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1 Predictors of Intention Translation in Flexible Sigmoidoscopy Screening For Colorectal  
2 Cancer  
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23 Acknowledgements: This study was funded by a project grant from Cancer Research UK  
24 (C27064/A17326) to CVW.

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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.

55

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).

110

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)

163 we felt it was important to continue to test this association as it would have important  
 164 implications for how diabetic patients prevent themselves from colorectal cancer.

165 Being able to determine predictors of actual BSS attendance as part of a prospective  
 166 design could provide novel insights into genuine barriers to BSS which could further enhance  
 167 ongoing efforts to support individuals, particularly those who are inclined to have the test.  
 168 This could further increase the potential of the programme to substantially reduce the public  
 169 health burden associated with CRC incidence and mortality.

170

## 171 **Method**

### 172 **Participants**

173 Between May 2015 and April 2016, 83 General Practices (GPs) located in England  
 174 were recruited to this study. Questionnaires were sent to registered patients within each  
 175 practice aged between 54 and 10 months and 55 and two months (the point at which they  
 176 become eligible for BSS and receive their BSS pre invitation letter).

177 GPs were asked to exclude patients who they did not consider to be proficient enough  
 178 at reading English to understand and complete the questionnaire, and would not meet the  
 179 eligibility criteria for BSS, i.e. patients who were diagnosed with CRC, ulcerative colitis,  
 180 diverticular disease or Crohn's disease.

### 181 **Ethical approval**

182 This study received ethical approval from NRES Committee South Central-Berkshire  
 183 B (letter dated 21st May 2014).



## 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 (Haggard & 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 $\alpha$
<b>Core HBM variables</b>		
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	-
<b>Non-Core HBM</b>		
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	
<b>Non-HBM beliefs</b>		
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)	
<b>Core HBM variables</b>					
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
<b>Non HBM variables</b>					
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	(%)	
<b>Non-Core HBM constructs</b>					
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%)	
<b>Health and lifestyle variables</b>					
Health behaviours					
Not following recommendations	115	(13.00%)	1312	(91.94%)	<0.001
Following recommendations	22	(20.37%)	86	(79.63%)	
<b>External/circumstantial variables</b>					
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 <sup>nd</sup>	29	(7.99%)	334	(92.01%)	
3 <sup>rd</sup>	21	(7.32%)	266	(92.68%)	
4 <sup>th</sup>	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 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
<b>Core HBM constructs</b>				
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
<b>Non-core HBM variables</b>				
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**
<b>Health and lifestyle variables</b>				
Health Behaviours				
Not following recommendations	Ref.		Ref.	
Following recommendations	0.343	0.207 - 0.568**	0.311	0.164 - 0.590**
<b>External/circumstantial variables</b>				
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> <sup>2</sup>			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)	
<b>Core HBM variables</b>					
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
<b>Non HBM variables</b>					
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	(%)	
<b>Non-core HBM variables</b>					
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%)	
<b>Health and Lifestyle Variables</b>					
Health behaviours					
Not following recommendations	171	(13.00%)	684	(80.00%)	0.947
Following recommendations	11	(20.37%)	43	(79.63%)	
<b>External / circumstantial variables</b>					
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 <sup>nd</sup>	46	(20.26%)	181	(79.74%)	
3 <sup>rd</sup>	29	(17.16%)	140	(82.84%)	
4 <sup>th</sup>	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
<b>Core HBM variables</b>				
Perceived benefits	5	1.276 - 2.146**	1.822	1.368 - 2.425**
Perceived barriers	6	0.368 - 0.739**	0.468	0.319 - 0.687**
<b>Non-core HBM variables</b>				
Cues to action				
Friend/non-blood relative history of bowel cancer				
No	Ref.		Ref.	
Yes	7	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	8	1.260 - 3.123**	1.749	1.071 - 2.858*
<b>External / circumstantial variables</b>				
Individual deprivation				
0 markers (least deprived)	Ref.		Ref.	
1 marker	9	0.456 - 1.057	0.775	0.496 - 1.211
2-3 markers	10	0.142 - 0.477**	0.258	0.135 - 0.495**
Diabetes				
No	Ref.		Ref.	
Yes	11	0.243 - 0.827*	0.479	0.245 - 0.938*
<i>N</i>			884	
<i>R</i> <sup>2</sup>			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**

