Predictors of Intention Translation in Flexible Sigmoidoscopy Screening For Colorectal Cancer

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Objective

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

Method

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

Results

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

Conclusion

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Method

Participants

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

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

Ethical approval

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

Procedures and Materials

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

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

Questionnaire

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Health and lifestyle variables

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

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

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

External/circumstantial variables.

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

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

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

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

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

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

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

Analysis

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

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

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

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

Results

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

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

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

Non-intenders vs intenders

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

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

Verification of attendance

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

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

Predictors of attendance among intenders

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

Discussion

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

This prospective study provided contrasting findings from the UK FSST, by finding attendance to be predicted by a range of attitudinal and psychosocial factors including perceived importance and test-specific barriers. This suggests more needs to be done to educate the public about the value of the test, and where possible reduce anticipated barriers 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 I think the test would reduce my chances of dying from bowel cancer	Perceived benefits	0.71
I think the test would be painful I think the test would take too much time I think the test would be embarrassing I think the test would be unnecessary if I did not have any symptoms I think the enema would be off-putting	Perceived barriers	0.64
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 I am worried about getting bowel cancer	Perceived susceptibility	0.63
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) N (%)		Intenders (N=1,415) N (%)		p-value*
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%)	
2nd	29	(7.99%)	334	(92.01%)	
3rd	21	(7.32%)	266	(92.68%)	0.089
4th	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%)	
1	19	(7.17%)	246	(92.83%)	<0.001
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
N			1,421	
R^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%)	
1 marker	36	(23.23%)	119	(76.77%)	<0.001
2-3 markers	21	(44.68%)	26	(55.32%)	
Area level deprivation (IMD quintiles)					
Least deprived	40	(16.88%)	197	(83.12%)	0.158

2nd	46	(20.26%)	181	(79.74%)	
3rd	29	(17.16%)	140	(82.84%)	
4th	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

	Unadjusted model		Adjusted model	
Variable	Odds ratio	95% CI	Odds ratio	95% CI
Core HBM variables				
Perceived benefits	1.65	1.276 - 2.146**	1.822	1.368 - 2.425**
Perceived barriers	0.51	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	1.49	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	1.91	1.260 - 3.123**	1.749	1.071 - 2.858*
External / circumstantial variables				
Individual deprivation				
0 markers (least deprived)	Ref.		Ref.	
1 marker	0.61	0.456 - 1.057	0.775	0.496 - 1.211
2-3 markers	0.26	0.142 - 0.477**	0.258	0.135 - 0.495**
Diabetes				
No	Ref.		Ref.	
Yes	0.44	0.243 - 0.827*	0.479	0.245 - 0.938*
N			884	
R^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