Interventions to promote colorectal cancer screening among people with a family history of colorectal cancer: A scoping review

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ABSTRACT

Background: The global incidence of colorectal cancer (CRC) is rising, with people having a family history of CRC (PFH-CRC) facing double the risk compared to the average-risk population. Despite this, CRC screening uptake among PFH-CRC remains low. There is a lack of systematic mapping of interventions promoting CRC screening in this high-risk population.

Objective: We conducted a scoping review to identify the types of interventions targeting PFH-CRC, their effectiveness in increasing CRC screening uptake, and the elements associated with the outcomes.

Methods: The Joanna Briggs Institute methodology for scoping review was followed. The search for eligible articles was conducted from the inception of each database until 17 July 2024 in PubMed, EMBASE, CINAHL, Cochrane, PsycINFO and Web of Science with no restrictions on language.

Results: Thirty studies from 1995 to 2023 across 13 countries were included; mostly from high-income countries. There was considerable variability in study design, intervention characteristics, and screening outcomes. Eleven studies used theoretical frameworks in intervention development. Fourteen studies reported statistically significant increases in screening uptake among PFH-CRC, most using complex, multiple-component interventions. Tailored print materials and patient navigation more consistently demonstrated increased screening uptake, while counselling yielded mixed results.

Conclusion: Interventions for promoting CRC screening uptake in PFH-CRC commonly incorporate print material, patient navigation and counselling, often combined into complex interventions. Future research should include more implementation studies to translate these interventions into real-world settings. Additionally, there are gaps in research from low- and middle-income countries, highlighting the need for further research in these resource-limited settings.

Abbreviations: CRC, colorectal cancer; FOBT, faecal occult blood test; FDR, first-degree relative; FIT, faecal immunochemical test; HCP, healthcare provider; HBM, health belief model; IP, index patient; MI, motivational interviewing; PFH-CRC, people with a family history of colorectal cancer; RCT, Randomised controlled trial; SDR, second-degree relative; Transtheoretical Model, TTM; Theory of Planned Behaviour, TPB

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1. Introduction

Colorectal cancer (CRC) ranks second in cancer-related deaths and third in diagnoses worldwide (Sung et al., 2021). Having a family history of CRC elevates CRC risk significantly, with first-degree relatives (FDR) facing a two to three times higher risk than the average risk population (Taylor et al., 2010, Roos et al., 2019). Clinical guidelines recommend earlier screening for people with a family history of CRC (PFH-CRC) (Rex et al., 2017, German Guideline Program in Oncology, 2019, Cairns et al., 2010, Sung et al., 2015, Pan American Health Organization, 2016, Cancer Council Australia Colorectal Cancer Guidelines Working Party, 2017), which has been shown to reduce CRC mortality rates (The Lancet et al., 2021). Yet less than 50% of PFH-CRC adhere to the recommended screening age and intervals (Lowery et al., 2016), and only 40% have ever undergone a screening colonoscopy (Ait Ouakrim et al., 2013). Barriers to screening include clinicians' insufficient collection of family history, lack of knowledge of guideline recommendations and inadequate screening monitoring systems (Lowery et al., 2016). On the other hand, facilitators of screening include healthcare providers' (HCP) recommendations and family encouragement (Lowery et al., 2016).

Strategies to promote CRC screening encompass client-directed or provider-directed approaches. Client-directed interventions aim to raise community demand for cancer screening services or reduce access barriers through education via mass media, public health campaigns, group or one-to-one sessions; client reminders and recall; client incentives; reducing costs for clients; and addressing structural barriers such as providing transportation and assisting in appointment scheduling (Baron et al., 2010). Provider-directed interventions minimise missed opportunities by HCPs to discuss, recommend and deliver cancer screening services through reminders, assessment, feedback, and incentives for the providers (Baron et al., 2010).

A literature review by Lowery et al. (2016) found that interventions tailored to PFH-CRC individuals' risk and perceived barriers, with barrier-overcoming strategies delivered by phone or in-person, were effective in promoting CRC screening among PFH-CRC (Lowery et al., 2016). However, the review was limited to English-language articles, randomised or observational studies from 2004 to 2015, and exclusively focused on those with a family history of non-hereditary CRC (Lowery et al., 2016).

This study aims to provide an updated review of interventions targeting CRC screening among PFH-CRC, detailing the types of interventions, their effectiveness, and the associated elements. The findings from this review can inform and guide the development of future interventions to effectively promote CRC screening within this high-risk population.

2. Method

2.1. Design

This scoping review followed the Joanna Briggs Institute review methodology (Peters et al., 2020) and is reported based on the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist (Tricco, 2018). The protocol was registered on the Open Science Framework (https://doi.org/10.17605/OSF.IO/E94JF).

Studies which described interventions targeting PFH-CRC to increase CRC screening uptake were included. Eligibility criteria were developed using the 'Participant, Concept and Context' approach (Peters et al., 2020), detailed in Supplementary material 1 .

Types of sources eligible for inclusion included peer-reviewed primary research articles, theses and dissertations. Study protocols, conference abstracts, editorials, and review articles were excluded. This scoping review considered any study design that met the eligibility criteria.

2.2. Search strategy

An initial limited search of PubMed and CINAHL was undertaken to identify articles on the topic with the following keywords: 'colorectal cancer', 'screening', 'intervention', and 'family history'. Text from titles and abstracts of relevant articles in the limited search and the index terms used to describe the articles were used to develop a full search strategy for PubMed, EMBASE, CINAHL, Cochrane, PsycINFO and Web of Science (see Supplementary material II). The search strategy, including keywords and index terms, was adapted for each database and reviewed by a librarian with expertise in search strategies. The final search for eligible articles was conducted on 17 July 2024. The search covered the period from the inception of each database until the final search date of 17 July 2024. Citation tracking was also conducted to identify other studies eligible for the scoping review. There were no restrictions on language or publication date.

2.3. Study selection

Articles retrieved from the search were imported into EndNote X9 and de-duplicated. They were then exported to Covidence (Veritas Health Innovation), a systematic review software. Four independent reviewers (TFAM, CSS BHC and STR) independently screened the titles and abstracts and examined the full texts of selected citations for assessment against the eligibility criteria. Exclusion reasons were recorded. Any discrepancies among reviewers were resolved through discussion, with input from three other co-researchers (LYK, NCJ and CM) sought if needed.

2.4. Data extraction, analysis and presentation

Data extraction was conducted using Covidence. A draft data extraction tool was developed and piloted on three articles. One reviewer (TFAM) extracted the data for all articles; another verified the data (BHC, CSS or STR). Any disagreements were resolved through discussion among them (TFAM, BHC, STR and CSS) or with additional reviewers (NCJ, LYK and CM) if required. Data from Covidence was then exported to Microsoft Excel for synthesis.

For research studies with several reports or publications (e.g. one publication for different outcomes in a study), we identified the study's main report, which contained the most comprehensive data on screening uptake in PFH-CRC for inclusion. However, other reports from each study were also reviewed. Additional data related to the description of interventions and other relevant outcomes were extracted into the main study findings to capture a more comprehensive description of the interventions.

Once studies were included, the general study characteristics (author, year of publication, country, study design, study population, final sample size) were extracted. Basic descriptive analysis (e.g., frequency) was used to report on the studies' characteristics. Textual data on the description of interventions were synthesised narratively using a descriptive qualitative content analysis approach (Pollock et al., 2023). The process for synthesising and categorising data relating to types of interventions was undertaken collaboratively and iteratively with all authors. The authors examined the types of interventions from the included studies, discussed initial thoughts, coded extracted statements and considered similarities that would lead to distinct categories. Supplementary material III provides an example of this data synthesis process. Studies which explicitly reported the type of intervention did not require narrative synthesis. The final categories and operational definitions of the main components of the interventions are presented in supplementary material IV

The following data on the intervention and its outcomes were extracted: theoretical framework used; target population (client (PFH-CRC) or provider); mode of delivery (phone, mail, online or in-person); personnel involved in delivery; and key findings, particularly CRC screening uptake in PFH-CRC. The data were reported in two separate tables based on the study design, i.e. (i) randomised controlled trial (RCT) or (ii) observational and implementation study designs. This enabled meaningful comparison of interventions within the same study design.

3. **Results**

3.1. Literature search

The database search identified 21092 records. Of these, 8902 duplicates were removed, resulting in 12190 records. Titles and abstracts from the 12190 records were assessed based on the eligibility criteria. One hundred and fifty-seven reports were selected for full-text screening. Twenty-two reports from citation tracking were assessed for eligibility. Figure 1 illustrates the selection process using the PRISMA diagram.

Of these, 39 reports were included in this scoping review: 35 from database searches and four from citation tracking. However, several of these reports originated from the same study, and 30 unique studies were eventually analysed. All included studies were published in English.

3.2. Study characteristics

Table 1 shows the characteristics of each included study. The studies were published between 1995 and 2023 in 13 countries. The earliest studies were published in the United Kingdom (UK) in 1995 (Carpenter et al., 1995) and 1996 (Cripps and Heald, 1996). There were no identified studies published from the year 1998 to 2006. Most of the studies (83.3%) were conducted in high-income countries (Carpenter et al., 1995, Cripps and Heald, 1996, Paskett et al., 2020, Esplen et al., 2019, Bauer et al., 2018, Ingrand et al., 2016, Carey et al., 2016, Bastani et al., 2015, Dekker et al., 2015, Redwood, 2014, Rabeneck et al., 2014, Kinney et al., 2014, Lowery et al., 2014, Armelao et al., 2010, Manne et al., 2009, Stephens and Moore, 2008, Rawl et al., 2008, Pezzoli et al., 2007, Glanz et al., 2007, Colombo et al., 1997, Carroll et al., 2020, Wu et al., 2022, González-López et al., 2023, Crispin et al., 2023, Dodd et al., 2019). Majority of studies were conducted in the United States of America (Paskett et al., 2020, Bastani et al., 2015, Redwood, 2014, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Rawl et al., 2008, Glanz et al., 2007, Wu et al., 2022); followed by three in Italy (Armelao et al., 2010, Pezzoli et al., 2007, Colombo et al., 1997), Australia (Carey et al., 2016, Stephens and Moore, 2008, Dodd et al., 2019) and Canada (Esplen et al., 2019, Rabeneck et al., 2014, Carroll et al., 2020); two in the UK (Carpenter et al., 1995, Cripps and Heald, 1996), Germany (Bauer et al., 2018, Crispin et al., 2023) and China (Meng et al., 2009, Bai et al., 2022); and one study was published in the following countries: Netherlands (Dekker et al., 2015), France (Ingrand et al., 2016), Iran (Salimzadeh et al., 2018), Egypt (Alwassief et al., 2023), Spain (González-López et al., 2023) and Montenegro (Panic et al., 2015).

Seventeen of the studies were RCTs (Paskett et al., 2020, Esplen et al., 2019, Bauer et al., 2018, Ingrand et al., 2016, Carey et al., 2016, Bastani et al., 2015, Dekker et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Stephens and Moore, 2008, Rawl et al., 2008, Glanz et al., 2007, Salimzadeh et al., 2018, Bai et al., 2022, Dodd et al., 2019, González-López et al., 2023). Twelve were observational studies (Carpenter et al., 1995, Cripps and Heald, 1996, Redwood, 2014, Rabeneck

et al., 2014, Armelao et al., 2010, Pezzoli et al., 2007, Colombo et al., 1997, Carroll et al., 2020, Meng et al., 2009, Panic et al., 2015, Crispin et al., 2023, Alwassief et al., 2023) and one was a hybrid implementation-effectiveness trial (Wu et al., 2022).

In all studies, the study participants, i.e. PFH-CRC, were FDRs of patients with CRC. Three studies included second-degree relatives (SDR) who fulfil the criteria based on CRC screening guidelines referred by the study (Crispin et al., 2023, Wu et al., 2022, Dodd et al., 2019). However, there were variations in the eligibility criteria of participants. Age entry requirements of participants were variable: from age 18 (Carey et al., 2016, Stephens and Moore, 2008, Carroll et al., 2020), 20 (Colombo et al., 1997), 25 (Cripps and Heald, 1996, Paskett et al., 2020, Esplen et al., 2019, Crispin et al., 2023), 30 (Kinney et al., 2014), 35 (Manne et al., 2009), 40 (Bauer et al., 2018, Bastani et al., 2015, Rawl et al., 2008, Glanz et al., 2007, Meng et al., 2009, Salimzadeh et al., 2018, Panic et al., 2015, Bai et al., 2022, González-López et al., 2023), 45 (Ingrand et al., 2016, Armelao et al., 2010) and 50 (Dodd et al., 2019). There were no age limits reported in eight studies (Carpenter et al., 1995, Cripps and Heald, 1996, Dekker et al., 2015, Rabeneck et al., 2014, Lowery et al., 2014, Redwood, 2014, Alwassief et al., 2023, Wu et al., 2022). Fourteen studies included participants who had not undergone colonoscopy in the past five to 10 years (Bauer et al., 2018, Ingrand et al., 2016, Redwood, 2014, Rabeneck et al., 2014, Kinney et al., 2014, Lowery et al., 2014, Armelao et al., 2010, Manne et al., 2009, Rawl et al., 2008, Meng et al., 2009, Bai et al., 2022, González-López et al., 2023, Crispin et al., 2023, Dodd et al., 2019). Half of the studies excluded people with a family history of hereditary cancer syndromes (Paskett et al., 2020, Esplen et al., 2019, Bauer et al., 2018, Carey et al., 2016, Bastani et al., 2015, Dekker et al., 2015, Redwood, 2014, Kinney et al., 2014, Armelao et al., 2010, Manne et al., 2009, Pezzoli et al., 2007, Glanz et al., 2007, González-López et al., 2023, Crispin et al., 2023, Alwassief et al., 2023).

Most studies (73.3%) recruited PFH-CRC from index patients (IP) with CRC identified by hospital specialists, registries, or medical records (Cripps and Heald, 1996, Paskett et al., 2020, Esplen et al., 2019, Bauer et al., 2018, Ingrand et al., 2016, Carey et al., 2016, Bastani et al., 2015, Dekker et al., 2015, Redwood, 2014, Rabeneck et al., 2014, Kinney et al., 2014, Armelao et al., 2010, Manne et al., 2009, Stephens and Moore, 2008, Rawl et al., 2008, Pezzoli et al., 2007, Glanz et al., 2007, Salimzadeh et al., 2018, Alwassief et al., 2023, Crispin et al., 2023, González-López et al., 2023, Bai et al., 2022). Other studies approached the PFH-CRC directly from population-based programmes (Rabeneck et al., 2014, Meng et al., 2009), the CRC Family Registry or Cancer Genetics Network (Lowery et al., 2014,

Colombo et al., 1997), primary care clinics (Carroll et al., 2020, Wu et al., 2022, Dodd et al., 2019), and surgical ward or outpatient clinic (Carpenter et al., 1995).

3.3. Characteristics and outcomes of the interventions

Tables 2 and 3 present the characteristics and outcomes of the interventions assessed in the 30 studies evaluated through (i) RCT, and (ii) observational and hybrid implementation-effectiveness study designs, respectively.

3.3.1. Types of interventions

i. Print materials

Nineteen studies used print materials to promote CRC screening among PFH-CRC. Of these, eight evaluated the effectiveness of tailored educational print materials as part of the intervention (Ingrand et al., 2016, Carey et al., 2016, Bastani et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Rawl et al., 2008, Glanz et al., 2007), while the remaining studies used non-tailored print materials (Carpenter et al., 1995, Cripps and Heald, 1996, Bauer et al., 2018, Dekker et al., 2015, Armelao et al., 2010, Stephens and Moore, 2008, Colombo et al., 1997, Carroll et al., 2020, González-López et al., 2023, Dodd et al., 2019, Alwassief et al., 2023).

The delivery methods for the print materials varied, including mail (Cripps and Heald, 1996, Bauer et al., 2018, Ingrand et al., 2016, Carey et al., 2016, Bastani et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Armelao et al., 2010, Stephens and Moore, 2008, Rawl et al., 2008, Manne et al., 2009), and in-person distribution by nurses, health educators, clinic assistants, or physicians (Carpenter et al., 1995, Ingrand et al., 2016, Dekker et al., 2015, Glanz et al., 2007, Carroll et al., 2020, González-López et al., 2023, Dodd et al., 2019, Alwassief et al., 2023). One study distributed the print materials both in-person and by mail (Colombo et al., 1997). In most studies, print materials were provided during the initial contact.

The tailored print materials were based on several tailoring variables, including risk profile, demographic information, and psychosocial factors such as perceived cancer risk, screening benefits, and barriers (detailed in supplementary material V). These materials contained personalised information about screening recommendations based on risk, the benefits of screening, and suggestions for overcoming identified barriers. In three studies, tailored print materials were also provided during

follow-up (Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009), summarising issues and personalised action plans discussed during counselling sessions.

In addition to print materials aimed at PFH-CRC, some studies provided materials for doctors, which included educational information about screening guidelines to encourage and motivate patients to undergo colonoscopy (Ingrand et al., 2016). Two studies provided doctors with copies of the print materials given to PFH-CRC (Carey et al., 2016, Kinney et al., 2014), while Dodd et al. (2019) provided doctors with a script to help communicate the significance of screening to patients (Dodd et al., 2019).

ii. *Counselling*

Eighteen studies integrated counselling as a key component of their interventions (Carpenter et al., 1995, Esplen et al., 2019, Bauer et al., 2018, Ingrand et al., 2016, Bastani et al., 2015, Rabeneck et al., 2014, Kinney et al., 2014, Lowery et al., 2014, Armelao et al., 2010, Manne et al., 2009, Pezzoli et al., 2007, Glanz et al., 2007, Meng et al., 2009, Salimzadeh et al., 2018, Bai et al., 2022, Dodd et al., 2019, Crispin et al., 2023, Wu et al., 2022). Among these studies, four studies employed motivational interviewing (MI) techniques to foster intrinsic motivation and behavioural change (Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Salimzadeh et al., 2018).

The counselling sessions were delivered by personnel possessing diverse backgrounds, including genetic counsellors (Esplen et al., 2019, Kinney et al., 2014), nurses and health educators (Bauer et al., 2018, Ingrand et al., 2016, Bastani et al., 2015, Manne et al., 2009, Glanz et al., 2007, Salimzadeh et al., 2018, Bai et al., 2022), as well as doctors, including primary care physicians (Carpenter et al., 1995, Rabeneck et al., 2014, Pezzoli et al., 2007, Dodd et al., 2019, Wu et al., 2022), and specialists (oncologists, gastroenterologists, internists, surgeons) (Meng et al., 2009) (Armelao et al., 2010, Crispin et al., 2023).

Seven studies utilised phone-based counselling (Bauer et al., 2018, Ingrand et al., 2016, Bastani et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Salimzadeh et al., 2018), while one study conducted counselling via voice calls on the WeChat mobile application (Bai et al., 2022). Eight studies offered in-person counselling sessions (Carpenter et al., 1995, Rabeneck et al., 2014, Armelao et al., 2010, Pezzoli et al., 2007, Meng et al., 2009, Dodd et al., 2019, Crispin et al., 2023, Wu et al., 2022). Esplen et al. (2019) compared the effectiveness of in-person versus phone counselling (Esplen et al., 2019). Glanz et al. (2007) adopted a hybrid approach, providing in-person counselling

during initial contact, followed by a phone call for additional counselling and follow-up (Glanz et al., 2007).

iii. Patient navigation

Six studies utilised trained personnel as patient navigators to facilitate CRC screening among PFH-CRC (Paskett et al., 2020, Redwood, 2014, Armelao et al., 2010, Colombo et al., 1997, Meng et al., 2009, Panic et al., 2015). These navigators encouraged the PFH-CRC to undergo CRC screening and assisted in scheduling colonoscopy appointments. In some studies, the navigators also helped address barriers to screening (Paskett et al., 2020, Meng et al., 2009). For example, the navigators provided support such as encouragement and explaining the importance of getting tested and potential outcomes; education on what the tests involve, what to expect, and key questions to ask; as well as referrals to local providers along with assistance in scheduling, to help address some of the barriers to screening (Paskett et al., 2020).

Two studies specifically mentioned using nurses as navigators (Armelao et al., 2010, Panic et al., 2015), while the background of the navigators in the remaining studies was not explicitly stated. All navigators communicated with PFH-CRC remotely, primarily through phone interactions. However, Colombo et al.(1997) took a different approach by also engaging with PFH-CRC in person to explain the screening procedure (Colombo et al., 1997). One study reported that 68.1% of participants had more than one encounter with a navigator, with an average of three encounters (Paskett et al., 2020).

iv. Other interventions

In addition to the three main intervention components, Bai et al. (2022) provided materials through the WeChat online mobile application (Bai et al., 2022). An online tailored message was sent to PFH-CRC, summarising the individual's family history risk, screening suggestions and key issues identified during the prior assessment and counselling session (Bai et al., 2022).

Six studies integrated risk assessment tools into their interventions. Four of these studies used online tools: three utilised a website accessible to both PFH-CRC and doctors (Paskett et al., 2020, Dekker et al., 2015, Wu et al., 2022), while one used the WeChat application (Bai et al., 2022). These online tools provided risk assessment alongside information and recommendations for CRC screening. In contrast, Carroll et al. (2020) employed a card for doctors that contained a risk assessment tool (Carroll et al., 2020).

Three studies incorporated reminder postcards as part of their intervention strategies (Redwood, 2014, Kinney et al., 2014, Lowery et al., 2014). Another study introduced a cost resource letter during

the 9-month follow-up, listing resources that offered free or reduced-cost colonoscopy services (Kinney et al., 2014).

Additionally, Carpenter et al. (1995) set up a family cancer screening clinic, where PFH-CRC could be referred for CRC screening (Carpenter et al., 1995). Dekker et al. (2015) included pocket cards on referral criteria and an educational session via presentation targeted at doctors as part of the intervention (Dekker et al., 2015).

3.3.2. Theoretical frameworks used in intervention design

Theoretical frameworks guided the development of interventions in 11 studies (Esplen et al., 2019, Ingrand et al., 2016, Bastani et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Stephens and Moore, 2008, Rawl et al., 2008, Glanz et al., 2007, Wu et al., 2022, Bai et al., 2022). The Health Belief Model (HBM) was the most widely adopted framework, used in nine studies (Esplen et al., 2019, Ingrand et al., 2016, Bastani et al., 2015, Lowery et al., 2014, Manne et al., 2009, Stephens and Moore, 2008, Rawl et al., 2008, Wu et al., 2022, Bai et al., 2022). The Transtheoretical Model (TTM) appeared in three studies (Lowery et al., 2014, Manne et al., 2009, Rawl et al., 2008), and the Theory of Planned Behaviour (TPB) was utilised in two studies (Bastani et al., 2015, Lowery et al., 2014). Other theoretical frameworks applied include the Theory of Reasoned Action (Ingrand et al., 2016), Extended Parallel Process Model (Kinney et al., 2014), Dual Process Theory (Manne et al., 2009), Social Cognitive Theory (Bastani et al., 2015), Social Influence Theory (Bastani et al., 2015), Precaution Adoption Process Model (Glanz et al., 2007) and the Transactional Model of Stress and Coping (Glanz et al., 2007). Several studies employed multiple theories to guide their intervention designs (Ingrand et al., 2016, Bastani et al., 2015, Lowery et al., 2014, Manne et al., 2009, Stephens and Moore, 2008, Rawl et al., 2008, Glanz et al., 2007).

3.3.3. Outcomes of interventions

The studies exhibited substantial variability in defining screening outcome measures, differing in several key areas: (i) CRC screening modality (colonoscopy only, faecal occult blood test (FOBT) only or any test including FOBT, sigmoidoscopy or colonoscopy); (ii) follow-up duration (ranging from 30 days to 12 years); (iii) analytic approach and (iv) type of CRC screening outcome evaluated (screening

uptake or adherence to screening guidelines). Additionally, data reporting sources varied, with outcomes either self-reported or verified through medical records.

3.3.3.1 CRC screening outcomes from RCT study designs

Among the 17 RCTs evaluating interventions, nine reported statistically significant improvements in CRC screening uptake, with increases ranging from 24.8% to 83.5%, and effect sizes between 1.24 and 10.24 times greater than control groups (Paskett et al., 2020, Ingrand et al., 2016, Bastani et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009, Salimzadeh et al., 2018, Bai et al., 2022, Dodd et al., 2019). The HBM emerged as the most frequently used theoretical framework (n=5), followed by the TTM and TPB, each used in two studies.

Five studies demonstrated that combining tailored print materials with counselling was more effective than non-tailored print materials alone (Ingrand et al., 2016, Bastani et al., 2015, Kinney et al., 2014, Lowery et al., 2014, Manne et al., 2009). However, sub-analyses in two of these studies found no significant difference between the combination of tailored print materials and counselling versus providing tailored print materials alone (Bastani et al., 2015, Manne et al., 2009). Bai et al. (2022) showed that online tailored material delivered via an application, along with counselling, were more effective than non-tailored online material alone (Bai et al., 2022). Dodd et al. (2019) found that counselling combined with non-tailored print material increased screening uptake compared to usual care (Dodd et al., 2019)., while Salimzadeh et al. (2018) reported that counselling alone was more effective than non-tailored generic information given orally by physicians (Salimzadeh et al., 2018). Paskett et al. (2020) showed that patient navigation was more effective than no navigation in the only RCT evaluating this intervention (Paskett et al., 2020).

Conversely, five RCTs reported no significant impact on CRC screening uptake (Esplen et al., 2019, Bauer et al., 2018, Dekker et al., 2015, Stephens and Moore, 2008, Rawl et al., 2008). Stephens et al. (2008) found no significant difference when comparing non-tailored print material for FDRs with standard information for IPs (Stephens and Moore, 2008). Dekker et al. (2015) reported that interventions targeted at IPs (non-tailored print material and website) did not significantly increase screening uptake among FDRs, with only 23% of the IPs sharing the information with their FDRs (Dekker et al., 2015). Bauer et al. (2018) found that additional phone counselling by nurses, combined with non-tailored print materials, did not significantly boost uptake compared to solely using non-tailored print material (Bauer et al., 2018). Esplen et al. (2019) found no significant differences among in-person counselling, telephone counselling and usual care (Esplen et al., 2019).

Two studies assessed adherence to screening recommendations (Carey et al., 2016, Glanz et al., 2007). Glanz et al. found that targeted counselling and tailored print materials significantly improved adherence compared to general health counselling and non-tailored print materials (Glanz et al., 2007).

Carey et al. (2016) reported that tailored print material for FDRs was more effective in promoting adherence than general CRC screening information (Carey et al., 2016). Lastly, González-López et al. (2023) compared two CRC screening strategies – faecal immunochemical test (FIT) and colonoscopy - and found that FIT did not significantly enhance screening acceptance among PFH-CRC (González-López et al., 2023).

3.3.3.2 CRC screening outcomes from observational and implementation study designs

Twelve studies utilised observational study designs (Carpenter et al., 1995, Rabeneck et al., 2014, Cripps and Heald, 1996, Redwood, 2014, Armelao et al., 2010, Pezzoli et al., 2007, Colombo et al., 1997, Carroll et al., 2020, Meng et al., 2009, Panic et al., 2015, Crispin et al., 2023, Alwassief et al., 2023) and did not employ theoretical frameworks. Among these, four studies reported statistically significant increases in screening uptake ranging from 37.69% to 77.6% (Armelao et al., 2010, Meng et al., 2009, Panic et al., 2015, Alwassief et al., 2023).

Meng et al. (2009) found that remote patient navigation and counselling significantly increased screening uptake (Meng et al., 2009). Armelao et al. (2010) conducted a prospective cohort study demonstrating increased colonoscopy uptake through a multi-step intervention: public education campaign, followed by delivery of non-tailored print materials, patient navigation and counselling, compared to a control group receiving only public education (Armelao et al., 2010). Alwassief et al. (2023) reported that a direct colonoscopy invitation was more effective than a two-step screening strategy (FIT followed by colonoscopy) (Alwassief et al., 2023). Panic et al. (2015) adopted a unique approach, conducting a comparative analysis of interventions targeting separate populations (Panic et al., 2015) where they found that the patient navigation support showed a significantly higher rate of colonoscopy uptake among FDRs compared to the average-risk population that invited for FOBT by a general practitioner (Panic et al., 2015).

Conversely, Caroll et al. (2020) found that non-tailored information materials and risk assessment tools for physicians had no significant effect on FDRs receiving a correct CRC screening test when comparing before and after intervention (Carroll et al., 2020).

Seven studies were cohort studies without comparison data to assess the statistical significance of the outcome in increasing the screening uptake (Carpenter et al., 1995, Cripps and Heald, 1996, Redwood, 2014, Rabeneck et al., 2014, Pezzoli et al., 2007, Colombo et al., 1997, Crispin et al., 2023). Six of these reported screening uptake rates between 29.9% and 94.4%. within two to seven years of follow-up. Pezzoli et al. (2007) reported the highest uptake (94.4%) attributing it mainly to their intervention involving direct physician-patient contact (Pezzoli et al., 2007). Rabeneck et al. (2014) reported the number of FDRs who underwent colonoscopy in 2011, following the launch of their

intervention (campaign and counselling) in 2008 (Rabeneck et al., 2014), without providing the total number of FDRs eligible or overdue for screening.

Additionally, Wu et al. (2022) conducted a hybrid implementation-effectiveness study design and found that a web-based clinical decision support tool for risk assessment and management recommendation, combined with counselling, significantly increased guideline-based screening uptake (Wu et al., 2022).

4. Discussion

This scoping review included 30 studies published between 1995 and 2023 across 13 countries. Of these, 17 studies employed RCTs, providing high level of evidence in evaluating the effectiveness of interventions for promoting CRC screening in PFH-CRC. However, the studies varied in their eligibility criteria and outcome measures, as well as in the characteristics of interventions, including their type, theoretical frameworks, components, delivery modes, and personnel involved.

Fourteen studies reported statistically significant increases in CRC screening uptake among PFH-CRC. Most of these successful interventions were complex, involving multiple components and tailored approaches (Craig et al., 2008, Skivington et al., 2021). This aligns with other reviews of screening strategies for non-communicable diseases (Rodríguez-Gómez et al., 2020, Hyseni et al., 2019). This pattern is further exemplified by Rawl et al. (2008) who found that while a single-point intervention using tailored print materials effectively moved individuals through stages of adoption pre-contemplation, contemplation and preparation); it did not significantly impact actual screening uptake (Rawl et al., 2008). This suggests that motivating individuals, especially those at higher risk, might require multiple interactions (Rawl et al., 2008).

In contrast, one study from a lower-middle-income country demonstrated that even single-component, single-point intervention could effectively increase CRC screening uptake (Salimzadeh et al., 2018). This effectiveness might be attributed to lower baseline awareness and limited access to healthcare resources in these settings, where any intervention, even if less complex, can significantly raise awareness and screening rates.

The review identified print materials, counselling, and patient navigation as the common intervention components. Among the RCTs, tailored print materials were the most frequently associated with positive outcomes. Some studies customised these materials based on variables from health behaviour models (Ingrand et al., 2016, Bastani et al., 2015, Lowery et al., 2014, Manne et al., 2009, Rawl et al., 2008). Notably, two studies utilised computer software for tailoring print materials, illustrating the role of technology in enhancing personalisation (Ingrand et al., 2016, Rawl et al., 2008). Recent advancements include the use of mobile applications for delivering tailored messages. For instance, Bai et al. (2022) demonstrated the effectiveness of using the WeChat application to provide

tailored online messages to PFH-CRC, highlighting a modern evolution in print material delivery and its positive impact on screening outcomes (Bai et al., 2022).

Patient navigation was effective in four studies that assessed it. Redwood et al. (2014) outlined various challenges in the implementation of patient navigation, including insufficient staff and resources, data sharing issues, a lack of coordination and education for providers and case managers, and difficulties accessing remote communities (Redwood, 2014).

The evidence on counselling's effectiveness in increasing screening uptake is mixed, aligning with the findings of a systematic review by Long et al. (2022) (Long et al., 2022). Salimzadeh et al. (2018) reported that one-time counselling using MI increased the knowledge of CRC and screening uptake among the intervention group (Salimzadeh et al., 2018). However, three other studies found that counselling, whether using MI or not, was not more effective than print materials alone, regardless of whether the materials were tailored (Bauer et al., 2018, Bastani et al., 2015, Manne et al., 2009). Manne et al. (2009) postulated that the relatively structured, script-based nature of counselling might have limited the exploration of practical and emotional barriers to screening (Manne et al., 2009). Manne et al. also speculated that resistance to counselling could be another factor, as 50% of participants cancelled or missed the session (Manne et al., 2009). A more in-depth analysis is needed to elucidate the underlying factors for the inability of counselling intervention to enhance CRC screening uptake beyond what print materials achieve. In terms of delivery methods, one study found no difference between phone and in-person counselling in increasing screening uptake (Esplen et al., 2019). While Bai et al. (2022) used the WeChat application for voice-call counselling (Bai et al., 2022), the effectiveness of video counselling, an increasingly popular method, has not yet been explored. This underscores the potential of digital platforms for counselling interventions that warrant further investigation.

Only eleven studies used theoretical frameworks in developing interventions, with seven demonstrating effectiveness. Six of these successful interventions were based on HBM. However, other HBM-based studies did not show improvement in CRC screening uptake, possibly due to study design issues such as inadequate follow-up time to fully capture colonoscopy participation (Rawl et al., 2008) or a ceiling effect, where screening intent and adherence were already high at baseline (Esplen et al., 2019). This low use of theory-based interventions and mixed findings on behaviour change align with conclusions from other reviews (Prestwich et al., 2015, Dalgetty et al., 2019). Beyond study design, the ineffectiveness may also stem from not fully utilising all aspects of the theoretical framework (Michie and Prestwich, 2010). While the evidence linking theory-based interventions to behaviour change efficacy remains inconclusive, theories can still provide valuable insights for designing effective

interventions by identifying relevant factors and guiding the goals, content, and delivery of the interventions. (Davidoff et al., 2015, O'Cathain et al., 2019).

Among the 14 studies that effectively increased uptake, 10 recruited participants through IP identified from registries or treating physicians. Surprisingly, only two of these studies recruited PFH-CRC directly from primary care settings (Wu et al., 2022, Dodd et al., 2019) despite the crucial role of primary care doctors in preventive care (Abdullah et al., 2022, Snipelisky et al., 2016). This may be due to the challenges in identifying PFH-CRC in primary care, where doctors, due to heavy workloads and inadequate systems, may not routinely inquire about family history (Ingrand et al., 2009, Hussein et al., 2020). Therefore, identifying PFH-CRC through IPs appears more feasible. Moreover, positive family dynamics were observed to facilitate screening uptake (Ingrand et al., 2016).

Despite the challenges, primary care physicians' involvement were effective in encouraging screening among patients with a family history of CRC, as demonstrated in five studies (Paskett et al., 2020, Ingrand et al., 2016, Kinney et al., 2014, Dodd et al., 2019, Wu et al., 2022). Dodd et al. (2019) notably reported the highest odds ratio for screening uptake, specifically involving primary care doctors who encouraged patients during regular appointments, highlighting the significant impact these physicians can have in promoting CRC screening.

Although HCPs' recommendations are key predictors of screening uptake (Laiyemo et al., 2014, Ramdass et al., 2014, Rollet et al., 2021), only six effective studies incorporated interventions using doctors (Ingrand et al., 2016, Carey et al., 2016, Dekker et al., 2015, Rabeneck et al., 2014, Kinney et al., 2014, Pezzoli et al., 2007, Carroll et al., 2020, Armelao et al., 2010, Meng et al., 2009, Wu et al., 2022, Dodd et al., 2019), while most used non-clinicians. Task-shifting may be beneficial in areas with a shortage of doctors, provided that adequate training and competency measures are in place.

Several studies in this review emphasised the importance of overcoming financial barriers to screening (Bastani et al., 2015, Armelao et al., 2010, Rawl et al., 2008, Salimzadeh et al., 2018). This issue was particularly evident when the study by Rawl et al. was the only one that found tailored print interventions to be ineffective, largely due to participants lacking insurance coverage, which hindered their ability to undergo colonoscopies (Rawl et al., 2008). This highlights the critical need to consider the accessibility of both interventions and screening procedures, as financial barriers can significantly compromise the effectiveness of even well-designed interventions.

4.1. Strengths and limitations

This scoping review employed a rigorous and transparent approach to selecting relevant articles and reporting, adhering to PRISMA-ScR guidelines. The involvement of an academic librarian enhanced the search strategy. However, the focus on screening uptake as the primary outcome may have led to the exclusion of other important outcomes, such as implementation intervention outcomes, including acceptability, feasibility, and appropriateness. Additionally, by limiting the review to peer-reviewed

articles, there is a possibility of overlooking interventions that were not published in journals or indexed in the selected databases. Finally, since the quality appraisal of the studies was not within the scope of this review, we are unable to draw conclusions about the quality of the studies included and the strength of the evidence. A systematic review may be conducted to assess the rigour of the interventions aimed at increasing screening uptake.

5. Conclusion

In conclusion, this scoping review revealed that print material, counselling, and patient navigation were the most common interventions tested in promoting CRC screening uptake in PFH-CRC. Most of the interventions were complex, involving combinations of multiple components. The synthesis of the characteristics and outcomes of the interventions serves as a valuable guide for developing future interventions. Future studies should include a more in-depth analysis to identify underlying factors associated with the outcomes and implementation research to transfer evidence-based interventions into real-world settings. Furthermore, there are gaps in the evidence from low- and middle-income countries, emphasising the necessity for further research to evaluate the effectiveness of interventions in resource-constrained settings.

Patient consent for publication

Not required

Ethics approval

This scoping review does not require ethics approval.

CRediT authorship contribution statement

Abdul Malik Tun Firzara: Conceptualisation, Formal analysis, Funding acquisition Methodology, Investigation, Project administration, Resources, Writing – original draft, review & editing, Visualisation. **Hooi Chin Beh**: Investigation, Formal analysis, Writing – review & editing. **Christine Shamala Selvaraj**: Investigation, Formal analysis, Writing – review & editing. **Christian Mallen**: Supervision, Conceptualisation, Methodology, Formal analysis, Writing – review & editing. **Chirk Jenn Ng**: Supervision, Conceptualisation, Methodology, Formal analysis, Writing – review & editing, Funding acquisition. **Yew Kong Lee**:

Supervision, Conceptualisation, Methodology, Formal analysis, Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

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References

ABDULLAH, M. Y., ALSHEHRI, S. A., MAHNASHI, H. A., ALSHAHRANI, S. S., ALKHALDI, S. S., ALSHAMMARI, S. M., ALOTAIBI, R. S., QUTUB, R. M., JAMHAN, A. Y., ALHUSSAIN, S. A., ABDULQADER, A. K. & BINMAHRI, M. K. 2022. Role of primary care physician in health promotion and education. *International Journal Of Community Medicine And Public Health,* 9**,** 4705-4709.

AIT OUAKRIM, D., LOCKETT, T., BOUSSIOUTAS, A., HOPPER, J. L. & JENKINS, M. A. 2013. Screening participation for people at increased risk of colorectal cancer due to family history: a systematic review and meta-analysis. *Fam Cancer,* 12**,** 459-72.

ALWASSIEF, A., BAKR, I. S. & DAWOD, H. M. 2023. Utility of Fecal Immunochemical Test in Screening for Colorectal Cancer in Egyptian Individuals with Family History of Advanced Colonic Neoplasia. *Middle East Journal of Cancer,* 14**,** 162-169.

ARMELAO, F., ORLANDI, P. G., TASINI, E., FRANCESCHINI, G., FRANCH, R., PATERNOLLI, C. & DE PRETIS, G. 2010. High uptake of colonoscopy in first-degree relatives of patients with colorectal cancer in a healthcare region: a population-based, prospective study. *Endoscopy,* 42**,** 15-21.

BAI, Y., WONG, C. L., PENG, X., CHOI, K. C. & SO, W. K. W. 2022. Effectiveness of a tailored communication intervention on colonoscopy uptake for firstdegree relatives of colorectal cancer patients: A randomized controlled trial. *Asia Pac J Oncol Nurs,* 9**,** 100068.

BARON, R. C., MELILLO, S., RIMER, B. K., COATES, R. J., KERNER, J., HABARTA, N., CHATTOPADHYAY, S., SABATINO, S. A., ELDER, R. & LEEKS, K. J. 2010. Intervention to Increase Recommendation and Delivery of Screening for Breast, Cervical, and Colorectal Cancers by Healthcare Providers: A Systematic Review of Provider Reminders. *American Journal of Preventive Medicine,* 38**,** 110-117.

BASTANI, R., GLENN, B. A., MAXWELL, A. E., GANZ, P. A., MOJICA, C. M., ALBER, S., CRESPI, C. M. & CHANG, L. C. 2015. Randomized trial to increase colorectal cancer screening in an ethnically diverse sample of first-degree relatives. *Cancer,* 121**,** 2951-9.

BAUER, A., RIEMANN, J. F., SEUFFERLEIN, T., REINSHAGEN, M., HOLLERBACH, S., HAUG, U., UNVERZAGT, S., BOESE, S., RITTER-HERSCHBACH, M., JAHN, P., FRESE, T., HARRIS, M. & LANDENBERGER, M. 2018. Invitation to Screening Colonoscopy in the Population at Familial Risk for Colorectal Cancer. *Dtsch Arztebl Int,* 115**,** 715-722.

BUDDE, H., WILLIAMS, G. A., SCARPETTI, G., KROEZEN, M. & MAIER, C. B. 2022. European Observatory Policy Briefs. *What are patient navigators and how can they improve integration of care?* Copenhagen (Denmark): European Observatory on Health Systems and Policies

CAIRNS, S. R., SCHOLEFIELD, J. H., STEELE, R. J., DUNLOP, M. G., THOMAS, H. J. W., EVANS, G. D., EADEN, J. A., RUTTER, M. D., ATKIN, W. P., SAUNDERS, B. P., LUCASSEN, A., JENKINS, P., FAIRCLOUGH, P. D., WOODHOUSE, C. R. J., DEVELOPED ON BEHALF OF THE BRITISH SOCIETY OF, G., THE ASSOCIATION OF COLOPROCTOLOGY FOR GREAT, B. & IRELAND 2010. Guidelines for colorectal cancer screening and surveillance in moderate and high risk groups (update from 2002). *Gut,* 59**,** 666.

CANCER COUNCIL AUSTRALIA COLORECTAL CANCER GUIDELINES WORKING PARTY. 2017. *Clinical practice guidelines for the prevention, early detection and management of colorectal cancer* [Online]. Available: https://wiki.cancer.org.au/australia/Guidelines:Colorectal_cancer [Accessed].

CAREY, M., SANSON-FISHER, R., MACRAE, F., CAMERON, E., HILL, D., D'ESTE, C., SIMMONS, J. & DORAN, C. 2016. Can a print-based intervention increase screening for first degree relatives of people with colorectal cancer? A randomised controlled trial. *Aust N Z J Public Health,* 40**,** 582-587.

CARPENTER, S., BROUGHTON, M. & MARKS, C. G. 1995. A screening clinic for relatives of patients with colorectal cancer in a district general hospital. *Gut,* 36**,** 90-2.

CARROLL, J. C., PERMAUL, J. A., SEMOTIUK, K., YUNG, E. M., BLAINE, S., DICKS, E., WARNER, E., ROTHENMUND, H., ESPLEN, M. J., MOINEDDIN, R. & MCLAUGHLIN, J. 2020. Hereditary colorectal cancer screening: A 10-year longitudinal cohort study following an educational intervention. *Preventive Medicine Reports,* 20**,** 101189.

COLOMBO, L., CORTI, G., MAGRI, F., MAROCCHI, A., BRAMBILLA, P., CRESPI, C., MANIERI, L., GHEZZI, S., GIANNONE, D., MERLINO, L. & MOCARELLI, P. 1997. Results of a pilot study of endoscopic screening of first degree relatives of colorectal cancer patients in Italy. *J Epidemiol Community Health,* 51**,** 453-8.

CRAIG, P., DIEPPE, P., MACINTYRE, S., MICHIE, S., NAZARETH, I. & PETTICREW, M. 2008. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ,* 337**,** a1655.

CRIPPS, N. P. & HEALD, R. J. 1996. Family based colorectal cancer screening in a district hospital. *Gut,* 38**,** 421-5.

CRISPIN, A., REHMS, R., HOFFMANN, S., LINDOERFER, D., HALLSSON, L. R., JAHN, B., MÜHLBERGER, N., SROCZYNSKI, G., SIEBERT, U. & MANSMANN, U. 2023. Colorectal Cancer Screening for Persons With a Positive Family History—Evaluation of the FARKOR Program for the Secondary Prevention of Colorectal Cancer in Persons Aged 25 to 50. *Dtsch Arztebl Int,* 120**,** 786-792.

DALGETTY, R., MILLER, C. B. & DOMBROWSKI, S. U. 2019. Examining the theory-effectiveness hypothesis: A systematic review of systematic reviews. *Br J Health Psychol,* 24**,** 334-356.

DAVIDOFF, F., DIXON-WOODS, M., LEVITON, L. & MICHIE, S. 2015. Demystifying theory and its use in improvement. *BMJ Qual Saf,* 24**,** 228-38.

DEKKER, N., HERMENS, R. P., DE WILT, J. H., VAN ZELST-STAMS, W. A., HOOGERBRUGGE, N. & THE, R. S. G. 2015. Improving recognition and referral of patients with an increased familial risk of colorectal cancer: results from a randomized controlled trial. *Colorectal Disease,* 17**,** 499-510.

DODD, N., CAREY, M., MANSFIELD, E., OLDMEADOW, C. & EVANS, T. J. 2019. Testing the effectiveness of a general practice intervention to improve uptake of colorectal cancer screening: a randomised controlled trial. *Aust N Z J Public Health,* 43**,** 464-469.

ESPLEN, M. J., HARRINGTON, S., LEUNG, Y. W., ARONSON, M., ROTHENMUND, H., SEMOTIUK, K., WONG, J., GALLINGER, S., DICKS, E. & MCLAUGHLIN, J. 2019. Telephone versus in-person colorectal cancer risk and screening intervention for first-degree relatives: A randomized controlled trial. *Cancer,* 125**,** 2272-2282.

GERMAN GUIDELINE PROGRAM IN ONCOLOGY. 2019. *Evidence-based guideline for colorectal cancer. Version 2.1* [Online]. German Cancer Society, German Cancer Aid,

AWMF. Available: https://www.leitlinienprogramm-onkologie.de/leitlinien/kolorektales-karzinom/ [Accessed].

GLANZ, K., STEFFEN, A. D. & TAGLIALATELA, L. A. 2007. Effects of Colon Cancer Risk Counseling for First-Degree Relatives. *Cancer Epidemiology Biomarkers & Prevention*, 16**,** 1485.

GONZÁLEZ-LÓPEZ, N., QUINTERO, E., GIMENO-GARCIA, A. Z., BUJANDA, L., BANALES, J., CUBIELLA, J., SALVE-BOUZO, M., HERRERO-RIVAS, J. M., CID-DELGADO, E., ALVAREZ-SANCHEZ, V., LEDO-RODRÍGUEZ, A., DE-CASTRO-PARGA, M. L., FERNÁNDEZ-POCEIRO, R., SANROMÁN-ÁLVAREZ, L., SANTIAGO-GARCIA, J., HERREROS-DE-TEJADA, A., OCAÑA-BOMBARDO, T., BALAGUER, F., RODRÍGUEZ-SOLER, M., JOVER, R., PONCE, M., ALVAREZ-URTURI, C., BESSA, X., RONCALES, M. P., SOPEÑA, F., LANAS, A., NICOLÁS-PÉREZ, D., ADRIÁN-DE-GANZO, Z., CARRILLO-PALAU, M. & GONZÁLEZ-DÁVILA, E. 2023. Screening uptake of colonoscopy versus fecal immunochemical testing in first-degree relatives of patients with non-syndromic colorectal cancer: A multicenter, open-label, parallel-group, randomized trial (ParCoFit study). *PLoS Medicine*, 20.

HUSSEIN, N., MALIK, T. F. A., SALIM, H., SAMAD, A., QURESHI, N. & NG, C. J. 2020. Is family history still underutilised? Exploring the views and experiences of primary care doctors in Malaysia. *Journal of community genetics*, 11**,** 413-420.

HYSENI, L., MADEN, M., BOLAND, A., KYPRIDEMOS, C., COLLINS, B. & O'FLAHERTY, M. 2019. Umbrella review of strategies to improve uptake of screening programmes. *European Journal of Public Health*, 29**,** ckz185.653.

INGRAND, I., DEFOSSEZ, G., RICHER, J. P., TOUGERON, D., PALIERNE, N., LETARD, J. C., BEAUCHANT, M. & INGRAND, P. 2016. Colonoscopy uptake for high-risk individuals with a family history of colorectal neoplasia: A multicenter, randomized trial of tailored counseling versus standard information. *Medicine (Baltimore)*, 95**,** e4303.

INGRAND, I., DUJONCQUOY, S., BEAUCHANT, M., LETARD, J. C., MIGEOT, V. & INGRAND, P. 2009. General practitioner and specialist views on colonoscopic screening of first-degree relatives of colorectal cancer patients. *Cancer Epidemiol*, 33**,** 223-30.

KINNEY, A. Y., BOONYASIRIWAT, W., WALTERS, S. T., PAPPAS, L. M., STROUP, A. M., SCHWARTZ, M. D., EDWARDS, S. L., ROGERS, A., KOHLMANN, W. K., BOUCHER, K. M., VERNON, S. W., SIMMONS, R. G., LOWERY, J. T., FLORES, K., WIGGINS, C. L., HILL, D. A., BURT, R. W., WILLIAMS, M. S. & HIGGINBOTHAM, J. C. 2014. Telehealth personalized cancer risk communication to motivate colonoscopy in relatives of patients with colorectal cancer: the family CARE Randomized controlled trial. *J Clin Oncol*, 32**,** 654-62.

LAIYEMO, A. O., ADEBOGUN, A. O., DOUBENI, C. A., RICKS-SANTI, L., MCDONALD-PINKETT, S., YOUNG, P. E., CASH, B. D. & KLABUNDE, C. N. 2014. Influence of provider discussion and specific recommendation on colorectal cancer screening uptake among U.S. adults. *Prev Med,* 67**,** 1-5.

LONG, N. N., LAU, M., LEE, A., YAM, N. E., KOH, N. Y. K. & HO, C. S. H. 2022. Motivational Interviewing to Improve the Uptake of Colorectal Cancer Screening: A Systematic Review and Meta-Analysis. *Front Med (Lausanne),* 9**,** 889124.

LOWERY, J. T., AHNEN, D. J., SCHROY, P. C., 3RD, HAMPEL, H., BAXTER, N., BOLAND, C. R., BURT, R. W., BUTTERLY, L., DOERR, M., DOROSHENK, M., FEERO, W. G., HENRIKSON, N., LADABAUM, U., LIEBERMAN, D., MCFARLAND, E. G., PETERSON, S. K., RAYMOND, M., SAMADDER, N. J., SYNGAL, S., WEBER, T. K., ZAUBER, A. G. & SMITH, R. 2016. Understanding the contribution of family history to colorectal cancer risk and its clinical implications: A state-of-the-science review. *Cancer,* 122**,** 2633-45.

LOWERY, J. T., HORICK, N., KINNEY, A. Y., FINKELSTEIN, D. M., GARRETT, K., HAILE, R. W., LINDOR, N. M., NEWCOMB, P. A., SANDLER, R. S., BURKE, C., HILL, D. A. & AHNEN, D. J. 2014. A randomized trial to increase colonoscopy screening in members of high-risk families in the colorectal cancer family registry and cancer genetics network. *Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology,* 23**,** 601-610.

MANNE, S. L., COUPS, E. J., MARKOWITZ, A., MEROPOL, N. J., HALLER, D., JACOBSEN, P. B., JANDORF, L., PETERSON, S. K., LESKO, S., PILIPSHEN, S. & WINKEL, G. 2009. A randomized trial of generic versus tailored interventions to increase colorectal cancer screening among intermediate risk siblings. *Ann Behav Med,* 37**,** 207-17.

MENG, W., BI, X. W., BAI, X. Y., PAN, H. F., CAI, S. R., ZHAO, Q. & ZHANG, S. Z. 2009. Barrier-focused intervention to increase colonoscopy attendance among nonadherent high-risk populations. *World J Gastroenterol,* 15**,** 3920-5.

MICHIE, S. & PRESTWICH, A. 2010. Are interventions theory-based? Development of a theory coding scheme. *Health Psychol,* 29**,** 1-8.

O'CATHAIN, A., CROOT, L., DUNCAN, E., ROUSSEAU, N., SWORN, K., TURNER, K. M., YARDLEY, L. & HODDINOTT, P. 2019. Guidance on how to develop complex interventions to improve health and healthcare. *BMJ Open,* 9**,** e029954.

PAN AMERICAN HEALTH ORGANIZATION. 2016. *Expert Consultation on Colorectal Cancer Sreening in Latin America and the Cariibbean. Meeting Report (Washington, DC - 16, 17 March 2016)* [Online]. Washington (DC), USA. Available: https://www3.paho.org/hq/index.php?option=com_content&view=article&id=11762:16-17-

march-meeting-on-colorectal-cancer-screening-in-the-americas&Itemid=41766&lang=en [Accessed].

PANIC, N., RÖSCH, T., SMOLOVIC, B., RADUNOVIC, M., BULAJIC, M., PAVLOVIC-MARKOVIC, A., KRIVOKAPIC, Z., DJURANOVIC, S., ILLE, T. & BULAJIC, M. 2015. Colorectal cancer screening in a low-incidence area: general invitation versus family risk targeting: a comparative study from Montenegro. *Eur J Gastroenterol Hepatol,* 27**,** 1222-5.

PASKETT, E. D., BERNARDO, B. M., YOUNG, G. S., KATZ, M. L., REITER, P. L., TATUM, C. M., OLIVERI, J. M., DEGRAFFINREID, C. R., GRAY, D. M., PEARLMAN, R. & HAMPEL, H. 2020. Comparative Effectiveness of Two Interventions to Increase Colorectal Cancer Screening for Those at Increased Risk Based on Family History: Results of a Randomized Trial. *Cancer Epidemiol Biomarkers Prev,* 29**,** 3-9.

PETERS, M. D. J., MARNIE, C., TRICCO, A. C., POLLOCK, D., MUNN, Z., ALEXANDER, L., MCINERNEY, P., GODFREY, C. M. & KHALIL, H. 2020. Updated methodological guidance for the conduct of scoping reviews. *JBI Evidence Synthesis,* 18.

PEZZOLI, A., MATARESE, V., RUBINI, M., SIMONI, M., CARAVELLI, G. C., STOCKBRUGGER, R., CIFALA, V., BOCCIA, S., FEO, C., SIMONE, L., TREVISANI, L., LIBONI, A. & GULLINI, S. 2007. Colorectal cancer screening: results of a 5-year program in asymptomatic subjects at increased risk. *Dig Liver Dis,* 39**,** 33-9.

POLLOCK, D., PETERS, M. D. J., KHALIL, H., MCINERNEY, P., ALEXANDER, L., TRICCO, A. C., EVANS, C., DE MORAES, É. B., GODFREY, C. M., PIEPER, D., SARAN, A., STERN, C. & MUNN, Z. 2023. Recommendations for the extraction, analysis, and presentation of results in scoping reviews. *JBI Evidence Synthesis,* 21.

PRESTWICH, A., WEBB, T. L. & CONNER, M. 2015. Using theory to develop and test interventions to promote changes in health behaviour: evidence, issues, and recommendations. *Current Opinion in Psychology,* 5**,** 1-5.

RABENECK, L., TINMOUTH, J. M., PASZAT, L. F., BAXTER, N. N., MARRETT, L. D., RUCO, A., LEWIS, N. & GAO, J. 2014. Ontario's ColonCancerCheck: results from canada's first province-wide colorectal cancer screening program. *Cancer Epidemiol Biomarkers Prev,* 23**,** 508-15.

RAMDASS, P., PETRARO, P., VIA, C., SHAHROKNI, A. & NAWAZ, H. 2014. Providers role in colonoscopy screening for colorectal cancer. *Am J Health Behav,* 38**,** 234-44.

RAWL, S. M., CHAMPION, V. L., SCOTT, L. L., ZHOU, H., MONAHAN, P., DING, Y., LOEHRER, P. & SKINNER, C. S. 2008. A randomized trial of two print interventions to increase colon cancer screening among first-degree relatives. *Patient Educ Couns,* 71**,** 215-27.

REDWOOD, D. G. 2014. Use of family history to improve colorectal cancer screening outreach among alaska native people. *Dissertation Abstracts International: Section B: The Sciences and Engineering,* 75**,** No-Specified.

REX, D. K., BOLAND, C. R., DOMINITZ, J. A., GIARDIELLO, F. M., JOHNSON, D. A., KALTENBACH, T., LEVIN, T. R., LIEBERMAN, D. & ROBERTSON, D. J. 2017. Colorectal Cancer Screening: Recommendations for Physicians and Patients From the U.S. Multi-Society Task Force on Colorectal Cancer. *Gastroenterology,* 153**,** 307-323.

RIMER, B. K. & KREUTER, M. W. 2006. Advancing Tailored Health Communication: A Persuasion and Message Effects Perspective. *Journal of Communication,* 56**,** S184-S201.

RODRÍGUEZ-GÓMEZ, M., RUIZ-PÉREZ, I., MARTÍN-CALDERÓN, S., PASTOR-MORENO, G., ARTAZCOZ, L. & ESCRIBÀ-AGÜIR, V. 2020. Effectiveness of patient-targeted interventions to increase cancer screening participation in rural areas: A systematic review. *International Journal of Nursing Studies,* 101**,** 103401.

ROLLET, Q., TRON, L., DE MIL, R., LAUNOY, G. & GUILLAUME, É. 2021. Contextual factors associated with cancer screening uptake: A systematic review of observational studies. *Prev Med,* 150**,** 106692.

ROOS, V. H., MANGAS-SANJUAN, C., RODRIGUEZ-GIRONDO, M., MEDINA-PRADO, L., STEYERBERG, E. W., BOSSUYT, P. M. M., DEKKER, E., JOVER, R. & VAN LEERDAM, M. E. 2019. Effects of Family History on Relative and Absolute Risks for Colorectal Cancer: A Systematic Review and Meta-Analysis. *Clinical Gastroenterology and Hepatology,* 17**,** 2657-2667.e9.

SALIMZADEH, H., KHABIRI, R., KHAZAEE-POOL, M., SALIMZADEH, S. & DELAVARI, A. 2018. Motivational interviewing and screening colonoscopy in high-risk individuals. A randomized controlled trial. *Patient Education and Counseling,* 101**,** 1082-1087.

SKIVINGTON, K., MATTHEWS, L., SIMPSON, S. A., CRAIG, P., BAIRD, J., BLAZEBY, J. M., BOYD, K. A., CRAIG, N., FRENCH, D. P., MCINTOSH, E., PETTICREW, M., RYCROFT-MALONE, J., WHITE, M. & MOORE, L. 2021. Framework for the development and evaluation of complex interventions: gap analysis, workshop and consultation-informed update. *Health Technol Assess,* 25**,** 1-132.

SNIPELISKY, D., CARTER, K., SUNDSTED, K. & BURTON, M. C. 2016. Primary Care Physicians Practicing Preventive Medicine in the Outpatient Setting. *Int J Prev Med,* 7**,** 5.

STEPHENS, J. H. & MOORE, J. W. 2008. Can targeted intervention in CRC patients' relatives influence screening behaviour? A pilot study. *Colorectal Dis,* 10**,** 179-86.

SUNG, H., FERLAY, J., SIEGEL, R. L., LAVERSANNE, M., SOERJOMATARAM, I., JEMAL, A. & BRAY, F. 2021. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: A Cancer Journal for Clinicians,* 71**,** 209-249.

SUNG, J. J. Y., NG, S. C., CHAN, F. K. L., CHIU, H. M., KIM, H. S., MATSUDA, T., NG, S. S. M., LAU, J. Y. W., ZHENG, S., ADLER, S., REDDY, N., YEOH, K. G., TSOI, K. K. F., CHING, J. Y. L., KUIPERS, E. J., RABENECK, L., YOUNG, G. P., STEELE, R. J.,

LIEBERMAN, D. & GOH, K. L. 2015. An updated Asia Pacific Consensus Recommendations on colorectal cancer screening. *Gut,* 64**,** 121.

TAYLOR, D. P., BURT, R. W., WILLIAMS, M. S., HAUG, P. J. & CANNON-ALBRIGHT, L. A. 2010. Population-based family history-specific risks for colorectal cancer: a constellation approach. *Gastroenterology,* 138**,** 877-85.

THE LANCET, G., AMP & HEPATOLOGY 2021. USPSTF recommends expansion of colorectal cancer screening. *The Lancet Gastroenterology & Hepatology,* 6**,** 1.

TRICCO, A., LILLIE, E, ZARIN, W, O'BRIEN, KK, COLQUHOUN, H, LEVAC, D, MOHER, D, PETERS, MD, HORSLEY, T, WEEKS, L, HEMPEL, S ET AL. 2018. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med.,* 169(7):467-473.

VERITAS HEALTH INNOVATION, M., AUSTRALIA Covidence systematic review software,.

WU, R. R., MYERS, R. A., NEUNER, J., MCCARTY, C., HALLER, I. V., HARRY, M., FULDA, K. G., DIMMOCK, D., RAKHRA-BURRIS, T., BUCHANAN, A., GINSBURG, G. S. & ORLANDO, L. A. 2022. Implementation-effectiveness trial of systematic family health history based risk assessment and impact on clinical disease prevention and surveillance activities. *BMC Health Services Research,* 22**,** 1486.

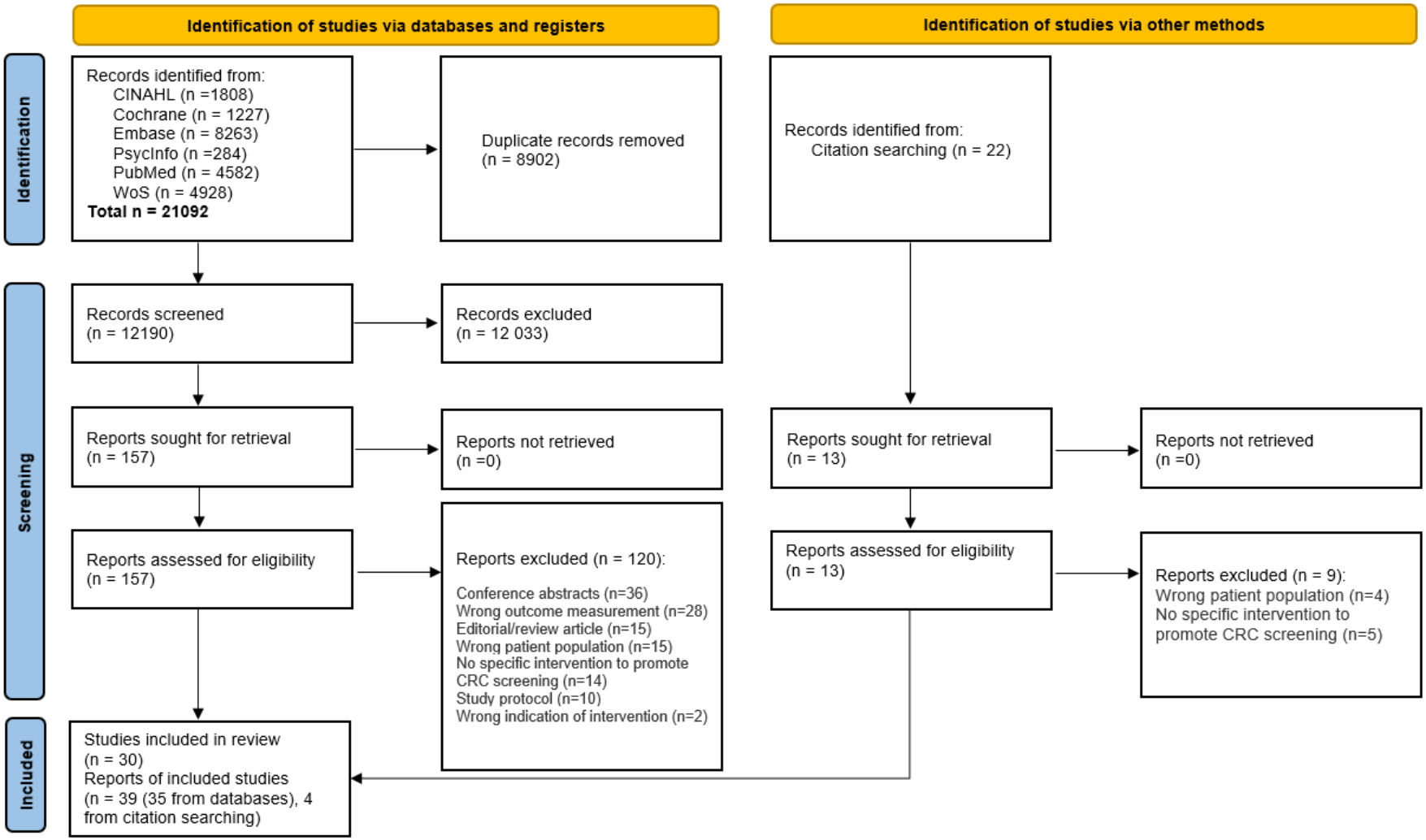

Figure 1. PRISMA flow diagram on the study selection process for scoping review of interventions used in promoting CRC screening in people with a family history of CRC.

Table 1

Characteristics of studies with interventions to promote colorectal cancer screening among people with a family history of colorectal cancer (arranged by most recent publication year).

(Author, Publication year), Country	Study design	Study inclusion and exclusion criteria for people with a family history of colorectal cancer	Final sample size (PFH-CRC)
(González-López et al., 2023), Spain	RCT	FDRs of CRC patients; aged 40 years above or 10 years before youngest IP age of diagnosis; had not done colonoscopy within past 5 years *Excluded those with IBD, CRC, family history of hereditary CRC*	870
(Crispin et al., 2023), Germany	Observational	FDR or SDR of CRC patients ; aged 25-50; had not done colonoscopy within past 5 years *Excluded those with FAP, IBD, known family history of hereditary non-polyposis colorectal cancer (HNPCC) & any persons receiving follow-up care for CRC*	25847
(Alwassief et al., 2023), Egypt	Observational	FDR of CRC (advanced neoplasia) patients *Excluded those with family history of hereditary CRC*	1470
(Bai et al., 2022), China	Cluster RCT	FDRs of CRC patients; aged 40-75 or 10 years before index case age of diagnosis; had not done colonoscopy within past 5 years *Excluded those with history of cancer or IBD*	188
(Wu et al., 2022), USA	Hybrid implementation-effectivess	FDR or SDR of CRC patients (eligibility based on guideline used by the study)	145
(Carroll et al., 2020), Canada	Observational	FDRs of CRC patients; aged ≥18	297
(Paskett et al., 2020), USA	RCT	FDRs of CRC patients; aged 25-75 *Excluded those with Lynch syndrome, pregnant, or with IBD, hereditary cancer syndrome*	1043
(Esplen et al., 2019), Canada	RCT	FDRs of CRC patients; aged 25-80 *Excluded FH suggestive of hereditary cancer syndromes, history of CRC or other malignancy*	278
(Dodd et al., 2019), Australia	RCT	FDR or SDR of CRC patients (eligibility based on guideline used by the study); aged 50-74; had not done FIT within past 2 yrs, and colonoscopy within past 5 years *Excluded those with personal history of CRC, IBD*	114
(Bauer et al., 2018), Germany	Cluster RCT	FDRs of CRC patients; aged 40-75 or no more than 10 years less than that of IP at 1st diagnosis; had not done colonoscopy within past 5 years *Excluded those with history of bowel cancer, FAP, IBD*	261

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Table 1 *(continued)*

(Author, Publication year), Country	Study design	Study inclusion and exclusion criteria for people with a family history of colorectal cancer	Final sample size (PFH-CRC)
(Salimzadeh et al., 2018), Iran	RCT	FDRs of CRC patients; aged between 40 (or 10 years younger than IP at diagnosis) and 75; had not done colonoscopy within past 5 years *Excluded those with personal history of CRC or IBD*	227
(Ingrand et al., 2016), France	RCT	Siblings of CRC or colorectal adenomatous polyps patients, due for screening. *Excluded those with FAP/Lynch, too young (< 45, or more than 5 years younger than the IP at CRC diagnosis)*	304
(Carey et al., 2016), Australia	RCT	FDRs of CRC patients; aged ≥18 *Excluded those with prior diagnosis of CRC, FAP, IBD*	574
(Bastani et al., 2015), USA	RCT	FDRs of CRC patients; aged 40-80; not up to date with CRC screening *Excluded personal history of CRC and CRC high-risk syndromes*	1280
(Panic et al., 2015), Montenegro	Observational	FDRs of CRC patients; aged ≥40, or 10 years before index case age of diagnosis.	710
(Dekker et al., 2015), Netherlands	Cluster RCT	FDRs of CRC patients *Excluded patients with genetically confirmed hereditary CRC*	392
(Redwood, 2014), USA	Observational	FDRs of CRC patients, due for screening *Excluded those with familial syndromes, personal history of adenomas or CRC;*	1979
(Rabeneck et al., 2014), Canada	Observational	FDRs of CRC patients with no colonoscopy done in prior 10 years	66314
(Kinney et al., 2014), USA	Cluster RCT	FDRs of CRC patients categorised as intermediate risk (having a single FDR diagnosed with CRC before age 60 years, or one FDR diagnosed at age 60 years or older plus an additional first- or second-degree biologic relative diagnosed at any age); aged 30-74; no colonoscopy done for past 5 years *Excluded those with hereditary cancer syndrome*	481
(Lowery et al., 2014), USA	RCT	unaffected at-risk members of families that met criteria for HNPCC or non-HNPCC high risk (1 FDR with CRC <60; or 2 or more FDRs with CRC at any age); due for colonoscopy screening.	632

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Table 1 *(continued)*

(Author, Publication year), Country	Study design	Study inclusion and exclusion criteria for people with a family history of colorectal cancer	Final sample size (PFH-CRC)
(Armelao et al., 2010), Italy	Observational	FDRS of CRC patients; aged 45; have not done colonoscopy in past 5 years *Excluded history of FAP/Lynch syndrome, IBD and/or severe co-morbidity with reduced life expectancy)*	725
(Manne et al., 2009), USA	RCT	Siblings of CRC patients; aged ≥35 or less than 10 years younger than the age of diagnosis of IP; not on schedule for CRC screening *Excluded those with history of cancer, IBD, hereditary cancer syndromes*	412
(Meng et al., 2009), China	Observational	Non-adherent high-risk subjects who did not attend colonoscopy examination (from population-based screening)- which include FDRs with CRC (among others); aged 40-74	1430
(Stephens and Moore, 2008), Australia	Pilot-RCT	FDRs of CRC patients; aged >18	91
(Rawl et al., 2008), USA	RCT	FDRs of CRC patients; aged ≥40; had not had screening based on American Cancer Society guideline.	140
(Pezzoli et al., 2007), Italy	Observational	FDRs of patients with CRC or adenomas diagnosed before 60 years; aged 45-75; had not done colonoscopy for past 3 years; *Excluded those with genetic disorder, polyp, Ulcerative colitis, Crohn's*	750
(Glanz et al., 2007), USA	RCT	FDR of CRC patients; aged ≥40 *Excluded those with 2 or more FDRs with CRC and personal history of CRC*	176
(Colombo et al., 1997), Italy	Observational	FDRs of CRC patients; aged 20-75	778
(Cripps and Heald, 1996), UK	Observational	FDRs of CRC patients diagnosed at 45 or less; aged ≥25	609
(Carpenter et al., 1995), UK	Observational	FDRs of CRC patients (1 FDR under 50 years, or 2 of any age with CRC)	111

Abbreviation: PFH-CRC, people with a family history of colorectal cancer; FDR, first-degree relative; CRC, colorectal cancer; RCT, randomised controlled trial; IBD, inflammatory bowel disease; IP, index patient; FAP, Familial adenomatous polyposis; HNPCC, hereditary non-polyposis colorectal cancer

Table 2

Characteristics and outcomes of interventions promoting CRC screening among PFH-CRC: RCT study design (arranged by most recent publication year)

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(González-López et al., 2023)	*Intervention 1:* *i.* Screening strategy 1: FIT and colonoscopy in case of a positive FIT	-	X					X	-	1. The uptake of colonoscopy screening (screening strategy 2) (34.1%) was similar to the uptake of FIT screening (Screening strategy 1) (35.9%) (OR = 1.08, 95% CI [0.82, 1.43], p = 0.560). 2.The detection rate of advanced colorectal neoplasia was significantly higher in the colonoscopy group than in the FIT group (OR 3.64, 95% CI [1.55, 8.53], p = 0.003).
	ii. Non-tailored print material		X					X	-	
	Intervention 2: i. Screening strategy 2: one-time colonoscopy	-	X					X	-	
	ii. Non-tailored Print material		X					X	-	
(Bai et al., 2022)	*Intervention:* i. Online tailored risk assessment tool	HBM	X				X (WeChat)		-	1. Colonoscopy uptake at 3-month was 43.6% in intervention group vs 24.5% in control group (OR: 2.75, 95% CI 1.43-5.30). 2. Compared with participants in the control group, those in the intervention group had a significant improvement of perceived susceptibility, cues to action and a significant reduction in perceived barriers were also found at 3-month. 3. There were no significant effects on perceived severity, benefits and self-efficacy at 3-month.
	ii.Counselling		X		X		X (WeChat)		trained nurse	
	iii. Online tailored message (initial & follow-up)		X				X (WeChat		-	
	iv. Non-tailored online brochure		X				X (WeChat)		-	
	Control: i. Non-tailored online brochure only	-	X				X (WeChat)		-	

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Table 2 *(continued)*

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Paskett et al., 2020)	*Intervention:* i. Risk assessment tool, information on screening and the recommendation	-	X				X (website)		-	1. Among those who received a recommendation to have a colonoscopy immediately, colonoscopy uptake at 14-month was 52.8% in the intervention group vs 29.8% in control group (OR: 2.98; 95% CI 1.68-5.28). 2. Intervention fidelity: all participants received a recommendation from website. Of those randomized to the website plus PN intervention, 88.9% spoke with the navigator (8 refused and 49 were unable to be contacted by the navigator).
	ii. Remote patient navigation		X		X				Patient navigator	
	Control: Risk assessment tool, information on screening and the recommendation	-	X				X		-	
(Esplen et al., 2019)	Intervention 1: Counselling (in-person)	HBM	X					X	Health psychologist and/or genetic counselor	1. Baseline screening intent & adherence were high, and therefore did not reach statistically significant improvement. There were no significant differences among the 3 groups over time. At 1-year, the colonoscopy completion rates were 70.5% (in-person), 78.9% (telephone), and 76.1% (control). 2. At 2-month, satisfaction level between the in-person and telephone arms was not statistically significant (p=0.264). 3. At 2-month, participants in the in-person arm and telephone arm demonstrated improvements in knowledge and perceived risk but were not found to be statistically different from each other. However, when comparing each intervention with controls, knowledge in the in-person arm was found to be statistically significantly higher, but the difference between the telephone and control arms was not.
	Intervention 2: Counselling (telephone)	HBM	X		X				Health psychologist and/or genetic counselor	
	Intervention 3: Usual care then at 2-month, written information given based on risk	-	X			X			-	

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Table 2 *(continued)*

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Dodd et al., 2019)	*Intervention 1:* i. iFOBT kit with return postage ;	-	X					X	Clinic assistant	1. At 6-week, 39% of participants in intervention group completed iFOBT screening compared to 6% in usual care (OR = 10.24 (95% CI: 2.9–36.6, p=0.0006).
	ii. Non-tailored print material	-	X	X (GP)				X	-	2. 51% participants reported reading the printed material and were significantly more likely to complete CRC screening.
	iii. Counselling	-	X					X	GP	
	Control: Usual care	-	X					X	GP	
(Salimzadeh et al., 2018)	*Intervention:* i. Counselling using MI	-	X		X				Oncology nurse	1. Colonoscopy uptake at 6-month was 83.5% in intervention group compared to 48.2% in control group (crude OR 5.4; 95% CI, 2.9-10.0, P <.001).
	Control: Non-tailored generic information (for IP and FDR)		X		X			X (IP only)	Physician	2. At 6-month, significantly higher correct answers to knowledge regarding CRC and screening among FDRs in intervention group vs control (P<0.05).
(Bauer et al., 2018)	*Intervention:* i.Counselling	-	X		X				Nursing staff	1. Colonoscopy uptake within 30 days after enrolment was 79% in intervention vs 71% in control group (relative risk [RR=1.11; 95% confidence interval [0.97; 1.28]; p=0.16). The RR decreased to 1.09 ([0.95; 1.25]; p=0.22) after adjustment for cluster size and the distance between recruitment center and residence of FDR.
	ii. Non-tailored printed material		X			X		X	-	
	Control: Non-tailored print material only	-	X			X		X	-	2. Anxiety regarding bowel preparation and fear of pain were significantly more often as reasons for not having a colonoscopy in intervention group (p<0.05)

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Table 2 *(continued)*

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Ingrand et al., 2016)	*Intervention:* i.Tailored print material (initial only)	HBM, TRA	X (siblings & IP)	X		X		X (IP only)	Main: Nurse Others: physician (gastroenterologist /surgeon)	1. Colonoscopy uptake within 1 year: 56.3% in intervention group and 35.4% in control group (p=0.0027); with OR=2.37 (1.35; 4.15). 2. Having supportive spouse handling phone calls and supported screening; and good sibling dynamics – facilitated screening
	ii. Counselling		X		X					
	Control: Non-tailored standardised oral information	-	X (IP only)					X (IP only)	Physician (gastroenterologist /surgeon)	
(Carey et al., 2016)	*Intervention:* Tailored print material	-	X	X		X			-	1. Adherence to screening guideline[a] At 12-month, 58% of FDRs in the control group and 61% in the intervention group were adherent to screening guidelines (mixed effects logistic regression group by time interaction effect =2.7; 95%CI=1.2-5.9; P=0.013).
	Control: Usual care: Non-tailored information	-	X	X		X			-	
(Bastani et al., 2015)	*Intervention:* i. Tailored print material (initial only)	HBM, TPB, SCT, SIT	X			X			-	1. Uptake of FOBT, sigmoidoscopy and colonoscopy were measured at 6 and 12-month. Tailored information alone (OR 1.6) and cumulative stepped intervention (OR 1.6) both demonstrated statistically significant effects in the total sample. 2. Statistically significant effects were observed for the cumulative tailored print material plus telephone intervention at 12-month (26% intervention vs 18% control) and the tailored print material intervention alone at 6-month (15% intervention vs 10% control). 3. There was no significant effect size difference noted between the tailored print material alone vs cumulative interventions (p>0.05); however the study was not powered for this contrast.
	ii. Counselling for those non-adherent at 6-month (based on interview responses)		X		X				Trained counsellors	
	Control: Usual care - No intervention	-							-	

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Table 2 *(continued)*

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Dekker et al., 2015)	*Intervention:* i.Non-tailored printed material information for patients	-	X					X	-	1. Uptake of colonoscopy by moderate risk relatives did not change significantly (control, 36% before vs 41% after; p=0.70; intervention, 33% before vs 19% after, p=0.21). 2. Website was used by 67% patients and 35% of clinicians. 3. Patients' main reasons not to use the website: not wanting to deal with potentially hereditary CRC, technical problems, forgotten login code 3. Only 23% of CRC patients discussed the website with their relatives. 4. Only 24% of patients read the brochure. 5. Patients valued information from their doctor as most useful, followed by brochure and website.
	ii.Website for patients & clinicians (information, Risk calculator, decision support intervention)		X	X			X (web-site)		-	
	iii. Clinician-targeted education (via presentation)			X					-	
	iv. Pocket cards on referral criteria for clinician			X					-	
	Control: Usual Care	-							-	
(Kinney et al., 2014)	*Intervention:* i. Tailored print materials (initial & follow-up)	EPMM	X	X		X			-	1. Colonoscopy uptake at 9-month: 34.5% in intervention group vs 15.7% in control group (P<.001) (OR = 2.83, 95% CI [1.87-4.28]). 2. Colonoscopy uptake at 15-month (among those non-adherent at 9-month): 42.7% in intervention group vs 24.1% in control group (OR, 2.37; 95% CI, 1.59-3.52). 3. Colonoscopy uptake by 15-month was not increased by the addition of the cost-resource letter (OR, 0.80; 95% CI, 0.52-1.23). 4. Direct cost of delivering intervention was $42.20 per participant; print-only was $8.20. 5. Impact of intervention was similar for urban and rural dwellers
	ii. Counseling using MI		X		X				Genetic counsellors	
	iii. Tailored reminder card		X			X			-	
	iv. Cost resource letter given at 9-month		X			X			-	
	Control: i. Non-tailored print material ii.Cost resource letter (at 9-month)	-	X			X			-	

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Table 2 *(continued)*

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Lowery et al., 2014)	*Intervention:* i. Counselling using MI	HBM, TPB, TTM	X		X				Trained non-medical interviewer	1. Colonoscopy uptake in the intervention group was 43.2% at baseline and increased to 54.0% at 24-month (p<0.004). 2. Colonoscopy uptake in control group was 52.1% at baseline, and reduced to 49.8% at 24-month (p=0.56). 3. Using an ITT: the tailored telephone intervention was associated with a 24% increase in colonoscopy adherence at 24-month (HR, 1.24; P< 0.04). 4. Predictors: *Increased adherence*: had previous colonoscopy, intent to have screening, appropriate CRC risk perception, and knowledge of risk-appropriate screening intervals. *Lower adherence:* Not having a regular doctor, having perceived barrier to screening.
	ii. Tailored print material (follow-up only)		X			X			-	
	iii. Reminder postcard		X			X			-	
	Control: Non-tailored print material	-	X			X			-	
(Manne et al., 2009)	*Intervention 1:* i) Tailored print material (at initial & follow-up)	HBM, TTM, DPT	X			X			-	1. Screening (Colonoscopy or flexible sigmoidoscopy or FOBT) uptake at 6-month increased in all three intervention groups. In ITT analyses, uptake at follow-up was 13.7% in intervention 3, 24.8% in intervention 2, and 25.9% in intervention 1. 2. Those in intervention 1 were significantly (Wald Chi-square=4.40; p=0.036) more likely to be screened than those in intervention 3, as were those in the intervention 2 (Wald Chi-square=6.15; p=0.013). However, there was no difference for those in the two tailored conditions (interventions 1 and 2). 3. Since there were no differences between the two tailored conditions, the data for these arms were combined and compared to intervention 3. In this analysis, those in the combined tailored condition were 2.12 times more likely to be adherent than those in the intervention 3.
	ii) Counselling using MI		X		X				Health educators	
	Intervention 2: tailored print material only	-	X			X			-	
	Intervention 3: Non-tailored print material	-	X			X			-	

(continued on next page)

Table 2 *(continued)*

Study (Author /Year)	Type of intervention & control	Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Stephens and Moore, 2008)	*Intervention:* i. Non-tailored printed material for FDRs	Risk perception theories	X			X			-	1. Uptake of screening (FOBT or colonoscopy) at 3-month was 6% intervention vs 8% control, p=0.91. **2.** No difference in intention to partake future screening activities between both groups
	Control: Non-tailored standard information for IP only	-	X					X (IP only)	Surgeon	
(Rawl et al., 2008)	*Intervention:* i. Tailored print material	1.HBM 2.TTM/Stages of change theory	X		X (to obtain risk profile only)	X			Trained interviewers to obtain risk profile only	1.CRC screening uptake (FOBT, sigmoidoscopy, colonoscopy) at 3 months showed modest but statistically insignificant increases (14% tailored vs. 21% non-tailored; p = 0.30). **2.** Tailored intervention had significantly greater effects on forward stage movement for CRC screening depending on stage of adoption at baseline, race, and objective CRC risk. Receipt of the tailored intervention was 2.5 times more likely to move baseline precontemplators and contemplators forward in stage of adoption for colonoscopy (95% CI: 1.10–5.68).
	Control: i. Non-tailored print material									
(Glanz et al., 2007)	*Intervention 1:* i.Counselling (initial F2F and follow-up (phone))	PAPM, TM of stress & coping	X		X			X	Nurse/health educator	1. Adherence to screening recommendation[b] The intervention had a significant treatment effect at 4 months (13% greater increase than control) that plateaued to a trend at 12 months. For those who were nonadherent at baseline, the intervention led to a 17% net increase in screening adherence
	ii.Tailored print material		X						-	
	Control: i.General health counselling ii.Non-tailored print material iii.Follow-up phone calls	-	X		X			X	-	

[a]Defined by: Those in the adherent group reported having had the appropriate test for their age and risk category in the recommended time frame. Those in the non-adherent group were over-screened (commenced screening younger than is recommended or had a more intensive test than recommended) or under-screened (overdue for screening or had a less intensive test than recommended.
[b]CRC screening adherence, defined as, a person receiving the appropriate screening test (or a more intensive test) within the recommended time frame. The appropriate test for each individual was assessed based on their risk level, age, and self-reported doctor recommendation.
Abbreviation: (-), not reported; CI, confidence interval; CRC, colorectal cancer; DPT, Dual Process Theory; EPPM, extended parallel process model; FDRs, first degree relatives; iFOBT, immunochemical fecal occult blood test; GP, general practitioner; HBM, health belief model; IP, index patient; ITT, intention to treat; MI, motivational interviewing; OR, odds ratio; PAPM, Precaution Adoption Process Model; PFH-CRC, people with a family history of colorectal cancer; PN, patient navigation; RCT, randomised controlled trial; RR, relative risk; SCT, social cognitive theory; SIT, social identity theory; TM, Transactional Model; TPB, theory of planned behavior; TRA, theory of reasoned action; TTM, transtheoretical model; UI, uncertainty interval

Table 3

Characteristics and outcomes of interventions promoting CRC screening among PFH-CRC: Observational and hybrid implementation-effectiveness study design (arranged by most recent publication year).

Study (Author /Year)	Type of intervention & control	Study design / Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Crispin et al., 2023)	*Intervention :* i. risk assessment (simplified +/- comprehensive family history)	Prospective, population-based (no comparison data)	X					X	physician from broad range of specialties	1. At follow-up, 63.6% participated in screening measures (either iFOBT or colonoscopy). 2. Colonoscopy revealed adenoma in 232 persons (17,6 %), advanced adenoma in 78 (5.9%) and carcinoma in 4 (0.3%).
	ii. Counselling (and SDM on how to proceed	-	X					X	specialists: gastroenterologists, qualified internists, surgeons	
(Alwassief et al., 2023)	*Intervention 1:* i.Screening strategy 1. Direct invitation to colonoscopy	Cross-sectional -	X					X	-	1. A significantly more proportion of individuals who chose a strategy 1 complied with doing colonoscopy (45.1%), compared those who chose screening strategy 2 (29.8%) (P < 0.05).
	ii. non-tailored print material		X					X	-	
	Intervention 2 : i. screening strategy 2. Invitation to 2-step screening strategy (FIT+colonoscopy)		X					X	-	
	ii.non-tailored print material		X					X	-	

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Table 3 *(continued)*

Study (Author /Year)	Type of intervention & control	Study design / Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Wu et al., 2022)	*Intervention :* i. Clinical decision support (CDS) tool (risk assessment & management recommendation)	Type 3 hybrid implementation-effectiveness trial	X	X (PCP)			X (web-based)		-	1. At 24-month follow-up: For patients there was a 10.8% increase in guideline-based screening uptake (generated by CDS) in the subset of participants age < 50 years old (from 68.4 to 79.2%), 95%CI: 57.3-92.0, and 18.7% in those aged ≥ 50 years old (from 68.1 to 86.8%), 95% CI: 74.0-94.1.
	ii. counseling	HBM	X					X	Primary Care provider	2. For providers there was a 7.4% increase in guideline uptake (placing screening order based on CDS tool recommendation) in the subset of participants age < 50 years old, and 7.6% in those aged ≥ 50 years old with an EMF colonoscopy recommendation.
(Carroll et al., 2020)	*Intervention:* i.Non-tailored information (for PFH-CRC)	Prospective longitudinal cohort	X					X	Family practitioner	1. Over 10 years 2/3 PFH-CRC received the correct CRC screening test[c] at appropriate timing (baseline 75%, 5-year 62%, 10-year 65%). No significant difference over the years.
	ii. Risk assessment tool (for physician)	-		X				X	-	2. Almost threequarters of PFH-CRC reported having spoken with their providers about their FH of CRC but report that only 51–63% of providers recommended screening. 3. The majority of physicians recommended the "correct" screening test for those at population CRC risk, however a quarter reported giving PFH-CRC the choice of colonoscopy or FOBT, when colonoscopy has generally been advised for these patients. 4. PFH-CRC are more likely to have correct screening if their physician recommended screening (RR1.69; 95% CI 1.15, 2.49; p = 0.007).

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Table 3 *(continued)*

Study (Author /Year)	Type of intervention & control	Study design / Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Panic et al., 2015)	*Intervention for cohort 1:*Patient Navigation for FDRs	Prospective cohort (comparative analysis) -	X		X				Nurse	1. The compliance level differed significantly among the programs as 76.05% of the patients in intervention 1 agreed to the offered testing modality (colonoscopy) compared with 33.3% in intervention 2 (P<0.01).
	Intervention for cohort 2: FOBT screening program for average risk individuals		X					X	General practitioner	
(Redwood, 2014)	*Intervention:* Patient Navigation	Prospective cohort (no comparison group/data) -	X		X	X		X	Patient navigator	1. Within 4 years, 600 persons were reached out to and 254 first-degree relatives were screened for CRC (colonoscopy) as a result of the outreach efforts (42.3%).
(Rabeneck et al., 2014)	*Intervention:* i.Counseling	Prospective cohort (no comparison group/data) -	X					X	Primary care provider	1. 66,314 people at increased risk were screened using colonoscopy (total target population age 50-74 regardless risk factors: 3.4mil) in year 2011.
	ii.Campaign for PCP and public		X	X		X	X (web site)	X	Ministry of Health-Ontario (organizer)	

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Table 3 *(continued)*

Study (Author /Year)	Type of intervention & control	Study design / Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Armelao et al., 2010)	*Intervention:* i.Non-tailored print material	Prospective cohort (with control group)	X			X			-	1. Colonoscopy uptake at 2-year: 77.6% in intervention and 8% in control group (P< 0.0001). 2. Predictors: (i) FDRs age <60 years (OR 2.50, 95 % CI 1.72-3.62), (ii) complex family history (one CRC at <60 or two or more CRC) (OR 1.54; 95 %CI 1.04-2.33) and (iii) living in a rural area (OR 1.64, 95 %CI 1.12<2.44).
	ii.Remote patient Navigation	-	X		X				Nurse	
	iii.Counseling		X					X	Gastroenterologist	
	iv.Public education campaign		X					X	Public health authorities	
	Control: Public education campaign only		X					X	Public health authorities	
(Meng et al., 2009)	*Intervention:* i.Remote patient navigation	Prospective longitudinal cohort	X		X			X	Prevention care managers	1. Colonoscopy uptake was 23.04% before intervention, and 37.69% after intervention (within 12 month) (p<0.001). 2. Intervention was more effective among subjects with only objective barriers* (OR: 34.590, 95% CI: 23.204-51.563). **Objective barriers: intolerance of pain, lack of time on working days, intolerance of bowel prep, inconvenience and complexity of colonoscopy procedure*
	ii. Counseling	-	X					X	Oncologist/epidemiologist	
(Pezzoli et al., 2007)	*Intervention:* i.Awareness campaign (for HCP, patients and FDR)	Prospective cohort (no comparison group/data)	X	X			X (web-site)	X	Researchers	1. At 5-year, 94.4% agreed to endoscopy.
	ii.Counseling	-	X					X	Physician	

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Table 3 *(continued)*

Study (Author /Year)	Type of intervention & control	Study design / Theory	Target population		Mode of delivery				Personnel involved in delivery	Findings
			Client	Provider	Phone	Mail	Online	In-person		
(Colombo et al., 1997)	*Intervention:* i..Patient Navigation	Prospective cohort (No comparison group/data)	X		X			X	Trained medical personnel	1. After seven years, 29.9% undergone endoscopic examination. 2. Highest compliance in the age groups 30-39 and 40-49. Lower compliance in the group 50-59, and a drop in people aged 60 or older ($p<0.05$).
	ii. Non-tailored printed material	-	X			X		X	Family practitioners	
(Cripps and Heald, 1996)	*Intervention:* i.Non-tailored printed material	Prospective cohort (No comparison group/data) -	X			X			-	1. Within 2 years, 64.9% people completed the protocol (FOBT +/- colonoscopy based on risk). 2. Compliance improved as more volunteers were enrolled but was consistently in the region of 60%. 3. Compliance was significantly better if contact was made within one year of diagnosis of the index relative (75% vs 62.1%, $\chi^2=5.7$, $p<0.05$).
(Carpenter et al., 1995)	*Intervention*: Family Cancer screening clinic which consisted of: i. Non-tailored print material, ii. Counselling including risk assessment and referral for colonoscopy	Prospective cohort (no comparison group/data) -	 X X					 X X	 - Clinic assistant with background of genetic, research nurse, general practitioners	1. At 4-year, acceptance of screening by colonoscopy was 88% (77 of 88) in the higher risk category (> 1 in 10). **>1 in 10: one relative <45 or 2 FDRs, or 3 FDRs* *2.* The FDRs were relieved to have a chance of discussing their fears and to make personal screening plan.

[c]Proportion of patients receiving the correct CRC screening test (FIT or colonoscopy) at appropriate time interval. This study assessed under-screening not over-screening.

Abbreviation: CRC, colorectal cancer; PFH-CRC, people with family history of colorectal cancer; FDRs, first degree relatives; FH, family history; iFOBT, immunochemical faecal occult blood test; FIT, faecal immunochemical test; RR, relative risk; CI, confidence interval; PCP, primary care provider; OR, odds ratio; HCP, healthcare provider; CDS, clinical decision support