non-blood relative history of bowel cancer				
No	Ref.		Ref.	
Yes	1.489	0.999 - 2.219	1.454	0.946 - 2.233
Health motivation				
Interest in non-screening prevention methods				
Not at all, somewhat	Ref.		Ref.	
Moderately, very	1.984	1.260 - 3.123**	1.749	1.071 - 2.858*
External / circumstantial variables				
Individual deprivation				
0 markers (least deprived)	Ref.		Ref.	
1 marker	0.694	0.456 - 1.057	0.775	0.496 - 1.211
2-3 markers	0.260	0.142 - 0.477**	0.258	0.135 - 0.495**
Diabetes				
No	Ref.		Ref.	
Yes	0.449	0.243 - 0.827*	0.479	0.245 - 0.938*
<i>N</i>			884	
<i>R</i> ²			0.107	

Left hand side of the table shows the unadjusted logistic regressions for those covariates who had a significant association with attendance. The right hand side shows the adjusted model for these variables.

* $p < 0.05$; ** $p < 0.01$

Figure 1 Flow through the study

