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Review Article

Rapid review of factors associated with flexible sigmoidoscopy screening use

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ABSTRACT

Flexible sigmoidoscopy (FS) screening has been shown to reduce colorectal cancer (CRC) incidence and mortality among screened adults. The aim of this review was to identify patient-related factors associated with the screening test's use.

We searched PubMed for studies that examined the association between FS screening use and one or more factors. To determine the eligibility of studies, we first reviewed titles, then abstracts, and finally the full paper. We started with a narrow search, which we expanded successively (by adding 'OR' terms) until the number of new publications eligible after abstract review was < 1% of the total number of publications. We then abstracted factors from eligible papers and reported the number of times each was found to be positively or negatively associated with FS screening use.

We identified 42 papers, most of which reported studies conducted in the United States of America (n = 21, 50%) and the United Kingdom (n = 13, 31%). Across studies, a wide range of factors were examined (n = 123), almost half of which were found to be associated with FS screening use at least once (n = 60). Sociodemographic and health and lifestyle factors that were frequently positively associated with FS screening use included: male gender, higher socioeconomic status and a family history of CRC. Frequently positively associated psychosocial factors included low perceived barriers and high perceived benefits.

Findings suggest that future research should focus on developing a theoretical framework of cancer screening behaviour to allow a greater level of consistency and specificity in measuring key constructs.

1. Background

Colorectal cancer (CRC) is a leading cause of morbidity and mortality in Europe and North America (Ferlay et al., 2015). Several large randomised controlled trials (RCTs) have shown that a single flexible sigmoidoscopy (FS) screen between the ages of 55 and 64 can significantly reduce the incidence and mortality of the disease among people who complete the test (Elmunzer et al., 2012). As a result, several countries have begun implementing FS-based screening programmes for the early detection and prevention of CRC (Bevan and Rutter, 2018), with England currently rolling out the test as part of its national Bowel Cancer Screening Programme (BCSP), and some healthcare and insurance providers offering it as one of several screening test options in the United States of America (USA).

As with all screening, the extent to which the public health benefits of FS screening are realised is highly dependent on uptake (Geurts et al., 2015). In a recent review of the evidence for FS screening, Littlejohn and colleagues found that uptake of FS screening was low compared with other CRC screening tests, such as the guaiac faecal occult blood test (gFOBt) and faecal immunochemical test (FIT) (Littlejohn et al., 2012). Indeed, in nine trials that included non-selected samples (i.e. samples not pre-identified as 'willing' to attend FS), uptake of FS screening was lower than stool-based screening (i.e. gFOBt or FIT) in six, the same as FIT in one (gFOBt was not included), and higher than a combination of FS and gFOBt or FIT in two (Littlejohn et al., 2012).

Researchers exploring low uptake in FS screening have examined the association between FS screening use and a wide range of factors, including the perceived barriers and benefits of screening (Tang et al.,

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2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011), and having a preference for the gender of the practitioner performing the test (Walsh et al., 2004). To date, reviews of these studies have combined findings with those focusing on factors associated with other CRC screening tests, such as colonoscopy and FIT (Beydoun and Beydoun, 2008; Wools et al., 2015). For example, in a recent review by Wools and colleagues, findings from studies examining factors associated with colonoscopy screening use and FS screening use were combined to report factors associated with 'lower endoscopy' screening use (Wools et al., 2015). While such reviews are useful in terms of identifying factors broadly associated with groups of CRC screening tests, they fail to explore important intrinsic differences between tests which might affect peoples' willingness to do each test differently. For example, FS only looks at the rectum and sigmoid colon (Atkin et al., 1993), while colonoscopy examines the whole of the large bowel, resulting in the need for a more intensive bowel preparation, a longer time for the procedure, and a higher complication rate (Whitlock et al., 2008).

The aim of this review, therefore, was to identify factors that have been frequently associated with FS screening use specifically. The results will be used to inform the development of interventions to promote uptake within the English Bowel Cancer Screening Programme as part of a research project funded by Yorkshire Cancer Research.

2. Methods

2.1. Search strategy and study selection

We searched PubMed (March 2018) for studies that examined the association between one or more patient-related factors and FS screening use. To be eligible, a full text English article had to be available. Studies were excluded if they examined the association between patient-related factors and non-screening FS, or any other lower endoscopic screening test. Trials which examined the impact of one or more interventions on FS screening use were also excluded, as were qualitative studies. No other limitations were set in terms of the year of publication or study design.

An answer to our research question was required within a relatively short timeframe (six months were allocated to the development of interventions for our Yorkshire Cancer Research study), and so a rapid review of the available literature was performed. As such, rather than using the customary search strategy associated with systematic reviews, which begin as comprehensively as possible, we began with a narrow search and expanded successively (by adding 'OR' terms) until the number of new publications eligible on abstract review was < 1% of the total (see Table 1). The major assumption with this method was that, if successive expansions yield diminishing numbers of potentially eligible publications, and the most recent expansion yields a relatively small addition to the pool, stopping the expansion at this point is unlikely to lead to a major loss of information. This search strategy has previously been described by Duffy and colleagues, who found that 92% of papers were identified prior to reference list searches (i.e. 60 of 65 papers were identified through the search strategy alone) (Duffy et al., 2017).

The combination and order in which search terms were entered was based on the total number of new publications obtained at each stage (i.e. the combination with the highest yield was selected for each stage; this was to ensure we did not arrive at a final search yielding < 1% of new publications potentially eligible for inclusion prematurely). All papers were assessed by two reviewers (RK and VW). Each reviewer assigned papers a value of 1 ('include') or 0 ('exclude'). Discrepancies between reviewer scores were resolved through discussion. Papers passing title and abstract review underwent full paper review. The reference lists of papers eligible after full paper review were searched for further potential papers that, in turn, were subject to abstract and, if eligible, full paper review. The same process was applied to the

Table 1
Results of successively broadening the search terms until newly identified papers potentially eligible on abstract review was < 1% of the total papers found by the search.

PubMed search[a]	Number of publications	Number of publications selected on title review	New publications potentially eligible after abstract review	Percentage of new publications potentially eligible
'(Flexible Sigmoidoscopy OR Sigmoidoscopy) AND Screening AND (Participation OR Attendance) AND (Barriers OR Facilitators)'	N = 28	N = 14	N = 8	29%
'(Flexible Sigmoidoscopy OR Sigmoidoscopy OR **Bowel Scope**) AND Screening AND (Participation OR Attendance OR **Compliance**) AND (Barriers OR Facilitators OR **Factors**)'	N = 74	N = 43	N = 10	14%
'(Flexible Sigmoidoscopy OR Sigmoidoscopy OR **Bowel Scope** OR **Endoscopy**) AND Screening AND (Participation OR Attendance OR **Compliance** OR **Adherence**) AND (Barriers OR Facilitators OR **Factors** OR **Predictors**)'	N = 159	N = 78	N = 7	4%
'(Flexible Sigmoidoscopy OR Sigmoidoscopy OR **Bowel Scope** OR **Endoscopy** OR **Endoscopic**) AND Screening AND (Participation OR Attendance OR **Compliance** OR **Adherence** OR **Utilization**) AND (Barriers OR Facilitators OR **Factors** OR **Predictors** OR **Determinants**)'	N = 218	N = 104	N = 1	< 1%

[a] Search terms were limited to titles and abstracts.

reference lists of reviews detected through the searches (DeBarros and Steele, 2013; Donovan and Syngal, 1998; St, 2000; Winawer et al., 1990; Janes et al., 1999; Menees and Fenner, 2007), with two reviewers assessing the title, abstract and full paper of any potentially eligible new papers.

2.2. Data collection

Data on the first author, year of publication, study setting, programme delivery (i.e. organised vs. opportunistic), study design, context (i.e. real life vs. RCT/pilot programme), sample size, outcome, analysis, gender of participants, factors examined and results were abstracted from eligible papers. The list of factors accumulated was then categorised into 'sociodemographic', 'health and lifestyle' and 'psychosocial' factors. For the purposes of this study, sociodemographic variables were defined as 'statistical data about the characteristics of a population', while health and lifestyle factors were defined as 'factors that described the health behaviours, perceived health and previous medical history of individuals'. Psychosocial variables were defined as those variables that examined 'psychological attributes' (Singh-Manoux, 2003). To decide whether factors were significantly associated with FS screening use, we used the cut-off p-value used to define statistical significance within each individual study.

2.3. Data analysis

Cohen's kappa was used to assess inter-rater agreement for the database and reference list searches (Cohen, 1960). Descriptive statistics were used to report the characteristics of studies and the number of times factors were examined and found to be positively or negatively associated with FS screening use. The data were managed within SPSS Ver. 25.0.

3. Results

3.1. Study characteristics

After abstract review, 26 papers were deemed eligible. On full paper review, 4 were then excluded. From the reference lists of the remaining papers, and the six identified review papers, a further 20 were added, bringing the total number of papers included to 42. Inter-rater agreement for the database and reference list searches was 'very high' (Cohen's kappa for the database and reference list searches was 0.87 and 0.92, respectively).

The basic attributes of the included studies are presented in Table 2 (a more detailed overview is presented in Appendix 1). The majority of papers reported studies performed in the USA (n = 21, 50%) or the UK (n = 13, 31%), examined screening use within opportunistic programmes (n = 22, 52.4%), employed cross-sectional designs (n = 30, 71.4%), had sample sizes of > 1000 participants (n = 24, 57.1%), and assessed having attended/ever had a once-only FS screening appointment (n = 29, 65.9%).

3.2. Factors

Across the 42 studies, 123 factors were examined (25 sociodemographic factors, 50 health and lifestyle factors, and 48 psychosocial factors). The frequencies of factors found to be significantly positively or negatively associated with FS screening use at least once are reported in Table 3. All consistently non-significant factors are reported in the appendix (see Appendix 2).

3.3. Sociodemographic factors

The most frequently examined sociodemographic factors were: gender (n = 28) (Power et al., 2008; Sutton et al., 2000; Whitaker et al., 2011; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Blom et al., 2008; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; Juon et al., 2003; Segnan et al., 2007; Investigators, 2002; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993), age (n = 26) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Hol et al., 2009; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; McCaffery et al., 2002; Juon et al., 2003; Segnan et al., 2007; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000), education (n = 15) (Sutton et al., 2000; Walsh et al., 2004; Lawsin et al., 2007; Taylor et al., 2003; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Bostick et al., 1994), marital status (n = 12) (Tang et al., 2001; Power et al., 2008; Wardle et al., 2005; Lawsin et al., 2007; Taylor et al., 2003; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Brenes and Paskett, 2000; Bostick et al., 1994), socioeconomic status (n = 10) (Power et al., 2008; Wardle et al., 2005; Whitaker et al., 2011; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; van Dam et al., 2013), ethnicity (n = 9) (Sutton et al., 2000; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Brenes and Paskett, 2000; Robb et al., 2008), income (n = 6) (Tang et al., 2001; Walsh et al., 2004; Lawsin et al., 2007; Blom et al., 2008; Kang and Bloom, 1993; Bostick et al., 1994) and employment status (n = 5) (Power et al., 2008; Wardle et al., 2005; van Dam et al., 2013; Senore et al., 2010; McCarthy and Moskowitz, 1993). Those most frequently positively associated with FS screening use included: male gender (n = 12/28; 42.9%) (Sutton et al., 2000; Whitaker et al., 2011; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Hol et al., 2009; McGregor et al., 2016; Van Jaarsveld et al., 2006; McCaffery et al., 2002; Segnan et al., 2007; Bostick et al., 1993; McCarthy and Moskowitz, 1993), higher socioeconomic status (n = 9/10; 90%) (Power et al., 2008; Wardle et al., 2005; Whitaker et al., 2011; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007), older age (n = 5/26; 19.2%) (Walsh et al., 2004; Janz et al., 2003; Walsh et al., 2002; Hol et al., 2009; Ruffin et al., 2000), higher education (n = 4/15; 26.6%) (Lawsin et al., 2007; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; Bostick et al., 1994), being married (n = 4/12; 33.3%) (Wardle et al., 2005; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003) and White, Black, or Hispanic ethnicity (n = 5/9; 55.6%) (Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Robb et al., 2008). Other sociodemographic factors examined less frequently, but found to be positively associated with FS screening use at least once, included: higher income (n = 2/6; 33.3%) (Blom et al., 2008; Bostick et al., 1994), having a full time job (n = 1; 20%) (Wardle et al., 2005) and being a home owner (n = 1; 100%) (Sutton et al., 2000). Negative associations were reported for two factors: older age (n = 1/26; 3.9%) (Ko et al., 2005) and male gender (n = 1/28; 3.6%) (Blom et al., 2008). No statistically significant positive or negative associations were reported for 11/25 (44%) sociodemographic factors (see Appendix 2), including social network index (Kang and Bloom, 1993; Bostick et al., 1994) and access to a car or van (Sutton et al., 2000).

Table 2
Summary of characteristics of articles included in the review.

Design feature	Number of studies (%)	References
Country		
USA	21 (50%)	(Tang et al., 2001; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Kang and Bloom, 1993; Juon et al., 2003; Bostick et al., 1993; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000; Bostick et al., 1994; Muldoon et al., 1996; Shapiro et al., 2001; Rawl et al., 2004; Thrasher et al., 2002)
UK	13 (31.0%)	(Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; Investigators, 2002; Robb et al., 2008; Vrinten et al., 2015)
The Netherlands	3 (7.0%)	(Hol et al., 2009; van Dam et al., 2013; Kremers et al., 2000)
Italy	2 (4.8%)	(Segnan et al., 2007; Senore et al., 2010)
Germany	1 (2.4%)	(Gölder et al., 2007)
Sweden	1 (2.4%)	(Blom et al., 2008)
Norway	1 (2.4%)	(Larsen et al., 2006)
Programme delivery		
Opportunistic screening	22 (52.4%)	(Tang et al., 2001; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Kang and Bloom, 1993; Juon et al., 2003; Bostick et al., 1993; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000; Bostick et al., 1994; Muldoon et al., 1996; Gölder et al., 2007; Shapiro et al., 2001; Rawl et al., 2004; Thrasher et al., 2002)
Organised screening	20 (47.6%)	(Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Blom et al., 2008; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; Segnan et al., 2007; Investigators, 2002; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; Robb et al., 2008; Larsen et al., 2006; Vrinten et al., 2015)
Study design		
Cross-sectional	30 (71.4%)	(Tang et al., 2001; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Taylor et al., 2003; Yip et al., 2006; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; Bevan et al., 2015; Brotherstone et al., 2007; Juon et al., 2003; Segnan et al., 2007; Investigators, 2002; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Senore et al., 2010; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000; Bostick et al., 1994; Muldoon et al., 1996; Shapiro et al., 2001; Rawl et al., 2004; Vrinten et al., 2015; Thrasher et al., 2002)
Prospective	11 (26.2%)	(Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Lawsin et al., 2007; Blom et al., 2008; McCaffery et al., 2002; Kremers et al., 2000; McCarthy and Moskowitz, 1993; Robb et al., 2008; Gölder et al., 2007)
Prospective and retrospective	1 (2.4%)	(Larsen et al., 2006)
Context		
Real world context	22 (52.4%)	(Tang et al., 2001; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; McGregor et al., 2016; Kang and Bloom, 1993; Juon et al., 2003; Bostick et al., 1993; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000; Bostick et al., 1994; Muldoon et al., 1996; Shapiro et al., 2001; Rawl et al., 2004; Thrasher et al., 2002)
Pilot programme	6 (14.3%)	(Blom et al., 2008; Robb et al., 2010; Bevan et al., 2015; Brotherstone et al., 2007; Kremers et al., 2000; Gölder et al., 2007)
RCT	14 (33.3%)	(Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Hol et al., 2009; Van Jaarsveld et al., 2006; McCaffery et al., 2002; Segnan et al., 2007; Investigators, 2002; van Dam et al., 2013; Senore et al., 2010; Robb et al., 2008; Larsen et al., 2006; Vrinten et al., 2015)
Sample size		
< 100	1 (2.4%)	(Taylor et al., 2003)
100–299	9 (21.4%)	(Tang et al., 2001; Lawsin et al., 2007; Yip et al., 2006; Juon et al., 2003; Lewis and Jensen, 1995; Kremers et al., 2000; McCarthy and Moskowitz, 1993; Brenes and Paskett, 2000; Rawl et al., 2004)
300–999	8 (19.1%)	(Whitaker et al., 2011; Walsh et al., 2004; Janz et al., 2003; Kang and Bloom, 1993; Brotherstone et al., 2007; van Dam et al., 2013; Senore et al., 2010; Gölder et al., 2007)
1000–4999	14 (33.3%)	(Power et al., 2008; Sutton et al., 2000; Blom et al., 2008; Hol et al., 2009; Robb et al., 2010; Van Jaarsveld et al., 2006; Bevan et al., 2015; Bostick et al., 1993; Richardson et al., 1995; Bostick et al., 1994; Robb et al., 2008; Muldoon et al., 1996; Vrinten et al., 2015; Thrasher et al., 2002)
5000–50,000	7 (16.7%)	(Wardle et al., 2005; Walsh et al., 2002; McGregor et al., 2016; McCaffery et al., 2002; Segnan et al., 2007; Ruffin et al., 2000; Larsen et al., 2006)
> 50,000	3 (7.1%)	(Ko et al., 2005; Investigators, 2002; Shapiro et al., 2001)
Outcome		
Attendance/non-attendance at once-only FS	22 (52.4%)	(Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Blom et al., 2008; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; Segnan et al., 2007; Investigators, 2002; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Robb et al., 2008; Gölder et al., 2007; Larsen et al., 2006; Vrinten et al., 2015)
Ever had FS	6 (14.2%)	(Tang et al., 2001; Kang and Bloom, 1993; Juon et al., 2003; Bostick et al., 1993; Lewis and Jensen, 1995; Bostick et al., 1994)
Up to date with FS	13 (31.0%)	(Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000; Muldoon et al., 1996; Shapiro et al., 2001; Rawl et al., 2004)
Ever had FS and up to date with FS	1 (2.4%)	(Thrasher et al., 2002)

(*continued on next page*)

Table 2 (*continued*)

Design feature	Number of studies (%)	References
Analysis		
Univariable analysis	11 (26.2%)	(Whitaker et al., 2011; Ko et al., 2005; Yip et al., 2006; Van Jaarsveld et al., 2006; Bevan et al., 2015; Investigators, 2002; Bostick et al., 1993; McCarthy and Moskowitz, 1993; Ruffin et al., 2000; Gölder et al., 2007; Rawl et al., 2004)
Multivariable regression	29 (69.0%)	(Tang et al., 2001; Sutton et al., 2000; Wardle et al., 2005; Walsh et al., 2004; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Blom et al., 2008; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Kang and Bloom, 1993; McCaffery et al., 2002; Brotherstone et al., 2007; Juon et al., 2003; Segnan et al., 2007; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; Richardson et al., 1995; Brenes and Paskett, 2000; Robb et al., 2008; Muldoon et al., 1996; Larsen et al., 2006; Shapiro et al., 2001; Vrinten et al., 2015; Thrasher et al., 2002)
Discriminant analysis	1 (2.4%)	(Power et al., 2008)
Analysis of covariance	1 (2.4%)	(Bostick et al., 1994)
Gender of participants		
Both	39 (92.9%)	(Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Blom et al., 2008; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; Juon et al., 2003; Segnan et al., 2007; Investigators, 2002; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Ruffin et al., 2000; Bostick et al., 1994; Robb et al., 2008; Muldoon et al., 1996; Gölder et al., 2007; Larsen et al., 2006; Shapiro et al., 2001; Rawl et al., 2004; Vrinten et al., 2015; Thrasher et al., 2002)
Females only	3 (7.1%)	(Tang et al., 2001; Richardson et al., 1995; Brenes and Paskett, 2000)
Males only	0 (–)	–

3.4. Health and lifestyle factors

The most frequently examined health and lifestyle factors were: family history of CRC (n = 10) (Tang et al., 2001; Sutton et al., 2000; Wardle et al., 2005; Janz et al., 2003; Walsh et al., 2002; Blom et al., 2008; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Brenes and Paskett, 2000; Gölder et al., 2007), perceived health (n = 9) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Kang and Bloom, 1993; Juon et al., 2003; van Dam et al., 2013; Senore et al., 2010; Richardson et al., 1995; Brenes and Paskett, 2000), insurance status (n = 7) (Tang et al., 2001; Walsh et al., 2004; Walsh et al., 2002; Yip et al., 2006; Kang and Bloom, 1993; Juon et al., 2003; Brenes and Paskett, 2000), smoking status (n = 6) (Sutton et al., 2000; van Dam et al., 2013; Senore et al., 2010; Bostick et al., 1994; Larsen et al., 2006; Shapiro et al., 2001), recent bowel symptoms (n = 4) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; van Dam et al., 2013), recent mammography (n = 4) (Sutton et al., 2000; Walsh et al., 2002; Brenes and Paskett, 2000; Shapiro et al., 2001), physical activity (n = 4) (Sutton et al., 2000; Senore et al., 2010; Larsen et al., 2006; Shapiro et al., 2001) and chronic illness (n = 3) (Juon et al., 2003; Bostick et al., 1994; Larsen et al., 2006). Those most frequently positively associated with FS screening use included: a family history of CRC (n = 5/10; 50%) (Wardle et al., 2005; Walsh et al., 2002; Blom et al., 2008; McCarthy and Moskowitz, 1993; Gölder et al., 2007), good perceived health (n = 4/9; 44.4%) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Richardson et al., 1995), being a current non-smoker or smoking fewer than 20 cigarettes a day (n = 3/6; 50%) (Sutton et al., 2000; Larsen et al., 2006; Shapiro et al., 2001), one or more recent bowel symptoms (n = 2/4; 50%) (Power et al., 2008; Wardle et al., 2005), having health insurance (n = 2/7; 28.6%) (Walsh et al., 2004; Janz et al., 2003) and attending a breast screen within the last three years (n = 2/4; 50%) (Janz et al., 2003; Shapiro et al., 2001). Other health and lifestyle factors examined less frequently, but found to be positively associated with FS screening use at least once, included: visiting a physician within the past year (n = 1/1; 100%) (Bostick et al., 1994), having a pap smear (n = 1/2; 50%) (Shapiro et al., 2001) or cholesterol check within the past year (n = 1/1; 100%) (Shapiro et al., 2001), having a usual source of care (n = 1/1; 100%) (van Dam et al., 2013) and visiting the physician regularly (n = 1/1; 100%) (Lawsin et al., 2007). Negative associations were reported for two factors: chronic conditions (n = 1/3; 33.3%) (Bostick et al., 1994) and frequent GP visits within the past three months (n = 1/2; 50%) (Wardle et al., 2005). No statistically significant positive or negative associations were reported for 25 (50%) health and lifestyle factors (see Appendix 2), including alcohol consumption (Larsen et al., 2006) and being overweight (Larsen et al., 2006).

3.5. Psychosocial factors

The most frequently examined psychosocial factors were perceived barriers (n = 7) (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Brenes and Paskett, 2000; Rawl et al., 2004), perceived benefits (n = 7) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Janz et al., 2003; Lewis and Jensen, 1995; Senore et al., 2010), perceived risk (n = 9) (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Ko et al., 2005; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; Brenes and Paskett, 2000), attitudes towards medical tests (n = 3) (Power et al., 2008; Sutton et al., 2000; Senore et al., 2010), anticipated regret (n = 2) (Power et al., 2008; van Dam et al., 2013) and receipt of a physician recommendation to have the test (n = 2) (Lawsin et al., 2007; Taylor et al., 2003). Those most frequently positively associated with FS screening use included lower perceived barriers (n = 7/7, 100%) (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Brenes and Paskett, 2000; Rawl et al., 2004), higher perceived benefits (n = 5/7; 71.4%) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Lewis and Jensen, 1995), higher perceived risk (n = 2/9; 22.2%) (Janz et al., 2003; Kremers et al., 2000), receipt of a recommendation from the clinician to have the test (n = 2/4; 50%) (Lawsin et al., 2007; Taylor et al., 2003) and positive attitudes towards medical tests (n = 2/3; 66.7%) (Power et al., 2008; Sutton et al., 2000). Other psychosocial factors found to be positively associated with FS screening use at least once, included: lower perceived test pain (n = 1/1; 100%) (Lewis and Jensen, 1995), higher consideration of future consequences (n = 1/1; 100%) (Whitaker et al., 2011), higher acculturation (n = 1/2; 50%) (Tang et al., 2001), higher knowledge of FS screening (n = 1/1; 100%) (van Dam et al., 2013), receiving a recommendation to have the test from a family member (n = 1/1; 100%) (Walsh et al., 2004), having

Table 3
Barriers and facilitators of FS screening use.

Factor	No. of studies evaluating factor	No. of studies reporting factor as significant facilitator (%)	No. of studies reporting factor as significant barrier (%)	No. of studies reporting factor as non-significant
Demographic factors (n = 14)				
Male gender	28 (Power et al., 2008; Sutton et al., 2000; Whitaker et al., 2011; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Blom et al., 2008; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; Juon et al., 2003; Segnan et al., 2007; Investigators, 2002; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993)	12 (42.9%) (Sutton et al., 2000; Whitaker et al., 2011; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Hol et al., 2009; McGregor et al., 2016; Van Jaarsveld et al., 2006; McCaffery et al., 2002; Segnan et al., 2007; Bostick et al., 1993; McCarthy and Moskowitz, 1993)	1 (3.6%) (Blom et al., 2008)	15 (53.6%) (Power et al., 2008; Walsh et al., 2004; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Robb et al., 2010; Kang and Bloom, 1993; Bevan et al., 2015; Brotherstone et al., 2007; Juon et al., 2003; Investigators, 2002; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010)
Older age	26 (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Hol et al., 2009; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; McCaffery et al., 2002; Juon et al., 2003; Segnan et al., 2007; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Ruffin et al., 2000)	5 (19.2%) (Walsh et al., 2004; Janz et al., 2003; Walsh et al., 2002; Hol et al., 2009; Ruffin et al., 2000)	1 (3.9%) (Ko et al., 2005)	20 (76.9%) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; McCaffery et al., 2002; Juon et al., 2003; Segnan et al., 2007; Bostick et al., 1993; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000)
High level of education	15 (Sutton et al., 2000; Walsh et al., 2004; Lawsin et al., 2007; Taylor et al., 2003; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Bostick et al., 1994)	4 (26.7%) (Lawsin et al., 2007; Van Jaarsveld et al., 2006; Kang and Bloom, 1993; Bostick et al., 1994)	–	11 (73.3%) (Sutton et al., 2000; Walsh et al., 2004; Taylor et al., 2003; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; McCarthy and Moskowitz, 1993; Richardson et al., 1995; Brenes and Paskett, 2000; Bostick et al., 1994)
Being married	12 (Tang et al., 2001; Power et al., 2008; Wardle et al., 2005; Lawsin et al., 2007; Taylor et al., 2003; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Brenes and Paskett, 2000; Bostick et al., 1994)	4 (33.3%) (Wardle et al., 2005; Blom et al., 2008; Van Jaarsveld et al., 2006; Juon et al., 2003)	–	8 (66.7%) (Tang et al., 2001; Power et al., 2008; Lawsin et al., 2007; Taylor et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Brenes and Paskett, 2000; Bostick et al., 1994)
Low deprivation	10 (Power et al., 2008; Wardle et al., 2005; Whitaker et al., 2011; Hol et al., 2009; McGregor et al., 2016; Robb et al., 2010; McCaffery et al., 2002; Bevan et al., 2015; Brotherstone et al., 2007; van Dam et al., 2013)	9 (90%) (Power et al., 2008; Wardle et al., 2005; Whitaker et al., 2011; Lawsin et al., 2007; Taylor et al., 2003; Yip et al., 2006; McGregor et al., 2016; Robb et al., 2010; Van Jaarsveld et al., 2006)	–	1 (10%) (Segnan et al., 2007)
White or Black or Hispanic ethnicity	9 (Sutton et al., 2000; Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Brenes and Paskett, 2000; Robb et al., 2008)	5 (55.6%) (Walsh et al., 2004; Ko et al., 2005; Janz et al., 2003; Walsh et al., 2002; Robb et al., 2008)	–	4 (44.4%) (Sutton et al., 2000; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Brenes and Paskett, 2000)
High income	6 (Tang et al., 2001; Walsh et al., 2004; Lawsin et al., 2007; Blom et al., 2008; Kang and Bloom, 1993; Bostick et al., 1994)	2 (33.3%) (Blom et al., 2008; Bostick et al., 1994)	–	4 (66.7%) (Tang et al., 2001; Walsh et al., 2004; Lawsin et al., 2007; Kang and Bloom, 1993)
Being in employment	5 (Power et al., 2008; Wardle et al., 2005; van Dam et al., 2013; Senore et al., 2010; McCarthy and Moskowitz, 1993)	1 (20%) (Wardle et al., 2005)	–	4 (80%) (Power et al., 2008; van Dam et al., 2013; Senore et al., 2010; McCarthy and Moskowitz, 1993)
Inviting hospital or screening centre	2 (Blom et al., 2008; McGregor et al., 2016)	2 (100%) (Blom et al., 2008; McGregor et al., 2016)	–	–
City of residents home address	2 (Brenes and Paskett, 2000; Robb et al., 2008)	1 (50%) (Robb et al., 2008)	–	1 (50%) (Brenes and Paskett, 2000)

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Table 3 (*continued*)

Factor	No. of studies evaluating factor	No. of studies reporting factor as significant facilitator (%)	No. of studies reporting factor as significant barrier (%)	No. of studies reporting factor as non-significant
Residents home address - rural area or village	2 (Ko et al., 2005; Hol et al., 2009)	2 (100%) (Ko et al., 2005; Hol et al., 2009)	–	–
Residents home address – rural farm	1 (Muldoon et al., 1996)	1 (100%) (Muldoon et al., 1996)	–	–
Partner in home	1 (Richardson et al., 1995)	1 (100%) (Richardson et al., 1995)	–	–
Being a home owner	1 (Sutton et al., 2000)	1 (100%) (Sutton et al., 2000)	–	–
Health and lifestyle factors (n = 25)				
A family history of CRC	10 (Tang et al., 2001; Sutton et al., 2000; Wardle et al., 2005; Janz et al., 2003; Walsh et al., 2002; Blom et al., 2008; Lewis and Jensen, 1995; McCarthy and Moskowitz, 1993; Brenes and Paskett, 2000; Gölder et al., 2007)	5 (50%) (Wardle et al., 2005; Walsh et al., 2002; Blom et al., 2008; McCarthy and Moskowitz, 1993; Gölder et al., 2007)	–	5 (50%) (Tang et al., 2001; Sutton et al., 2000; Janz et al., 2003; Lewis and Jensen, 1995; Brenes and Paskett, 2000)
A family history of cancer (excl. CRC)	2 (Blom et al., 2008; Gölder et al., 2007)	1 (50%) (Gölder et al., 2007)	–	1 (50%) (Blom et al., 2008)
A family history of sigmoidoscopy	1 (Lewis and Jensen, 1995)	1 (100%) (Lewis and Jensen, 1995)	–	–
A personal history of GI disease	1 (Sutton et al., 2000)	1 (100%) (Sutton et al., 2000)	–	–
Perceived health status good	9 (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Kang and Bloom, 1993; Juon et al., 2003; van Dam et al., 2013; Senore et al., 2010; Richardson et al., 1995; Brenes and Paskett, 2000)	4 (44.4%) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Richardson et al., 1995)	–	7 (77.8%) (Kang and Bloom, 1993; Juon et al., 2003; van Dam et al., 2013; Senore et al., 2010; Brenes and Paskett, 2000)
One or recent more bowel symptoms	4 (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; van Dam et al., 2013)	2 (50%) (Power et al., 2008; Wardle et al., 2005)	–	2 (50%) (Sutton et al., 2000; van Dam et al., 2013)
One of more chronic conditions	3 (Juon et al., 2003; Bostick et al., 1994; Larsen et al., 2006)	–	1 (33.3%) (Bostick et al., 1994)	2 (66.7%) (Juon et al., 2003; Larsen et al., 2006)
Health insurance	7 (Tang et al., 2001; Walsh et al., 2004; Walsh et al., 2002; Yip et al., 2006; Kang and Bloom, 1993; Juon et al., 2003; Brenes and Paskett, 2000)	2 (28.6%) (Walsh et al., 2004; Walsh et al., 2002)	–	5 (71.4%) (Tang et al., 2001; Yip et al., 2006; Kang and Bloom, 1993; Juon et al., 2003; Brenes and Paskett, 2000)
A regular source of care	2 (Kang and Bloom, 1993; Richardson et al., 1995)	1 (50%) (Richardson et al., 1995)	–	1 (50%) (Kang and Bloom, 1993)
Clinician advice, received	1 (Lewis and Jensen, 1995)	1 (100%) (Lewis and Jensen, 1995)	–	–
Family practitioner	1 (Walsh et al., 2002)	1 (100%) (Walsh et al., 2002)	–	–
Resident provider	1 (Walsh et al., 2002)	1 (100%) (Walsh et al., 2002)	–	–
Visited physician within past year	1 (Bostick et al., 1994)	1 (100%) (Bostick et al., 1994)	–	–
Frequent GP visits in past three months	2 (Power et al., 2008; Wardle et al., 2005)	–	1 (50%) (Wardle et al., 2005)	1 (50%) (Power et al., 2008)
Visit physician regularly	1 (Lawsin et al., 2007)	1 (100%) (Lawsin et al., 2007)	–	–
Breast screen in last three years	4 (Sutton et al., 2000; Walsh et al., 2002; Brenes and Paskett, 2000; Shapiro et al., 2001)	2 (50%) (Walsh et al., 2002; Shapiro et al., 2001)	–	2 (50%) (Sutton et al., 2000; Brenes and Paskett, 2000)
Cervical screen in last three years	2 (Brenes and Paskett, 2000; Shapiro et al., 2001)	1 (50%) (Shapiro et al., 2001)	–	1 (50%) (Brenes and Paskett, 2000)
Cholesterol check in past 2 years	1 (Shapiro et al., 2001)	1 (100%) (Shapiro et al., 2001)	–	–
Smoking status, current non-smoker	6 (Sutton et al., 2000; van Dam et al., 2013; Senore et al., 2010; Bostick et al., 1994; Larsen et al., 2006; Shapiro et al., 2001)	3 (50%) (Sutton et al., 2000; Larsen et al., 2006; Shapiro et al., 2001)	–	3 (50%) (van Dam et al., 2013; Senore et al., 2010; Bostick et al., 1994)
Regular exercise	4 (Sutton et al., 2000; Senore et al., 2010; Larsen et al., 2006; Shapiro et al., 2001)	1 (25%) (Shapiro et al., 2001)	–	3 (75%) (Sutton et al., 2000; Senore et al., 2010; Larsen et al., 2006)
Daily fruit and vegetable servings	1 (Shapiro et al., 2001)	1 (100%) (Shapiro et al., 2001)	–	–
> 4 weekly servings of boiled potatoes	1 (Larsen et al., 2006)	1 (100%) (Larsen et al., 2006)	–	–
> 1 weekly servings of meat other than poultry	1 (Larsen et al., 2006)	1 (100%) (Larsen et al., 2006)	–	–

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Table 3 (*continued*)

Factor	No. of studies evaluating factor	No. of studies reporting factor as significant facilitator (%)	No. of studies reporting factor as significant barrier (%)	No. of studies reporting factor as non-significant
Cooking with hard margarine or oil	1 (Larsen et al., 2006)	1 (100%) (Larsen et al., 2006)	–	–
Seatbelt use	1 (Shapiro et al., 2001)	1 (100%) (Shapiro et al., 2001)	–	–
Psychological factors (n = 21)				
Lower perceived barriers	7 (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Brenes and Paskett, 2000; Rawl et al., 2004)	7 (100%) (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Brenes and Paskett, 2000; Rawl et al., 2004)	–	–
Higher perceived benefits	7 (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Janz et al., 2003; Lewis and Jensen, 1995; Senore et al., 2010)	5 (71.4%) (Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Whitaker et al., 2011; Lewis and Jensen, 1995)	–	2 (28.6%) (Janz et al., 2003; Senore et al., 2010)
Higher perceived risk	9 (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Janz et al., 2003; Lewis and Jensen, 1995; van Dam et al., 2013; Kremers et al., 2000; Senore et al., 2010; Brenes and Paskett, 2000)	2 (22.2%) (Janz et al., 2003; Kremers et al., 2000)	–	7 (77.8%) (Tang et al., 2001; Power et al., 2008; Sutton et al., 2000; Wardle et al., 2005; Lewis and Jensen, 1995; van Dam et al., 2013; Brenes and Paskett, 2000)
Higher general self-efficacy	1 (Kremers et al., 2000)	1 (100%) (Kremers et al., 2000)	–	–
Higher response-efficacy and certainty of not having CRC	1 (Kremers et al., 2000)	1 (100%) (Kremers et al., 2000)	–	–
Lower test fear	1 (Power et al., 2008)	1 (100%) (Power et al., 2008)	–	–
Lower test fatalism	1 (Power et al., 2008)	1 (100%) (Power et al., 2008)	–	–
Higher anticipated regret	2 (Power et al., 2008; van Dam et al., 2013)	1 (50%) (Power et al., 2008)	–	1 (50%) (van Dam et al., 2013)
Higher informational support	1 (Kremers et al., 2000)	1 (100%) (Kremers et al., 2000)	–	–
Higher practical support	1 (Kremers et al., 2000)	1 (100%) (Kremers et al., 2000)	–	–
Positive attitudes towards medical tests	3 (Power et al., 2008; Sutton et al., 2000; Senore et al., 2010)	2 (67%) (Power et al., 2008; Sutton et al., 2000)	–	1 (33%) (Senore et al., 2010)
Positive attitudes towards CRC screening	1 (van Dam et al., 2013)	1 (100%) (van Dam et al., 2013)	–	–
Uncomfortable thinking about cancer	1 (Vrinten et al., 2015)	–	1 (100%) (Vrinten et al., 2015)	–
Lower perceived test pain	1 (Lewis and Jensen, 1995)	1 (100%) (Lewis and Jensen, 1995)	–	–
Higher consideration of future consequences	1 (Whitaker et al., 2011)	1 (100%) (Whitaker et al., 2011)	–	–
Higher acculturation	2 (Tang et al., 2001; Walsh et al., 2004)	1 (50%) (Tang et al., 2001)	–	1 (50%) (Walsh et al., 2004)
Knowledge of FS	1 (van Dam et al., 2013)	1 (100%) (van Dam et al., 2013)	–	–
Physician recommendation	2 (Lawsin et al., 2007; Taylor et al., 2003)	2 (100%) (Lawsin et al., 2007; Taylor et al., 2003)	–	–
Family recommendation	1 (Walsh et al., 2004)	1 (100%) (Walsh et al., 2004)	–	–
Previously thought about getting test	1 (Walsh et al., 2004)	1 (100%) (Walsh et al., 2004)	–	–
MD gender preference	1 (Walsh et al., 2004)	–	1 (100%) (Walsh et al., 2004)	–

previously thought about getting the test done (n = 1/1; 100%) (Walsh et al., 2004) and positive attitudes towards CRC screening tests (n = 1/1; 100%) (van Dam et al., 2013). Negative associations were reported for two factors: finding thoughts about cancer uncomfortable (n = 1/1; 100%) (Vrinten et al., 2015) and having a preferred MD gender (n = 1/1; 100%) (Walsh et al., 2004). No statistically significant positive or negative associations were reported for 27/58 (46.6%) psychosocial factors (see Appendix 2), including perceived severity (Lewis and Jensen, 1995; Kremers et al., 2000) and worry about bowel cancer (Power et al., 2008; Wardle et al., 2005).

3.6. Variance

Three studies reported the amount of variance explained by their models (Sutton et al., 2000; Whitaker et al., 2011; Janz et al., 2003). This ranged from 9.9% in a prospective questionnaire study restricted to individuals who previously indicated that they 'probably' or 'definitely' would attend FS screening (Sutton et al., 2000), to 18.3% in a cross-sectional interview study that used The Health Belief Model as a framework to assess practices regarding CRC screening use (Janz et al., 2003).

4. Discussion

4.1. Main findings

This is the first review to focus on factors associated with FS screening use specifically. As such, it is the first to show that a wide range of factors are frequently associated with the use of this screening modality. It shows that, consistent with previous reviews examining factors associated with the use of CRC screening generally, male gender, higher socioeconomic status, a family history of CRC, good perceived health status, higher perceived benefits and lower perceived barriers are all frequently positively associated with FS screening use (Beydoun and Beydoun, 2008; Wools et al., 2015; Chen et al., 2017; Kiviniemi et al., 2011). It also shows that, in contrast with previous reviews, being overweight and having one or more chronic conditions are not frequently positively associated with FS screening use specifically (Beydoun and Beydoun, 2008; Wools et al., 2015). Indeed, having one or more chronic conditions was found to be negatively associated with FS screening use in one of three studies (no association was observed in two) (Juon et al., 2003; Bostick et al., 1994; Larsen et al., 2006), while being overweight was not associated with FS screening use in the one study that examined it (Larsen et al., 2006). One possible explanation for this discrepancy is that these factors were only examined in a small number of studies. Another possible explanation is that qualitative differences between screening tests result in some factors acting as a barrier or facilitator for some tests, but not others. With regard to why having one or more chronic conditions might be negatively associated with FS screening use specifically, and not CRC screening use in general, it is possible that chronic conditions, such as diabetes and cardiovascular disease, present practical barriers in terms of getting to the hospital and performing the bowel preparation, neither of which are relevant for completing home-based faecal occult blood test kits (by the same token, chronic conditions might also act as a barrier for colonoscopy screening; further research is required to test this). Another possible explanation is that people with certain chronic conditions, such as cardiovascular disease and high blood pressure, are simply not clinically eligible for FS, and so are less likely to report having had the test for this reason. Interviews with people who have chronic diseases might help explain why these individuals are more likely to complete one CRC screening test over another. This is only one of several possible avenues for future research, with a second being to identify the specific chronic conditions that inhibit people from attending FS screening, and a third being to develop interventions for those who have one or more chronic conditions, but are nonetheless eligible to have the test.

4.2. Contradictions within the literature

There were few contradictions within the literature. Only two factors, older age and male gender, were found to be both positively and negatively associated with FS screening use. Contradictions with age are likely to be due to differences in the age categories examined. For example, Ko and colleagues, who published the one study which found a negative association between older age and FS screening use, examined FS screening use in adults over the age of 65, and included a group of 80 + year olds, for whom CRC screening is not recommended (Ko et al., 2005). With regards to contradictions with gender, these are more likely to be due to differences in the way in which individuals are invited for screening. For example, Blom et al., who published the one study which found a negative association between male gender and FS screening use, found that uptake was the same for men and women who were called by a nurse, but not those who had to call the centre themselves to make an appointment (Blom et al., 2008).

4.3. Problems with the literature

There are several problems with the literature, the most important being the lack of/incomplete use of theory. Most studies either did not use any theory, or only used theory in part. For example, while twelve studies examined the use of one or more constructs derived from the Health Belief Model (HBM), only four included all of the model constructs and tested the theory as a whole. This issue is exacerbated by a lack of standardised measures for specific constructs. For example, in the seven studies that examined perceived benefits (one of the four constructs that comprise the HBM), scores were calculated using items varying in number and content, making it impossible to directly compare the studies.

Another important problem with the literature is that many of the studies did not explain why they were examining certain factors. For example, 'visiting a physician within the previous year' (Bostick et al., 1994), 'having a pap smear within the previous year' (Shapiro et al., 2001) and 'having a cholesterol check within the previous year' (Shapiro et al., 2001) all effectively examined 'contact with a healthcare provider within the previous year'. It is possible that these items could have been combined in the present review, but a lack of explanation/reference to theory meant that it was not possible to assess whether these factors should be combined without introducing bias.

4.4. Problems with the search strategy

Prior to reference list searches, the database searches detected 22 articles, which equated to 52% of the total. One possible explanation as to why such a large number of papers was missed by the database searches, is that search terms were restricted to the title and abstracts of papers, and most papers examined predictors for more than one CRC screening test, and consequently did not mention FS screening (or synonyms of) within the title/abstract specifically. Had we included more general terms, such as 'bowel cancer' and 'colorectal cancer' to our search strategy, or extended search terms beyond the titles and abstracts, it is likely that those papers detected through the reference list searches would have been picked up by the database searches. However, both of these would likely have resulted in a substantial increase in the total number of papers eligible for review, and thereby prolonged the review process.

4.5. Implications for future research

This review has several implications for future research. It highlights a number of demographic subgroups for whom FS screening use is low, and would therefore benefit from the development of targeted interventions. These subgroups include women, adults under the age of 65, non-Black and non-Hispanic ethnic minority groups (e.g. Chinese,

Indian and Pakistani), and people who are unmarried or divorced. In addition, this review highlights a number of modifiable psychosocial factors that could be targeted by interventions to improve FS screening use. These include the perceived barriers and benefits of screening. Existing evidence suggests that targeting these factors is likely to be effective (Wardle et al., 2003; Kerrison et al., 2016; Kerrison et al., 2017; Kerrison et al., 2018), and that 'the patient not wanting to do the preparation', 'the healthcare provider not suggesting the test to the patient', 'the patient being worried that the test is uncomfortable or painful', and 'the patient not knowing they should have the test' are among the most important barriers to FS screening (although none have been tested in a multivariate regression, and further research confirming the importance of these barriers is also required) (Jones et al., 2010).

Another potential area for future research, would be to conduct a full systematic review separating the predictors of the remaining CRC screening tests. As identified in this review, different factors appear to be important for different CRC screening tests, and information distinguishing which factors are important for which tests is currently lacking. Conducting a systematic review that aims to disentangle which factors are important for which tests might help inform the development of interventions for different CRC screening tests, as well as identify low uptake groups, for whom interventions can be targeted.

4.6. Limitations

This review has several limitations. Most importantly, the search strategy used was not comprehensive; it was limited to peer-reviewed articles available on PubMed, and omitted several search terms (e.g. 'non-compliance', 'under-utilisation', etc.), due to < 1% of articles being identified by the final search (as with the previous searches, the exact combination and order in which additional search terms would have been added to the search strategy would have been determined by the total number of new publications obtained by each of the possible combinations). As such, it is possible that it did not include several relevant studies. This is a common problem with rapid reviews, one which is often accepted in favour of reviewing the literature in a shorter period of time, usually because the time and resources required for a comprehensive systematic review are not available (Tricco et al., 2015).

Another important limitation of this review is that it did not include qualitative research studies (of which the database and reference list searches identified seven (Austin et al., 2009; Hall et al., 2016; Holt, 1991; McCaffery et al., 2001; Rawl et al., 2000; Ritvo et al., 2013; Weitzman et al., 2001)). Findings contained within these studies might help explain the associations identified within this review. For example, why it is that men are more likely to use FS screening than women. A qualitative synthesis of these studies might provide a valuable contribution to the literature.

Finally, this review did not sub-classify studies by design. In addition, no formal quality assessment was performed, and results were taken at face value. We have noted the characteristics of studies in the tables. Researchers should refer to the appendices for further information on each of the studies.

4.7. Strengths

This review had a number of strengths. Most importantly, it contained a high number of articles, and had no date restriction imposed. Furthermore, it focused entirely on FS screening use, and did not mix findings with those for other screening tests, or diagnostic FS, meaning that it was possible to extract factors that were associated with FS screening use specifically.

5. Conclusions

The findings of this review suggest that a number of factors, including male gender, higher socioeconomic status, a family history of CRC, good perceived health status, higher perceived benefits and lower perceived barriers are all frequently positively associated with FS screening use. In addition, the findings highlight a number of issues with the existing literature, including a lack of theory and standardised measures. Implications for future research include investigating which chronic conditions act as barriers to FS screening, as well as the development of targeted interventions for low uptake groups.

Conflicts of interest

Robert S Kerrison, Christian von Wagner, Trish Green, Monica Winfield, Una Macleod, Mark Hughes, Colin J Rees, Stephen Duffy and Lesley M McGregor declare they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2018.12.018.

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