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# Co-designing planning interventions to facilitate participation in mail-out bowel cancer screening

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## Abstract

**Background** Population mail-out bowel cancer screening programs save lives through prevention and early detection; however, their effectiveness is constrained by low participation rates. Many non-participants are “intenders”; that is, they intend to screen but fail to do so, often forgetting or procrastinating. This study aimed to co-design interventions to increase screening participation among intenders in the Australian National Bowel Cancer Screening Program.

**Methods** Three semi-structured interviews, and one online cross-sectional survey, were conducted between August 2021 and December 2022. Interviews with people who had completed and returned their latest screening kit (“completers”) were first conducted to identify the planning strategies they had used. Using survey data, logistic regressions were conducted to analyse strategies predictive of participants having returned their latest bowel cancer screening kit. Then, intenders were interviewed to explore their opinions of these strategies and worked with researchers to adapt these strategies into prototype interventions to facilitate screening participation. All interviews were analysed using the framework approach of codebook thematic analysis.

**Results** Interview participants who returned their kit shared their effective planning strategies, such as putting the kit in a visible place or by the toilet, planning a time at home to complete the kit, and using reminders. Survey participants who reported using such strategies were more likely to have completed their screening kit compared to those who did not. Prototype interventions developed and endorsed by intenders included providing a prompt to place the kit or a sticker near the toilet as a reminder, a deadline for kit return, the option to sign up for reminders, and a bag to store the sample in the fridge.

**Conclusions** These novel, consumer-led interventions that are built upon the needs and experience of screening invitees provide potential solutions to improve participation in population bowel cancer screening.

**Keywords** Colorectal cancer, Faecal occult blood test (FOBT), Participation, Screening, Co-design, Intervention, Behaviour change, Australia, Health action process approach

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## Background

Bowel cancer is the second leading cause of cancer-related death globally [1]. The likelihood of surviving bowel cancer is heavily dependent on the stage at which it is diagnosed, with the five-year survival rate up to 99% for stage one diagnoses, but decreasing to only 13% for late-stage diagnoses [2]. Population screening can reduce bowel cancer incidence and mortality through early detection of the disease, and removal of precancerous abnormalities [3]. As such, population level bowel cancer screening programs have been implemented in many countries [4]. In Australia, the National Bowel Cancer Screening Program (NBCSP) automatically distributes biennial at-home faecal occult blood test (FOBT) kits to all residents aged 50 to 74 years [5]. The test requires self-collection of two small faecal samples from two separate bowel movements, with samples stored in the fridge until participants can return them via post. If traces of faecal occult blood are detected within the stool sample, individuals are advised to contact their general practitioner to organise a colonoscopy for further investigation. Bowel cancers detected by the NBCSP are 1.7 times more likely to be detected at an early stage, and half as likely to become fatal, compared to cancers detected among never-screened individuals [6]. Despite this, only 40% of eligible Australians currently participate [7].

Individuals may not participate in bowel cancer screening for a wide variety of reasons. They may experience individual-level barriers, such as the fear of receiving a positive test result, hygiene concerns, embarrassment, and low self-efficacy [8–13], or confront systemic barriers, such as the lack of culturally sensitive information about bowel screening [14]. However, the majority (75%) of Australians who do not return their NBCSP screening kit reportedly *intend* to screen, yet do not [15]. A targeted focus on developing solutions for these individuals, referred to as “intenders”, to overcome barriers associated with procrastination and forgetting should have substantial impact on Australia’s population screening rates.

The imperfect relationship between an *intention* to engage in a behaviour (such as screening) and *execution* of said behaviour, known as the intention-behaviour gap, is a commonly reported barrier to behaviour change [16, 17]. Theoretical models, such as the Health Action Process Approach (HAPA) [18], propose mechanisms to bridge the intention-behaviour gap. For example, the HAPA model posits that planning is key to transitioning people from intention to action [18]. It specifies two types of planning: action planning, where people specify when, where, and how they will do a behaviour; and coping planning where strategies are utilised to overcome barriers [19]. While a lack of planning has been linked to increased procrastination and forgetting to participate

in cancer screening [9, 10, 12], a consistently effective means of promoting the use of planning strategies to overcome these barriers has yet to be established.

Many interventions designed to increase participation in population bowel cancer screening programs have been trialled or implemented in international settings, to varying degrees of success. These include strategies involving health professional endorsement, simplifying screening kit processes, altering messaging in invitation materials, and reminders in the form of letters, phone calls, or short message service (SMS) to recipients [20]. Very few interventions have been specifically designed to help screening invitees develop and implement action and coping planning strategies to bridge the intention-behaviour gap [18]. As such, there is a need to develop effective interventions that help intenders take action when it comes to bowel cancer screening. One approach to enhancing the effectiveness of future interventions is by engaging eligible screening recipients in the design process. Through “consumer consultations”, interventions are more likely to be relevant, meaningful, and implemented by individuals outside of the research context [21].

Therefore, this study aimed to identify action and coping planning strategies used by those who successfully participated in the NBCSP (i.e., “completers”) and to develop ways to translate these into interventions to increase participation among those who *intend* to screen but do not complete and return their NBCSP kit (i.e., “intenders”).

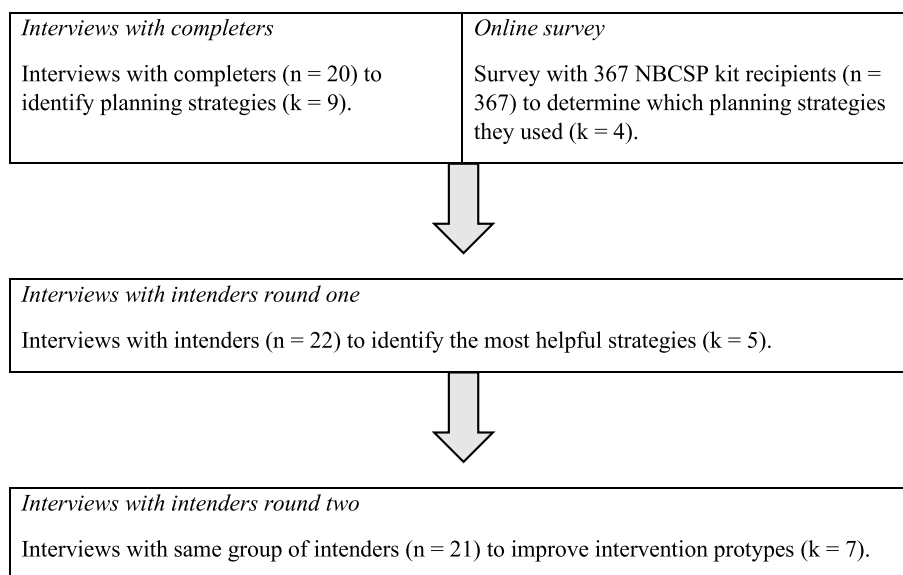
## Methods

### Study design

To develop effective, user-accepted interventions, we applied a mixed methods approach to co-design, utilising both qualitative and quantitative data obtained through a mixture of interviews and surveys [22]. Using an iterative approach, findings from each study component informed the methods and design applied in the subsequent component of the study.

As described in Fig. 1, 20 people who had completed their most recent FOBT kit through the NBCSP were interviewed to identify the strategies they used to overcome common barriers to screening. Four common strategies reported among the first 12 interviews were presented in an online survey in sample of  $n=367$  NBCSP kit recipients to gain quantitative data regarding the frequency at which these strategies were used and the degree to which each strategy was associated with kit return.

After data from both the online survey and the full interview sample had been analysed, a selection of the most common, feasible, and practical strategies for



**Fig. 1** Summary of included studies

overcoming the intention-behaviour gap were selected by the research team to be presented to intenders in the next round of interviews. This selection was based on the known parameters of population screening programs in Australia and similar settings in terms of available resources and system capabilities. For example, telephone navigation is known to increase bowel cancer screening participation [23, 24]; however, resource and cost constraints mean the wide-scale distribution of this strategy to all screening program invitees is unfeasible in Australia, thus it was not presented as a potential intervention strategy. Furthermore, given the aim of increasing screening among intenders (i.e. those who *want* to screen), strategies involving attitude change alone were not selected. The selected strategies were presented to intenders. These participants provided feedback on the potential effectiveness of the strategies and discussed how they might be incorporated into interventions to improve uptake in the NBCSP. Based on these responses, the research team designed seven different intervention prototypes and presented these to this same group of intenders, who provided further feedback and suggestions for improvement.

## Interviews

### Recruitment

Australian residents aged 50 to 74 years were invited via email to participate in interviews using a convenience sampling approach. Recruitment took place through online advertising and contact with consenting participants of prior research studies conducted by members of

the research team [8, 25, 26]. Participants were provided with a \$50 grocery voucher upon completion.

### Procedure

Twenty-to-thirty-minute semi-structured interviews were conducted via telephone or videoconferencing by experienced interviewers (LA and BV) and were recorded, deidentified, and transcribed for analysis. The recording failed for two participants; thus, analysis of their data was based on notes taken during the interview and interviewer recall. Participants provided informed consent and ethical approval was granted by a university-based Human Ethics Research Committee (H21REA152).

### Participants

Interviews with completers (aged 50–68 years;  $M=60.25$ ;  $SD=5.49$ ) took place between July and December 2021. Then, intenders (aged 50 to 70,  $M=59.77$ ,  $SD=6.51$  years) were interviewed once between July and December 2022, and again three months later. Twenty-one of the 22 intenders participated in both interviews. Full demographics are presented in Table 1.

### Interview questions

The completer interview questions were designed with reference to the HAPA model [18], capturing action planning and coping planning strategies used by these participants when completing their latest NBCSP kit. For example, “*Did you have a plan for when and how you would complete the kit?*” captured strategies related to when, where, and how they completed the screening kit,

**Table 1** Interview participant demographic characteristics (N = 42)

Demographic	Completers		Intenders	
	n	%	N	%
<b>Sex</b>				
Male	10	50%	9	59%
Female	10	50%	13	41%
<b>Remoteness<sup>a</sup></b>				
Major cities	9	45%	15	68%
Inner regional	8	40%	4	18%
Outer regional/remote	3	15%	1	5%
<b>Area-Level SES<sup>a</sup></b>				
Quintile 1 (lowest)	4	20%	5	23%
Quintile 2	7	35%	1	5%
Quintile 3	6	30%	2	9%
Quintile 4	1	5%	7	32%
Quintile 5 (highest)	2	10%	5	23%

<sup>a</sup> Remoteness and area-level SES are based on postcode and the Australian Bureau of Statistics 2016 geography standards [27]. Postcode was not obtained for n = 2 Intenders

and coping planning (e.g., “How did you feel about collecting a sample?... Did you have to plan how you were going to do this?” captured strategies used to overcome barriers or challenges completing the kit. Completers were also asked to provide suggestions that may help others to complete their kits.

In the intender interviews, participants were engaged in an open discussion about the utility of the strategies used to facilitate screening among completers, and when presented with the intervention prototypes, were invited to comment on their usefulness, relevance, and how best to implement them. Detailed interview guides are provided in Supplement 1. *Interview Data Analysis.*

All interview transcripts were coded by the first author (LA) using codebook thematic analysis [28]. Codes, or labels representing patterns of shared meaning in qualitative data, were developed based on content of the interview transcripts and compiled into a codebook with accompanying definitions (see Supplements 2–4) to enable replication of the coding strategy. For the completer interviews, a deductive coding approach was used to identify the use of action planning and coping planning strategies, as per the HAPA model [29]. Coping planning strategies were further categorised into strategies addressing four known barriers to bowel cancer screening: (i) a perceived lack of autonomy— need for control in making health decisions, (ii) disgust—feelings of discomfort or repulsion in reaction to the process of stool collection, storage and return, (iii) difficulty—physical challenges completing and returning the kit, and (iv)

avoidance—wanting to avoid negative outcomes, often due to fear [11, 25]. Then, each of the intender interviews were coded separately using an inductive approach to capture key feedback, informing the development of co-designed interventions to improve bowel cancer screening participation.

**Survey**

**Participants and procedure**

Survey data from participants were collected from a related research project exploring bowel cancer screening. Participants for these surveys were recruited using a convenience sampling approach via paid online advertising and distribution of survey links to community groups frequented by the target population (e.g., volunteer organisations). Ethical approval for the survey was granted by a university-based Human Research Ethics Committee (H19REA291). Participants were eligible if they were Australian residents aged 50 to 74 years (M = 64.06, SD = 6.33), had internet access and the ability to read English, and had completed and returned their last NBCSP kit or intended to do so. Participants that reported they had no intention to screen were excluded through preliminary screening questions, as the action planning strategies measured are not relevant for people who were not in the intention stage of behavioural change [18]. After providing informed consent, participants completed the online survey between November and December 2021 via Qualtrics [30]. Of the n = 8,584 participants who clicked the link to take part in the online survey, n = 1,542 consented to take part, and n = 347 were eligible to participate. This resulted in a final sample of n = 347 survey respondents. Sample characteristics are provided in Table 2.

**Measures**

**NBCSP Participation and intention (preliminary screening question)**

As described earlier, to assess eligibility for this study, participants were asked whether they returned their most recent NBCSP kit (0 = no, 1 = yes “completer”). Those that answered “no” to the NBCSP participation question, were asked “Which statement best describes your intention to use the home bowel cancer test kit?” (1 = “I still intended to use the home test kit, 2 = “I intended to use the home test kit but never did”, 3 = “I do not intend to use the home test kit, 4 = “I never intended to use the home test kit”). Responses of 1 and 2 were coded as “intender”, and other participants were removed.

**Planning actions**

Participants were presented with four items that described common strategies used by completers in the

**Table 2** Survey participant demographics (N = 347)

	n	%
<b>Screening outcome</b>		
Completer	291	83.86%
Intender	56	16.14%
<b>Sex</b>		
Male	57	16.47%
Female	288	83.24%
Prefer to self-describe	1	0.29%
<b>Remoteness</b>		
Major cities	224	66.08%
Inner regional	84	24.78%
Outer regional/remote	31	9.14%
<b>Area-level SES</b>		
Quintile 1 (lowest)	39	11.57%
Quintile 2	53	15.73%
Quintile 3	61	18.10%
Quintile 4	88	26.11%
Quintile 5 (highest)	96	28.49%
<b>Country of birth</b>		
Australia	199	76.54%
Other	61	23.46%
<b>Aboriginal or Torres Strait Islander</b>		
Yes	3	1.15%
No	253	97.31%
Rather not say	4	1.54%
<b>Highest level of education</b>		
University degree	140	54.90%
Certificate or Diploma	61	23.92%
Year 12 or lower	54	21.18%

interviews as having led to kit completion. According to the HAPA model, these strategies reflected ‘action planning’, including (i) placement of the kit in reach of the toilet (“I moved the home test kit to a place where it was in reach of my toilet”), (ii) placing the kit somewhere visible (“I placed the home test kit somewhere that can always be seen and not forgotten about”), (iii) scheduling a date on the calendar (“I scheduled a date on the calendar to do the home test kit”), and (iv) planning stool collection around a time at home (“I made a plan to do the home test kit on days when I had more time (e.g., on the weekend or on days that I worked from home”). Participants were asked if they had taken each of these actions after receiving their screening kit (“yes” or “no”). The number of planning actions taken was calculated for each participant resulting in a score ranging from zero to four.

### Survey data analysis

Logistic regression was used to assess if (i) each planning action and (ii) the total number of planning actions was

associated with screening participation (a dichotomous outcome variable). As the number of planning actions performed was a discrete ordinal variable, a monotonic effects approach was taken [28]. This approach allows for the overall size and direction of the effect to be calculated but allows for different sizes of effects to occur across each level of the predictor. Results were reported using odds ratios (OR) and corresponding 95% confidence intervals (CIs), whereby statistically significant ORs above 1 indicated that people who took the action were more likely to complete the kit. All data manipulation, analyses, and plotting were completed in R [31] using the dplyr [32], ggplot2 [33], and brms [34] packages.

## Results

### Interviews


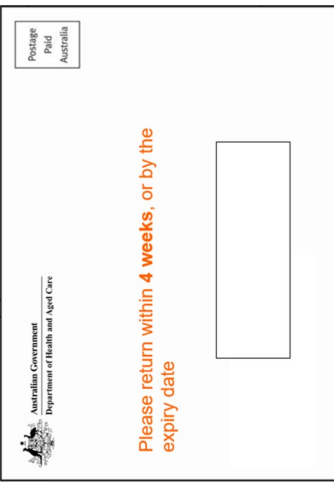
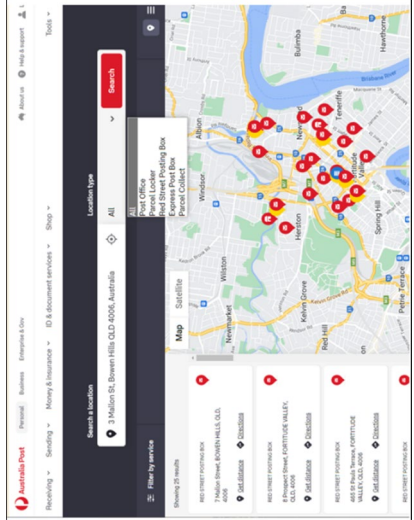
#### Interviews with completers

Four key action planning strategies were reported by participants who had completed the kit. They included: (i) placement of the kit in a visible location or ‘to-do’ pile, (ii) planning the timing of sample collection, (iii) planning access to a post box to return the kit, and (iv) using reminders. Additionally, four key coping planning strategies were identified by completers, including: (i) reframing sample collection and using storage bags to overcome disgust, (ii) reframing to overcome feelings of a lack of autonomy, (iii) familiarisation with instructions and materials to overcome physical difficulties, and (iv) focusing on motivators to overcome avoidance. A summary of each of these strategies is provided in Table 3. With the exception of the use of an additional storage bag and the use of gloves during sample collection, coping strategies were primarily focused on attitude change, which had limited relevance to participants who already *intend* to screen. Therefore, these strategies were not prototyped or presented to intenders.

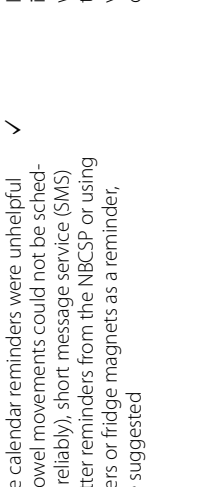
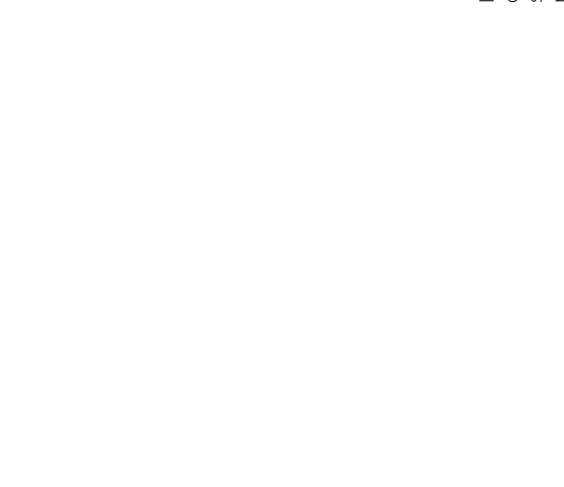
### Survey results

Logistic regression analyses demonstrated a positive effect of each planning action on screening participation (see Table 4). Effect sizes were large to very large. Respondents who reported placing the kit somewhere visible were 4.83 times more likely to have reported completing their last screening kit. Those who reported placing the kit within reach of the toilet were 7.91 times more likely to have completed their last screening kit. People who reported making a plan and scheduling a date in their calendar to complete their kit were 10.50 and 10.76 times more likely to have returned their last kit, respectively. The number of actions taken also had a positive and significant effect on screening participation, with the odds of having reported completing the kit increasing by 3.27, 95%CI [2.38, 4.78] for every action taken on average



**Table 3** Summary of completer and interder interview findings

Completer strategy	Description	Prototyped?	Description	Image of prototype
Storing kit in visible location	Leave the kit in a place likely to be seen daily, such as near the toilet, or in a 'to-do' pile. Provides continual reminder and helps overcome procrastination	✓	Including instructions on the kit to place the kit in a visible location	
Planning when to complete the kit	Setting time aside around usual bowel movements or during longer periods spent at home to facilitate easy collection and storage of the sample	✓	Including a deadline for when to complete and return the kit by to combat procrastination and help interders plan when to use the kit	
Planning where to return the kit	Identifying where to conveniently access a post office/box without compromising sample quality due to heat exposure (e.g., planning to return the kit to a post office while running errands)	✓	Including a QR code in the letters distributed with the screening kit to locate the closest post office/box to enable convenient kit return	

**Table 3** (continued)

Completer strategy	Description	Prototyped?	Description	Image of prototype
Using reminders	While calendar reminders were unhelpful (as bowel movements could not be scheduled reliably), short message service (SMS) or letter reminders from the NBCSP or using stickers or fridge magnets as a reminder, were suggested	✓	Including a QR code in the letters distributed with the screening kit to opt-in for reminders via SMS, digital calendar, or email	
			Including a token or sticker to be placed somewhere as a discrete reminder to complete the test kit	

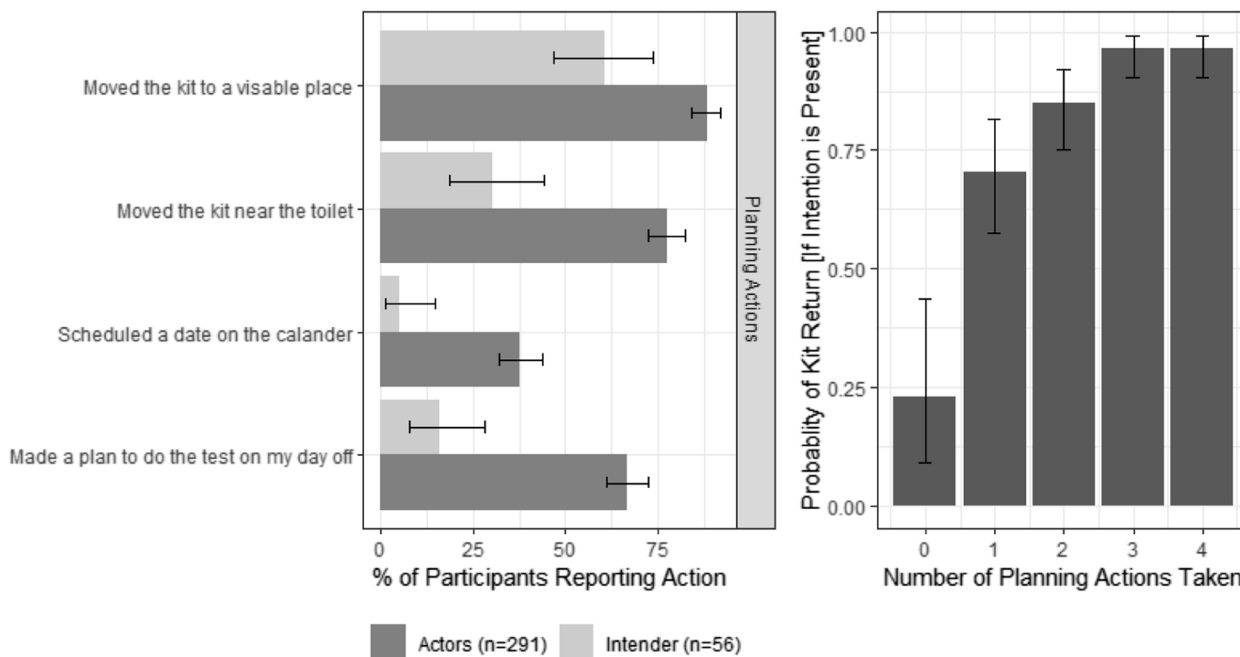
**Table 3** (continued)

Completer strategy	Description	Prototyped?	Description	Image of prototype
Use of gloves and storage bag	Using an additional bag to store the samples in when placing in the fridge, or wearing gloves during sample collection, to reduce disgust	✓	Including additional storage bags for fridge storage, or an insulated option to prevent the need for refrigeration	
Reframing to overcome autonomy barriers	Emphasising personal responsibility to screen to preserve their own health, and reminders that personal information disclosed was similar to other routine medical tests (e.g., blood testing)	✗	Including gloves in the kit to be worn during sample collection	
Reframing to overcome disgust barriers	Normalising screening by comparing it to other mundane activities (e.g., toilet cleaning) or by focusing on the benefits of screening	✗		
Familiarisation with instructions and materials to overcome perceived difficulty barriers	Reading the test kit instructions and inspecting the test kit contents (e.g., toilet liner) to reduce perceived difficulty of screening	✗		
Focusing on motivators to overcome avoidance	Reframing fear of receiving a positive test result with reminders of the importance of early detection, or by reflecting on their own and/or loved ones' history with cancer	✗		



**Table 4** Logistic regression analysis: effects of planning actions on participation in the NBCSP

Planning Action	Odds Ratio	95% CI	p value
Placed the home test kit in reach of my toilet	7.91	[4.26, 15.22]	<.001
Placed the home test kit somewhere it can be seen	4.83	[2.52, 9.21]	<.001
Scheduled a date on the calendar	10.76	[3.84, 44.91]	<.001
Made a plan to do it when I had time at home	10.50	[5.16, 23.71]	<.001



**Fig. 2** Percentage of Kit completers and intenders reporting taking each action, and the probability of kit completion for the number of planning actions taken

(a moderate to large effect). As seen in Fig. 2, performing zero actions was associated with a 0.23 95%CI [0.10, 0.44] probability of returning a kit whereas performing one action was associated with a 0.71 95%CI [0.57, 0.82] probability of returning a kit, with diminishing returns for every additional action after that.

**Interviews with intenders**

Findings from the first and second round of intender interviews are detailed below and summarised in Table 3.

**Storing the kit in a visible location**

Intenders endorsed completers’ strategy of placing the kit a visible location, stating that this would provide a continual reminder to complete the kit. This strategy was developed into a prototype intervention involving a message on the outside of the screening kit stating, “Keep this kit visible so you don’t forget”. Intenders generally endorsed this idea, agreeing that it would help combat

procrastination and forgetting. It was recommended that this message be clear, simple, and in large font to ensure accessibility for an older population. Participants also suggested that a visual instruction could be helpful, such as a diagram depicting an arrow pointing towards the toilet, to reminder invitees of where to place the kit. However, some participants expressed privacy concerns related to this strategy, as they did not want to leave the kit in a location visible to others.

**Planning when to use the kit**

Overall, intenders reported that writing down a date to complete the screening kit was unlikely to be a useful strategy, as it was not feasible to accurately schedule a bowel movement. Others found it off-putting to write “poo sample” in their calendar. Participants provided the unprompted suggestion that a deadline would make them more likely to schedule a time for the test:

*If [the kit] had the date on it ... then I would more than likely put it in the diary when I got it to think, okay ... where's the time I can do that? – Female, 65*

An intervention prototype was developed to address this, whereby a deadline or “return by” date was printed on the kit or its packaging. The use of a deadline was widely endorsed by intenders in the second interview round, as this strategy would increase urgency, prevent procrastination, and facilitate planning. The preferred timeframe for the deadline was within four weeks, including a subtle note about the kit being useable up until its designated expiry date. The preferred location of the deadline was on the envelope that the kit arrives in, to ensure recipients see the message regardless of whether they open the envelope, and on the invitation materials within.

#### **Planning where to return the kit**

Intenders endorsed the strategy of planning when to return the screening kit. They identified that including information about “hot zones” (i.e., times of the day to avoid returning the screening kit to a post box due to the risk of heat degrading the sample quality) would be particularly helpful. When presented with a prototyped intervention of a QR code to help locate their nearest post office or post box, however, most reported already being aware of this information, or expressed hesitancy to use QR codes. They often acknowledged that it may be useful for others but would not benefit them personally.

#### **Using reminders**

Most intenders endorsed the strategy of setting a reminder to complete the kit and noted that this would be particularly helpful if combined with a deadline; however, they again expressed that it was difficult to decide when to set a reminder for, as bowel movements could not be scheduled. The strategy of using reminders to facilitate kit completion was developed into two separate intervention prototypes. The first prototype involved a QR code to “opt in” for reminders via various modalities, including SMS and email. Intenders stated that SMS reminders to complete the kit would be a useful prompt, as this strategy resembled the reminders distributed for routine medical appointments. It was also noted that these reminders should be used sparingly, no more than twice per recipient, and should avoid links, as these may resemble spam and prevent some recipients from opening them. When presented with an option for an email reminder, some participants reported that this modality would be similarly effective, if not preferred, to SMS reminders to complete the kit. Some participants also recommended the use of MyGov, an online public

services platform used in Australia, to deliver automated reminders via email to prompt kit completion. Overall, opt-in reminders were particularly appealing if the reminders’ frequency and modality (e.g., SMS, calendar, email) could be customised. This was believed to maintain invitees’ autonomy, ensuring they felt reminded but not “nagged”. Regarding the content of the reminder, participants recommended that the message be short, simple, and include contact details to obtain support with screening if needed.

The second prototype involved providing invitees with a residue-free sticker or token to place in the bathroom as a reminder to complete the kit. Participants reported that a discrete token would be useful to place somewhere accessible, such as the bathroom mirror, near the toilet, or on the fridge. They suggested that this token could also be provided in the form of a suction cap or magnet. As most participants favoured digital diaries or calendars, the use of stickers for a physical calendar were unlikely to be useful. The preferred size of the token was that of a credit card. As for the appearance of the token, the logo from “Get2It”, an Australian bowel screening promotional campaign (see Table 3), was endorsed by the participants as it was sufficiently discrete yet still included imagery directly related to bowel cancer screening (i.e., a toilet roll), making it a relevant reminder. An additional suggestion was to include text with a deadline accompanying the token, such as “*Get2it in four weeks*”. Participants also recommended that the purpose of the token be made explicit when it is provided to invitees, for example, “*stick me where you’ll see me every day*”.

#### **Use of gloves and storage bag**

Some intenders endorsed the strategy of using gloves during sample collection, as this may reduce feelings of disgust; however, this was commonly referred to as something for “other people” and not necessarily relevant to oneself. Alternatively, some participants stated that including gloves with the kit would be wasteful, due to the excess plastic, and that those likely to use gloves may already own them, and that handwashing alone is suitable. When presented with the prototype intervention, including options for either plastic (loose-fitting) or latex (tight-fitting) gloves to be included in the screening kit, intenders had mixed responses. Some expressed concern that a “one-size” glove may not fit all screening invitees, rendering them ineffective, or that wearing gloves may reduce dexterity and adversely impact their ability to take the stool sample. Some participants noted that including gloves may inadvertently imply that the test was unhygienic or that it involved direct contact with stool. Thus, they recommended that if gloves were included in the kit,

a description should be added reiterating that gloves are optional, and that handwashing is preferable.

Intenders also endorsed the strategy of utilising an additional bag when storing the sample in the fridge, as this may reduce disgust and hygiene concerns. When presented with the intervention prototype, including various sizes and types of storage bags, intenders stated that a brown paper bag or opaque zip lock bag would be helpful in addressing privacy concerns by reducing the visibility of the sample. Additionally, a labelled bag was preferable to prevent confusion with other fridge items. Others preferred an insulated bag that prevented the need for fridge storage all together, as it could be placed somewhere out of sight. Many participants preferred the insulated bag to any other storage option if it meant the samples did not need to be refrigerated. Intenders noted that ideal size of the storage bag should be just large enough to fit sample tubes with ease, maintaining accessibility for those with mobility issues, such as arthritis. Others noted environmental and cost-related concerns of including additional materials, and subsequently preferred no storage bag, or at most, the paper bag.

## Discussion

The present study informed the co-design of seven intervention prototypes, intended to increase participation in at-home bowel cancer screening. These ranged from individual level strategies that invitees can implement (e.g., instructions to leave the kit in a visible location), to system level strategies the NBCSP can deliver (e.g., establishing a reminder service). As these interventions are based on strategies successfully applied by completers and tailored to the needs and preferences of screening intenders, these represent a set of interventions that are likely to have high acceptability and uptake in the target population.

Behavioural prompts are an effective strategy that population screening programs can implement to overcome the intention behaviour gap. For example, previous trials have found that sending a letter or SMS reminder can be an effective prompt to increase bowel cancer screening participation [35–37]. However, one potential limitation to this strategy is that their effectiveness may decay over time [38]. If a person cannot complete the kit soon after arrival of the reminder message, the risk of forgetting to complete their kit again increases. The current findings provide support for the use of more longstanding environmental prompts, such as leaving the kit in a visible place or including a reminder sticker, that may overcome the limitations of time sensitive digital prompts. With interviewees expressing varying preferences for reminders, it may be that providing screening program recipients with a combination of digital and

physical prompts will be the most successful method of overcoming procrastination and forgetting. Future research should explore the unique and combined effectiveness of these strategies in randomised controlled trials.

This study supports previous evidence that storing faecal samples in proximity to food is a barrier to screening participation, [10, 11]. This barrier is especially relevant for participants of the Australian program, which currently utilises a two-sample screening test. Due to Australia's warm climate, samples must be refrigerated in the interim between each sample's collection to ensure they remain viable. Intenders endorsed the use of an intervention whereby recipients are provided with additional storage materials to create an extra sealed layer between the sample and refrigerator contents. While this intervention was thought to prompt and facilitate kit use for those who intend to screen in the current study, it has been suggested elsewhere that providing storage bags such as this may also help increase motivate the decision in those who initially refuse to complete the kit due to hygiene concerns [18]. Furthermore, comparable bowel cancer screening programs in England, Northern Ireland, Scotland and Wales utilise one-sample kits (negating the need for refrigeration storage), and report participation rates that greatly exceed Australia's (i.e., 60–70%) [39, 40], suggesting this may be an effective means of increasing screening uptake. Ongoing collaboration with screening program organisers will be essential to facilitate the development and implementation of effective interventions and system-level modifications to Australia's bowel screening procedure, and to provide empirical evidence regarding the effectiveness of these strategies in increasing screening uptake in a naturalistic setting.

Providing a deadline to complete the FOBT kit may increase urgency and facilitate kit completion as indicated by participants. In fact, preliminary evidence of the effectiveness of issuing a 2-week deadline to bowel cancer screening kit recipients has recently been presented from a trial in Scotland [41, 42]. The NBCSP is unique compared to other Australian screening programs (i.e., for breast and cervical cancer) in that participation does not require attending a medical appointment with a healthcare professional. This means there is no precise timeframe in which the invitee must complete their screening kit. Cancer screening invitees have reported that this difference in the screening programs can lead to procrastination to participate in bowel cancer screening specifically [43]. The Australian NBCSP kit does feature an expiry date on the packaging, however, it is typically 6-months in the future and may not induce sufficient urgency needed to prevent procrastination. More research is needed to understand the optimal timeframe

for kit return deadlines that will encourage individuals to overcome procrastination and complete their screening kit [42].

While no single intervention was supported by all intenders consulted in the current study, every intender endorsed at least one intervention. Additionally, survey results showed screening probability increases substantially where participants engaged in more than one planning strategy. This indicates a multipronged approach will likely have the greatest effect on kit return as suggested in previous research [44]. The interventions presented here (see Table 3) can for the most part be combined as they are not mutually exclusive. For instance, a deadline, visual prompts and digital reminder can all be provided concurrently, however further co-design with participants and multi-arm RCTs should be conducted to assess the most acceptable and optimal combination of intervention that leads to increased kit return without placing too much burden on the recipient [45]. As suggested by Michie et al., (2009), a smaller set of well-chosen interventions are likely to be more effective than a large set of interventions that have little thought in their design [46].

This study is the first instance of an iterative and integrated approach that combines a mixed-methods study with consumer co-design to develop interventions to increase participation in bowel cancer screening in Australia. This unique approach not only describes and quantifies the current use of effective strategies for prompting bowel cancer screening, but it also develops solutions in collaboration with intervention targets based on these strategies. The methodology was further strengthened by the application of action planning and behaviour change theory; an approach known to yield more effective interventions [47, 48]. However, there are limitations to this research that need to be considered when interpreting the results. Participants in the interviews and survey were drawn from a convenience sample. This may have led to a self-selection bias such that individuals with higher health consciousness may be overrepresented in our sample, limiting the generalisability of the results. Further, this study sought consumer input from Australians within the general population; however, it is well understood that individuals in minority populations, such as those from culturally and linguistically diverse communities [49] and people with disabilities [50] face unique barriers to bowel cancer screening which may not adequately be addressed in the current study. Although findings from this study provide insight into screening intervention strategies likely to be highly acceptable and effective in encouraging “intenders” in the general Australian population to transition from intention to action, future research should focus on the co-design of

intervention strategies with people from diverse populations and those who do not intend to complete their kit. Input from the program organisers was not sought as part of this study. This input is needed to inform the practical ramifications of implementing these interventions, including feasibility and cost-effectiveness. Nevertheless, findings provide valuable advice for program organisers and a useful starting point for future intervention development and trials.

## Conclusions

Current findings provide several novel consumer-centred interventions for improving participation in population bowel cancer screening based upon the needs and experience of screening invitees. Multiple small changes to the invitation and kit materials such as issuing a text message reminder, noting a strict deadline, or providing a visual prompt such as a sticker in the bathroom may be particularly effective in prompting and facilitating kit return in the large proportion of kit recipients who intend, but fail to return their screening kit. Randomised controlled trials are needed to test these interventions with population screening programs to assess their unique and combined effectiveness.

## Abbreviations

NBCSP	National bowel cancer screening program
HAPA	Health action process approach
FOBT	Faecal occult blood test (FOBT)
OR	Odds ratio
CI	Confidence intervals
SES	Socioeconomic Status

## Supplementary Information

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Supplementary Material 1.  
Supplementary Material 2.  
Supplementary Material 3.  
Supplementary Material 4.

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## Authors' contributions

LA, LM and BG contributed to the study conception and design. Participant recruitment and data collection was conducted by LA, BV, LM and BG. Data preparation and analysis was conducted by LA, LM, KC and JV. All authors (LA, LM, KC, JV, BV, MI, BG) contributed to the interpretation of study findings. The first draft of the manuscript was written by LA, and reviewed by LM and BG. All authors (LA, LM, KC, JV, BV, MI, BG) reviewed and edited subsequent versions of the manuscript and approved the final manuscript.

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**Availability of data and materials**

Non-identifiable the data are available from the corresponding author upon reasonable request.

**Declarations****Ethics approval and consent to participate**

Ethical approval for these studies were granted by Human Research Ethics Committee at the University of Southern Queensland (ref. H21REA152 for interviews, H19REA291 for surveys). All subjects received an information sheet and provided informed consent prior to participating in this research.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare no competing interests.

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**References**

- Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* 2021;71(3):209–49.
- Australian Institute of Health and Welfare. Australian Institute of Health and Welfare. 2022 [cited 2022 Dec 5]. Cancer data in Australia, About. Available from: <https://www.aihw.gov.au/reports/cancer/cancer-data-in-australia/contents/about>.
- Schreuders EH, Ruco A, Rabeneck L, Schoen RE, Sung JJ, Young GP, et al. Colorectal cancer screening: a global overview of existing programmes. *Gut.* 2015;64(10):1637–49.
- Navarro M, Nicolas A, Ferrandez A, Lanás A. Colorectal cancer population screening programs worldwide in 2016: An update. *World J Gastroenterol.* 2017;23(20):3632.
- Australian Institute of Health and Welfare. National Bowel Cancer Screening Program monitoring report 2022. Australian Government; 2022 p. 122. [cited 2023 Jun 2] Available from: <https://www.aihw.gov.au/reports/cancer-screening/nbcsp-monitoring-2022/summary>.
- Deloitte Access Economics. Review of the National Bowel Cancer Screening Program - Questions and Feedback - Australian Government Department of Health - Citizen Space [Internet]. 2021 [cited 2023 Jun 2]. Available from: <https://consultations.health.gov.au/hearing-and-program-support-division/review-the-national-bowel-cancer-screening-program/>.
- Australian Institute of Health and Welfare. Australian Institute of Health and Welfare. 2024 [cited 2024 Jun 26]. National bowel cancer screening program monitoring report 2024, Summary. Available from: <https://www.aihw.gov.au/reports/cancer-screening/nbcsp-monitoring-2024/summary>.
- Anderson LE, Ireland MJ, Myers L, Avenell C, Connaughton, Goodwin BC. Psychological distress and bowel cancer screening participation. *Psycho Oncol.* 2022.
- Chapple A, Ziebland S, Hewitson P, McPherson A. What affects the uptake of screening for bowel cancer using a faecal occult blood test (FOBT): a qualitative study. *Soc Sci Med.* 2008;66(12):2425–35.
- Goodwin BC, March S, Crawford-Williams F, Chambers SK, Dunn J. "I'm not doing that". An in-depth examination of nonparticipation in mail-out bowel cancer screening programs. *Transl Behav Med.* 2020;10(6):1515–24.
- Goodwin BC, Myers L, Ireland MJ, March S, Ralph N, Dunn J, et al. Barriers to home bowel cancer screening. *Psychosocology.* 2021;30(10):1756–64.
- Hall NJ, Rubin GP, Dobson C, Weller D, Wardle J, Ritchie M, et al. Attitudes and beliefs of non-participants in a population-based screening programme for colorectal cancer. *Health Expect.* 2015;18(5):1645–57.
- Worthley DL, Cole SR, Esterman A, Mehaffey S, Roosa NM, Smith A, et al. Screening for colorectal cancer by faecal occult blood test: why people choose to refuse. *Intern Med J.* 2006;36(9):607–10.
- Phillipson L, Pitts L, Hall J, Tubaro T. Factors contributing to low readiness and capacity of culturally diverse participants to use the Australian national bowel screening kit. *Public Health Res Pract.* 2019;29(1).
- Durkin S, Gascoyne C, Ross M, Ilchenko E, Goodwin B, Broun K, et al. Participation in the National Bowel Cancer Screening Program: Research Insights Report. Cancer Council Victoria; 2021 [cited 2023 Sep 20]. Available from: <https://www.cancer.org.au/assets/pdf/bowel-screening-research-insights-for-health-professionals>.
- Faries MD. Why We Don't "Just Do It." *Am J Lifestyle Med.* 2016;10(5):322–9.
- Orbell S, Sheeran P. 'Inclined abstainers': A problem for predicting health-related behaviour. *Br J Soc Psychol.* 1998;37(2):151–65.
- Schwarzer R, Luszczynska A. How to overcome health-compromising behaviors: The health action process approach. *Eur Psychol.* 2008;13(2):141.
- Sniehotta FF, Schwarzer R, Scholz U, Schüz B. Action planning and coping planning for long-term lifestyle change: theory and assessment. *Eur J Soc Psychol.* 2005;35(4):565–76.
- Goodwin BC, Ireland MJ, March S, Myers L, Crawford-Williams F, Chambers SK, et al. Strategies for increasing participation in mail-out colorectal cancer screening programs: a systematic review and meta-analysis. *Syst Rev.* 2019;8(1):257.
- Moll S, Wyndham-West M, Mulvale G, Park S, Buettgen A, Phoenix M, et al. Are you really doing 'codesign'? Critical reflections when working with vulnerable populations. *BMJ Open.* 2020;10(11):e038339.
- Gallo J, Lee S. Mixed methods in behavioral intervention research. In: Behavioral Intervention Research: Designing, Evaluating, and Implementing [Internet]. 2015 [cited 2024 Jul 10]. Available from: [https://books.google.com.au/books?hl=en&lr=&id=4L8nCwAAQBAJ&oi=fnd&pg=PA195&dq=Mixed+methods+in+behavioral+intervention+research&ots=LN-tXVfEPi&sig=M11AF8jm7x1uwuQvaYreUo\\_PbIQ#v=onepage&q=Mixed%20methods%20in%20behavioral%20intervention%20research&f=false](https://books.google.com.au/books?hl=en&lr=&id=4L8nCwAAQBAJ&oi=fnd&pg=PA195&dq=Mixed+methods+in+behavioral+intervention+research&ots=LN-tXVfEPi&sig=M11AF8jm7x1uwuQvaYreUo_PbIQ#v=onepage&q=Mixed%20methods%20in%20behavioral%20intervention%20research&f=false).
- Selva A, Torà N, Pascual E, Espinàs JA, Baré M. Effectiveness of a brief phone intervention to increase participation in a population-based colorectal cancer screening programme: a randomized controlled trial. *Colorectal Dis.* 2019;21(10):1120–9.
- Coronado GD, Nyongesa DB, Petrik AF, Thompson JH, Escaron AL, Younger B, et al. Randomized Controlled Trial of Advance Notification Phone Calls vs Text Messages Prior to Mailed Fecal Test Outreach. *Clin Gastroenterol Hepatol.* 2020.
- Myers L, Goodwin B, Ralph N, March S. A health action process approach for developing invitee endorsed interventions to increase mail-out bowel cancer screening. *Applied Psychology: Health and Well-Being* [Internet]. 2022 [cited 2022 Mar 9];n/a(n/a). Available from: <https://doi.org/10.1111/aphw.12346>.
- Myers L, Ireland MJ, Viljoen B, Goodwin B. Evaluating changes to home bowel cancer screening kits: an end-user perspective study. *Cancer Causes Control.* 2023;34(7):583–94.
- Australian Bureau of Statistics. Australian Statistical Geography Standard (ASGS) [Internet]. 2016 [cited 2021 Jul 23]. Available from: [https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+\(ASGS\)](https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS)).
- Smith J, Firth J. Qualitative data analysis: the framework approach. *Nurse Res.* 2011;18(2):52–62.
- Schwarzer R. Modeling Health Behavior Change: How to Predict and Modify the Adoption and Maintenance of Health Behaviors. *Appl Psychol.* 2008;57(1):1–29.
- Qualtrics. Qualtrics AU. 2022 [cited 2022 Dec 13]. Learn about Research, Survey & Experience Management Software by Qualtrics. Available from: <https://www.qualtrics.com/au/>.
- R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. 2021; Available from: <https://www.R-project.org/>.

32. Wickham H, François R, Henry L, Müller K. dplyr: A Grammar of Data Manipulation. 2022; Available from: [tps://dplyr.tidyverse.org](https://dplyr.tidyverse.org), <https://github.com/tidyverse/dplyr>.
33. Wickham H. ggplot2: Elegant Graphics for Data Analysis. New York: Springer-Verlag; 2016. Available from: <https://ggplot2.tidyverse.org>.
34. Bürkner PC. brms: An R Package for Bayesian Multilevel Models Using Stan. *J Stat Softw*. 2017;29(80):1–28.
35. Hirst Y, Skrobanski H, Kerrison RS, Kobayashi LC, Counsell N, Djedovic N, et al. Text-message Reminders in Colorectal Cancer Screening (TRICCS): a randomised controlled trial. *Br J Cancer*. 2017;116(11):1408–14.
36. Larsen MB, Hedelund M, Flander L, Andersen B. The impact of pre-notifications and reminders on participation in colorectal cancer screening – A randomised controlled trial. *Prev Med*. 2022;1(164): 107229.
37. Lam TY, Wu PI, Tang RS, Luk AK, Ng S, Sung JJ. Mobile messenger–initiated reminders improve longitudinal adherence in a community-based, opportunistic colorectal cancer screening program: A single-blind, crossover randomized controlled study. *Cancer*. 2021;127(6):914–21.
38. Pirolli P, Mohan S, Venkatakrishnan A, Nelson L, Silva M, Springer A. Implementation Intention and Reminder Effects on Behavior Change in a Mobile Health System: A Predictive Cognitive Model. *J Med Internet Res*. 2017;19(11): e397.
39. Australian Institute of Health and Welfare. National Bowel Cancer Screening Program monitoring report 2023. 2023 [cited 2023 Oct 12]; Available from: <https://www.aihw.gov.au/reports/cancer-screening/nbcsp-monitoring-2023/summary>.
40. Cancer Research UK [Internet]. 2022 [cited 2024 Jan 10]. Bowel cancer screening. Available from: <https://www.cancerresearchuk.org/health-professional/screening/bowel-cancer-screening>.
41. Robb KA. Increasing uptake of FIT colorectal screening: the TEMPO randomised controlled trial testing a suggested deadline and a planning tool in Scotland, UK. In Turin, Italy; 2023.
42. Robb KA, Kotzur M, Young B, McCowan C, Hollands GJ, Irvine A, et al. Increasing uptake of FIT colorectal screening: protocol for the TEMPO randomised controlled trial testing a suggested deadline and a planning tool. *BMJ Open*. 2023;13(5):e066136.
43. Kotzur M, McCowan C, Macdonald S, Wyke S, Gattling L, Campbell C, et al. Why colorectal screening fails to achieve the uptake rates of breast and cervical cancer screening: a comparative qualitative study. *BMJ Qual Saf*. 2020;29(6):482–90.
44. Myers L, Goodwin B, March S, Dunn J. Ways to use interventions to increase participation in mail-out bowel cancer screening: a systematic review and meta-analysis. *Transl Behav Med*. 2020;10(2):384–93.
45. Squires JE, Sullivan K, Eccles MP, Worswick J, Grimshaw JM. Are multi-faceted interventions more effective than single-component interventions in changing health-care professionals’ behaviours? An overview of systematic reviews. *Implement Sci*. 2014;9(1):1–22.
46. Michie S, Jochelson K, Markham WA, Bridle C. Low-income groups and behaviour change interventions: a review of intervention content, effectiveness and theoretical frameworks. *J Epidemiol Commun Health*. 2009;63(8):610–22.
47. Dsouza JP, Broucke SV den, Pattanshetty S, Dhoore W. The application of health behavior theories to promote cervical cancer screening uptake. *Public Health Nursing* [Internet]. 2021 [cited 2021 Jul 22]; Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/phn.12944>.
48. Glanz K, Bishop DB. The role of behavioral science theory in development and implementation of public health interventions. *Annu Rev Public Health*. 2010;31(1):399–418.
49. Javanparast S, Ward PR, Carter SM, Wilson CJ. Barriers to and facilitators of colorectal cancer screening in different population subgroups in Adelaide. *South Aust Med J Aust*. 2012;196(8):521–3.
50. Floud S, Barnes I, Verfürden M, Kuper H, Gathani T, Blanks RG, et al. Disability and participation in breast and bowel cancer screening in England: a large prospective study. *Br J Cancer*. 2017;117(11):1711–4.

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