ORIGINAL ARTICLE

A health action process approach for developing invitee endorsed interventions to increase mail-out bowel cancer screening

Larry Myers[1,2,3] 🄳 | Belinda Goodwin[1,2] | Nicholas Ralph[2,4,5] | Sonja March[2,3]

[1]Cancer Research Centre, Cancer Council Queensland, Brisbane, Queensland

[2]Centre for Health Research, University of Southern Queensland, Springfield, Queensland

[3]School of Psychology and Counselling, University of Southern Queensland, Springfield, Queensland

[4]School of Nursing and Midwifery, University of Southern Queensland, Toowoomba, Queensland, Australia

[5]Faculty of Health, University of Technology Sydney, Ultimo, New South Wales, Australia

Correspondence
Dr. Larry Myers, Cancer Research Centre, Cancer Council Queensland. Brisbane, QLD, Australia.
Email: larrymyers@cancerqld.org.au

Funding information
Australian Government Research Training Program (RTP) Scholarship; University of Southern Queensland; Cancer Council Queensland

Abstract

Theory-based, user-informed interventions are needed to increase the low participation rates of population-based faecal occult blood test (FOBT) bowel cancer screening. This study investigated the theoretical fit of the health action process approach (HAPA) for home FOBT screening and measured screening invitees' attitudes towards different intervention strategies. A cross-sectional sample ($n = 377$), aged 50–74 years, participated in this study. Two scales were created for this study. The process approach to mail-out screening (PAMS) scale measured HAPA constructs, and the user ratings of mail-out screening interventions (UR-MSI) scale measured attitudes towards different intervention strategies. Structural equation modelling was used to assess the fit of PAMS scale responses to the HAPA model, and descriptive statistics were calculated for UR-MSI responses. PAMS results showed acceptable model fit, CFI = .968, RMSEA = .050 and explained 49.9% of the variation in FOBT screening participation. Positive ratings of interventions ranged from 20.47%, an intervention prompting planning to complete the FOBT kit, to 72.25%, an intervention promoting the

positive health outcome associated with FOBT screening. Intervention strategies should be combined such that they target all factors specified within the HAPA model. User-informed intervention design should be used to effectively facilitate FOBT uptake in the community.

KEYWORDS

behaviour change techniques, bowel cancer, cancer screening, health action process approach, oncology, user-informed interventions

INTRODUCTION

Bowel cancer is the second leading cause of cancer-related deaths (Sung et al., 2021). If detected early, the 5-year relative survival rate is as high as 95% (Australian Institute of Health and Welfare, 2021). Many countries implement population-based bowel cancer screening programmes that aim to increase the rate of early detection, improve survival and reduce the impact of the disease on health services (Navarro et al., 2017). Navarro et al. (2017) detail the different types of screening programmes that exist. One type that is used in countries such as Australia, England and the Netherlands is to mail faecal occult blood test (FOBT) kits to all members of the population that are at a higher risk of developing bowel cancer (e.g. 50–74 years; Navarro et al., 2017). Invitees are asked to collect small stool samples using these kits. Once completed, they are to mail the kit back to a pathology lab for processing. If the test is positive, this may be a sign of bowel cancer and the person is referred to their general practitioner for follow-up, at which point a colonoscopy is usually scheduled for a comprehensive diagnosis (Australian Institute of Health and Welfare, 2021).

While some individuals will receive false positive or negative FOBT results, it has been shown that overall this two-stage approach of national bowel cancer screening is cost-effective, sensitive at detecting early-stage bowel cancer and can increase bowel cancer survival rates (Ananda et al., 2016; Lew et al., 2017). However, low participation rates, particularly among males, younger invitees and those in low socio-economic areas, limit their efficacy (Australian Institute of Health and Welfare, 2021). For example, the current participation rate for the Australian National Bowel Cancer Screening Program (NBCSP) is only 43% (Australian Institute of Health and Welfare, 2021). If participation in the NBCSP were to be increased to 60%, an estimated 24,800 bowel cancer deaths would be prevented and $2 billion would be saved over the next 25 years (Lew et al., 2017). In order to achieve this increase in participation, behaviour change interventions need to be developed to facilitate the FOBT screening process for the screening invitees (Goodwin et al., 2019).

There are often multiple determinants that affect the uptake of a health behaviour, for example, peoples' attitudes, knowledge and reactions to stress (Glanz & Bishop, 2010). Psychological theories, such as the theory of planned behaviour or the health belief model, can be used to describe what the main determinants of health behaviours are and guide intervention design (Dsouza et al., 2021). Designing interventions based on psychological theory, especially when

targeting multiple components of that theory, has been shown to be an effective method for addressing behaviour change (Dsouza et al., 2021; Glanz & Bishop, 2010). For example, interventions based on the theory of planned behaviour constructs, including attitudes, subjective norms, perceived behavioural control and intentions, have increased cervical cancer screening behaviour (Dsouza et al., 2021). So far, developers of interventions aiming to increase participation in mail-out bowel cancer screening programmes rarely report basing their design on psychological theory (Myers, Goodwin, March, & Dunn, 2020). A lack of theoretically informed interventions may explain why only modest increases in participation have resulted from interventions to date (Goodwin et al., 2019; Myers, Goodwin, March, & Dunn, 2020).

The health action process approach (HAPA) could be used to make a theory-informed intervention. The model suggests that individuals progress through two stages when engaging in a health behaviour: a motivational stage where intentions to perform a health behaviour are established and a volitional stage where these intentions are translated into action (Schwarzer & Luszczynska, 2008). Crucially, behavioural intentions are thought to be dependent on four key factors that make up the 'motivational stage' of behaviour change (Schwarzer, 2008): risk perception, positive outcome expectancies, negative outcome expectancies and action self-efficacy (see supporting information for definitions; Table S1). According to the HAPA model, when these factors are satisfied, individuals will have high behavioural intentions and will enter a 'volitional stage' where intentions are transformed into action. The HAPA model posits that behavioural planning is the key mediating factor between intention and action (Schwarzer et al., 2011).

The HAPA model has been previously used to successfully model enduring health behaviours, such as physical activity and dietary behaviour (Schwarzer et al., 2007), as well as one off preventative health behaviours such as flu vaccinations (Ernsting et al., 2013). When used to explain one off-health behaviours, such as receiving the influenza vaccine and participating in bowel cancer screening, factors relating to behaviour maintenance and relapse prevention are omitted as they are not relevant (e.g. Ernsting et al., 2013). A realist review of FOBT screening interventions also showed that behaviour change strategies that aimed to increase FOBT screening motivations as well as facilitate the volitional components of FOBT screening were the most likely to be effective (Myers, Goodwin, Ralph, et al., 2020). For example, one effective trial combined strategies of providing bowel cancer screening-related health messages (motivational component) with a reminder to complete the FOBT kit (volitional component; Benton et al., 2017). This indicates that the HAPA model may be an appropriate framework to explain the variation in FOBT participation and to inform intervention design. To our knowledge, the HAPA framework has not been explicitly considered in designing FOBT screening interventions or used to model FOBT screening behaviour.

It is recommended that input is also gathered from end-users when designing behaviour change interventions (Yardley et al., 2015). It is vital that invitees perceive the benefit of an intervention so that they will engage with it (DeSmet et al., 2019). This is of particular importance in mail-out screening interventions, as there is little to no interpersonal communication between the deliverers of the intervention and the recipients. Therefore, user-engagement is a key factor in determining if an intervention will reach its full potential effectiveness (Yardley et al., 2015). The majority of research has focused on barriers that prevent FOBT screening participation (e.g. Goodwin et al., 2020; Hall et al., 2015). However, limited research has been conducted that investigates end-user's attitudes towards different behaviour change interventions to overcome these barriers. Intervention research combining behaviour change theory with end-user input has significant potential impact.

Aims

This study describes the development, testing and application of two survey measures designed to assist in intervention development to increase bowel cancer screening participation. The first is the *Process Approach to Mail-out Screening* (PAMS), designed to measure the constructs proposed by the HAPA model in the context of mail-out FOBT participation. The second is the *User Ratings of Mail-Out Screening Interventions* (UR-MSI) scale, designed to identify which intervention strategies invitees believe will make it more likely for them to participate in mail-out bowel cancer screening. In conjunction, these measures will be used to better understand which interventions can be applied to address the various barriers (e.g. perceived difficulty or forgetfulness; Hall et al., 2015) that occur during the process of participating in mail-out bowel cancer screening as described by the HAPA model.

METHODS

Scale design

Item generation

PAMS and UR-MSI scale items were established through an iterative process. This process consisted of initial item generation by the primary research team, followed by content validation and refinement by an external panel of experts (Zamanzadeh et al., 2015).

   The initial set of items in the PAMS scale was based on the definitions of the HAPA constructs and instructions on how to create HAPA-related scales published by the model's creators such that they fit the context of mail-out FOBT screening (Schwarzer et al., 2011; Schwarzer & Luszczynska, 2008). The number of response options for each item was based on previous studies (e.g. Ernsting et al., 2013) and instructions given in Schwarzer et al. (2003). There are seven constructs in the HAPA model that apply to mail-out FOBT screening; they along with their definitions and example items from Schwarzer et al. (2003) can be found in the supporting information (Table S1).

   The UR-MSI scale items consist of a series of example interventions based on Behaviour Change Techniques (BCTs) listed in the Behaviour Change Taxonomy v1 (Michie et al., 2013) that are applicable in the context of mail-out FOBT screening (e.g. '*Action planning*' and '*Information about health consequences*'). The example interventions in the UR-MSI were either based on interventions that have already been trialled (Myers, Goodwin, Ralph, et al., 2020) or were adaptations of BCT definitions such that they fit the context of mail-out FOBT screening.

Content validity

After the initial item generation and refinement was completed by the primary research team, an expert panel assessed each item and the scales overall for content validity. The expert panel consisted of eight public health experts/professionals including researchers and health promotion specialists. Of these, four panel members had extensive knowledge in behaviour change

and BCTs, and the remaining four were experts in health promotion, specialising in cancer screening.

The expert panel rated each item on a 4-point scale in terms of its relevancy (1 = not relevant, 2 = item needs some revision, 3 = relevant but needs minor revisions and 4 = very relevant) and in terms of its clarity (1 = clear, 2 = item needs some revision, 3 = clear but needs minor revisions and 4 = very clear). The panel was advised that when rating the relevancy of items on the UR-MSI scale, they were to consider the BCT definition the item was based on. When rating the relevancy of items on the PAMS scale, they were to consider the definition of the HAPA construct the item was intended to measure (i.e. risk perception, positive/negative outcome expectancies, action self-efficacy, intention and planning). Additionally, for the PAMS scale, the panel rated if the set of items measuring each HAPA construct comprehensively covered the construct's definition on a 4-point scale (1 = no, 2 = a little, needs major revision, 3 = yes, needs minor revision and 4 = yes). A separate content validity index (CVI) was calculated for relevancy, clarity and comprehensiveness whereby the number of judges that gave a rating of 3 or 4 was divided by the number of judges: giving the proportion of judges that deemed the item, or items, as relevant, clear or comprehensive. Items that received a CVI > .79 for both relevancy and clarity were kept (Zamanzadeh et al., 2015), and items with a lower CVI were amended and resubmitted to the content validity expert panel for re-evaluation until a .79 CVI was reached (Zamanzadeh et al., 2015). The set of PAMS subscale items was deemed to comprehensively cover each HAPA factor if the CVI for comprehensiveness exceeded .79 (Zamanzadeh et al., 2015).

Content validity results

There were 24 items generated for the PAMS scale. Of these, eight did not meet the predetermined CVI threshold in the first expert panel round. Subsequently, amendments were made to these eight items based on the panel's feedback and one additional item was added. These nine items were then re-evaluated by the panel, and all items exceeded the CVI threshold. The comprehensiveness for each HAPA factor with the PAMS scale exceeded .79. The final set of 25 PAMS items can be found in the supporting information (Table S2). There were 41 example interventions generated for the UR-MSI. Two items did not initially meet the .79 CVI threshold. Subsequently, revisions were made to these items based on the panel's feedback and after revaluation all UR-MSI items demonstrated a CVI greater than .79. The final set of UR-MSI items can be found in the supporting information (Figures S1–S5).

Survey recruitment and procedure

Participants were recruited through paid Facebook advertising and contacting community groups that are frequented by adults aged between 50 and 74 years, such as, bowls clubs, men's support groups, retired service leagues and social clubs. Invitees were offered an opportunity to win one of three grocery vouchers, up to the value of $50 (AUD) as an incentive to participate. Only Australian residents aged between 50 and 74 years (i.e. eligible participants of the NBCSP) were eligible to participate. Those who did not report previously receiving an FOBT kit in the

mail only completed the UR-MSI scale, those who did complete both the PAMS and UR-MSI scales. The survey was delivered via the Qualtrics survey platform and took approximately 30 min (Qualtrics, 2020). Participants provided informed consent, and ethical approval for this research was provided by a university-based Human Research Ethics Committee (ref: H19REA291).

Measures

The PAMS scale

The PAMS scale was intended to capture seven factors reflecting components of the HAPA model.

Risk perception
There were four items assessing the degree to which participants consider bowel cancer a risk to their health. On a 6-point scale, participants were asked to respond to items such as 'The threat of bowel cancer to your health is ...' (from 1 = 'very low' to 6 = 'very high').

Positive outcome expectancies
There were four items assessing the degree to which participants expected a positive consequence from participating in mail-out bowel cancer screening. Participants were asked to rate how much they agree or disagree with statements such as 'If I complete my FOBT kit, this will decrease my chance of dying from bowel cancer', on a 6-point scale (from 1 = 'strongly disagree' to 6 = 'strongly agree').

Negative outcome expectancies
There were five items assessing the degree to which the participant expected a negative consequence from participating in mail-out bowel cancer screening. Participants were asked to rate how much they agree or disagree with statements such as 'If I complete my FOBT kit, I am concerned I would feel disgust while collecting a stool sample', on a 6-point scale (from 1 = 'strongly disagree' to 6 = 'strongly agree').

Action self-efficacy
There were five items assessing how confident the participant was in overcoming barriers associated with mail-out bowel cancer screening. Participants were asked to rate how truthful statements such as 'I would be able to complete the FOBT kit even if I had to overcome some of the disgust that might arise from collecting stool samples' were for them on a 6-point scale (from 1 = 'not at all true' to 6 = 'very true').

Intention
The participant's desire to complete and return their FOBT kit was measured by asking a single question 'When you first received your last FOBT kit in the mail did you *intend* to complete and return it?' on a 5-point scale (from 1 = 'I didn't intend to complete and return it' to 5 = 'I had a very strong intention to complete and return it'). As FOBT screening participation is a very specific behaviour, single items can be a valid way to measure constructs related to it (Schwarzer & Luszczynska, n.d.).

Planning

There were five items assessing the level of planning the participant had engaged in to complete their last mailed FOBT kit. Participants were asked to rate how truthful statements were for them on a 6-point scale (from 1 = 'not at all true' to 6 = 'very true'). For example, 'The last time I received an FOBT kit I had a plan for where I was going to keep the kit'.

Participation

Participation in the NBCSP was assessed with the single item 'Last time you received an FOBT kit did you complete and return it?'. Participants could either respond with a 'yes' or 'no'.

Measures of internal consistency for the multiple indicator factors on the PAMS scale can be found in the supporting information (Table S3).

The UR-MSI scale

Intervention examples were divided into three sections with different question stems to reflect the wording of the item. The first group of example interventions (n = 20) reflected 'messages' and had the question stem 'Would you be more likely to complete and return your next FOBT kit if the following messages were included in the blue oval' (with a blue oval superimposed on an image of the envelope used in the NBCSP to send the FOBT kit; see supporting information; Figure S6). Example items included '90% of bowel cancers are treatable if detected early, doing this test will greatly reduce your risk of dying from bowel cancer' (BCT: 'Information about health consequences') and 'Concerned about your health? People often have a sense of relief when they get their result saying everything is all clear' (BCT: 'Information about emotional consequences'). The second group of example interventions reflected provisions that could be added to the NBCSP (n = 18) and had the question stem 'Would you be more likely to complete and return your next FOBT kit if you received the following with your next screening invitation?'. Example items included 'A sticky note you can put around the house to remind you to complete the FOBT kit' (BCT: 'Prompts/cues') and 'A series of pictures demonstrating each stage of the testing procedure' (BCT: 'Demonstration of the behaviour'). The third group of example interventions reflected services that could be provided alongside the NBCSP (n = 2) and had the question stem of 'Would you be more likely to complete and return your next FOBT kit if the following services were available with your next screening invitation?'. Items included 'A text-based messaging service you can use to get clear instructions on how to complete and return your FOBT kit' (BCT: 'Instructions on how to perform a behaviour') and 'Places in your community where you can physically return your FOBT kit instead of mailing it back' (BCT: 'Restructuring the physical environment'). Participants were asked to respond using a 5-point scale (1 = no, this would prevent me from participating, 2 = no, this would make me less likely to participate, 3 = this would make no difference, 4 = Yes, this would encourage me to participate and 5 = Yes, this would definitely make me participate).

Demographic information

Participants were asked to report their gender, age, income, highest education level, relationship status, country of origin and residential postcode. Residential postcode was used to

classify participants by geographic remoteness and socio-economic status according to the Australian Bureau of Statistics, Australian Statistical Geography Standard and Socio-Economic Indexes for Areas classification systems (Australian Bureau of Statistics, 2016b, 2016a).

Bowel cancer screening history

Participants were asked whether they received a home test kit through the NBCSP ('yes' or 'no') and how recently (in months).

Data analysis

Data management, data plotting and analysis of the UR-MSI items were done using the 'dplyr' and 'ggplot2' packages using the R statistical programme (R Core Team, 2020; Wickham, Wickham, n.d.-b, Wickham, n.d.-a). Confirmatory factor analysis (CFA) and structural equation modelling (SEM) were conducted to assess the measurement model and the structural model of the PAMS scale, respectively. SEM is a set of statistical techniques that allows relationships between multiple and single indicator variables to be estimated while at the same time removing measurement error. It is recommended that in applications of the HAPA model data are analysed using SEM (Schwarzer et al., 2003). This was conducted with the Lavaan (Rosseel, n.d.) R package using the bootstrapped diagonally weighted least squares estimator to account for the ordinal endogenous variables (i.e. level of intention and NBCSP participation) and the known nonnormal distribution of indirect effects (MacKinnon et al., 2004). For the factors in the PAMS scale that have multiple indicator variables (i.e. risk perception, positive and negative outcome expectancies, action self-efficacy and planning), McDonald's omega was calculated to assess their reliability (i.e. the amount of measurement error in a set of items) using the semTools R package (Hayes & Coutts, 2020; Jorgensen et al., 2021). McDonald's omega is a preferred reliability estimate over the traditional Cronbach's alpha, as it does not assume all items measure the latent factor with equivalent precision and generalises to Cronbach's alpha if that assumption holds (Hayes & Coutts, 2020).

For each multiple indicator factor (e.g. risk perception or planning), reliabilities of over .70 were considered acceptable (i.e. low enough levels of error measurement; Gana & Broc, 2019). Additionally, communalities (i.e. the amount of variation in the item that can be explained by the latent factor) were used to assess how well each individual item reflected the latent factor it was measuring. Communalities (h^2) are calculated by squaring the items factor loading, with h^2 values .16 (which is equal to a factor loading of 0.40) and over considered as acceptable (Gana & Broc, 2019).

For analysis of the UR-MSI, responses to the example interventions were collapsed into three outcomes to aid in interpretability. Ratings of one or two (i.e. responses of 'no, this would prevent me from participating' and 'no, this would make me less likely to participate') were collapsed into a category reflecting a perceived negative effect on participation. Responses of a three (i.e. response of 'this would make no difference') constituted its own category reflecting no effect on participation. Ratings of four and five (i.e. responses of 'yes, this would encourage me to participate' and 'yes, this would definitely make me participate') were collapsed into a category reflecting a positive effect on participation. The percentage of participant responses

that fell into each of these three categories was calculated for the overall sample as well as the subsets of people who did and did not return their last FOBT kit. Each example intervention (i.e. each UR-MSI item) was coded according to the factor of the HAPA model it was intended to relate to. For instance, the example intervention of delivering the message '90% of bowel cancers are treatable if detected early, doing this test will greatly reduce your risk of dying from bowel cancer' (BCT: '*Information about health consequences*') was coded under positive outcome expectancies. This coding was based on previous realist evaluation findings (Myers, Goodwin, Ralph, et al., 2020), the theory and techniques tool kit (Johnston et al., 2021) and discussions within the primary research team. A detailed description of each coding is presented in the supporting information (Table S4). Interventions within each HAPA factor were ranked according to the percentage of participants that responded with a positive effect on participation.

RESULTS

Sample characteristics

Data wereas collected from 485 participants between 11 September 2020 and 21 December 2020. However, only 377 people completed all items in the PAMS scale and 354 completed all items in the UR-MSI scale. Missing data were excluded in a listwise manner for the SEM analysis (as no full-information maximum likelihood estimation methods are available with ordinal variables) (Rosseel, n.d.) and a pairwise manner (i.e. per item) in the analysis comparing UR-MSI items. Noncompletion of the PAMS scale was not significantly associated with gender ($p = .815$), education level ($p = .673$), age ($p = .223$), remoteness ($p = .373$), socio-economic area (SES, $p = .113$) or past participation ($p = .449$). In terms of noncompletions of UR-MSI scale (which appeared later in the survey), missingness of data was not significantly associated with gender ($p = .090$), education level ($p = .508$), remoteness ($p = .468$) or socio-economic area ($p = .867$); however, it was significantly associated with increased age ($p = .049$) and past NBCSP nonparticipation ($p = .034$). The overall demographic characteristics can be seen in Table 1. The average age of the participants was 62.52 years ($SD = 7.12$), and 68.0% ($n = 259$) of people reported that they returned their last FOBT kit.

PAMS

Measurement model

For all the constructs within the PAMS scale that have multiple indicators (i.e. action self-efficacy, positive/negative outcome expectancies, risk perception and planning), a CFA was fit to assess how each item loaded onto its respective factor and to assess the overall fit of the measurement model. One of the risk perception items ('To what level of severity would the health-related problems associated with bowel cancer be if they weren't attended to, or if they remained undiscovered?') had a low standardised factor loading and low communality (loading = .271, $h^2 = .074$) and was removed from the analysis. The remaining items had standardised factor loadings of above .60 and communalities greater than .40 (see Figure 1). The measurement model showed acceptable fit; χ^2 (220) = 579.46, $p < .001$, CFI = .938,

TABLE 1 Sample characteristics

	n	(%)[a]
Gender		
Male	103	(28.7)
Female	253	(70.5)
Other	3	(0.8)
Born in Australia		
Yes	256	(74.2)
No	93	(25.8)
Married/De facto relationship		
Yes	222	(63.2)
No	129	(36.8)
Highest education level		
<Year 11	22	(6.1)
Years 11–12	34	(24.2)
TAFE/apprenticeship	66	(18.3)
University degree	199	(40.7)
Other	39	(10.8)
Socio-economic index for areas		
First quintile (most disadvantaged)	40	(11.2)
Second quintile	57	(16.0)
Third quintile	96	(27.0)
Fourth quintile	76	(21.3)
Fifth quintile (most advantaged)	87	(24.4)
Geographic remoteness		
1 (least remote)	227	(63.6)
2	101	(28.3)
3	28	(7.8)
4	1	(0.3)
5 (Most remote)	0	(0)

[a]Valid percentage.

TLI $= .928$, RMSEA $= .066$, 90%CI [.059, .072]. The internal consistency for each of these constructs was $\geq .80$ as shown in the supporting information (Table S3).

Structural model

The structural model of the PAMS scale is shown in Figure 1. The structural model also showed acceptable fit, $\chi^2(242) = 466.08$, $p < .001$, CFI $= .968$, TLI $= .964$, RMSEA $= .050$, 90%CI [.043, .056]. As seen in Figure 1, the only nonsignificant direct path was from risk perception to intention. The indirect paths from intention, positive outcome expectancies, negative outcome expectancies and action self-efficacy to participation were all significant, and the indirect path from

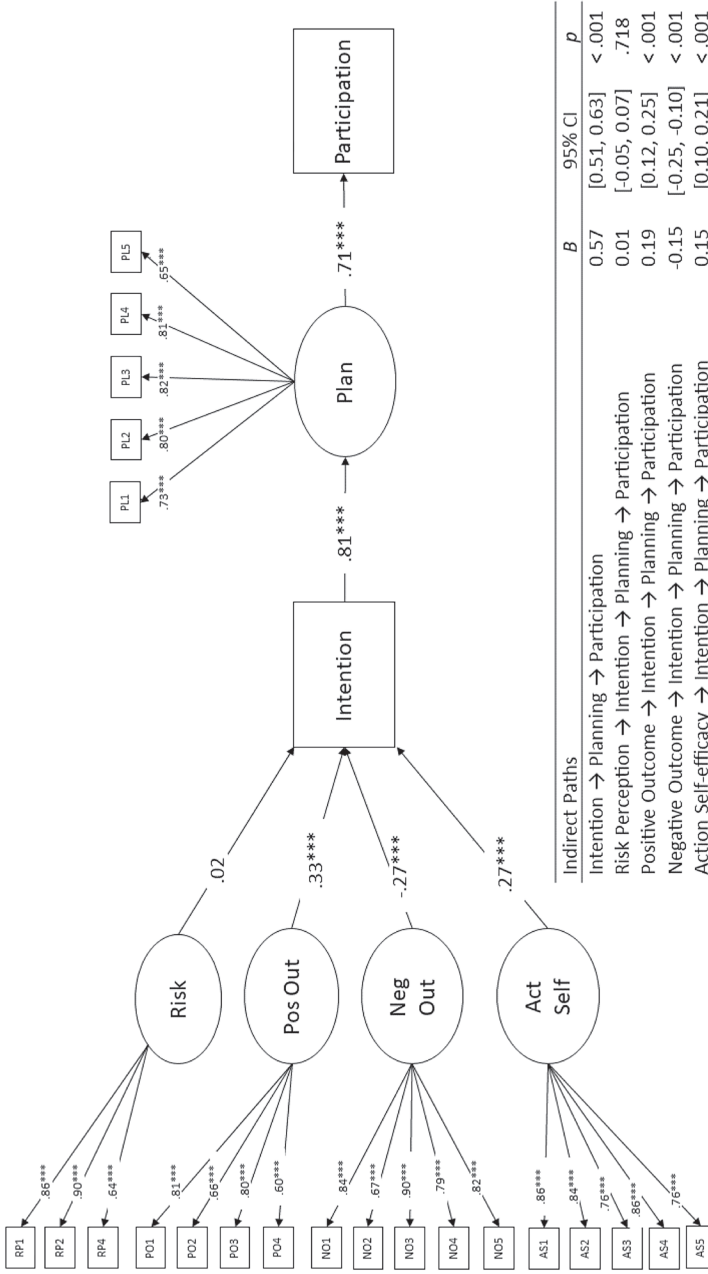*Standardised coefficients and factor loadings of the PAMS scale*

Indirect Paths	B	95% CI	p
Intention → Planning → Participation	0.57	[0.51, 0.63]	< .001
Risk Perception → Intention → Planning → Participation	0.01	[-0.05, 0.07]	.718
Positive Outcome → Intention → Planning → Participation	0.19	[0.12, 0.25]	< .001
Negative Outcome → Intention → Planning → Participation	-0.15	[-0.25, -0.10]	< .001
Action Self-efficacy → Intention → Planning → Participation	0.15	[0.10, 0.21]	< .001

FIGURE 1   Standardised coefficients and factor loadings of the process approach to mail-out screening (PAMS) scale. *Note.* *** = significant at the .001 level, B = standardised indirect effect, 95% CI = standardised 95% confidence interval

risk perception to participation was nonsignificant (see Figure 1). Overall, the model accounted for 39.5% of the variation in FOBT screening intention and 49.9% of the variation in FOBT participation.

UR-MSI

All example interventions and their respective responses can be seen in the supporting information (Figures S1–S5). The example intervention that had the highest percentage of positive responses overall, 72.25%, was delivering the message '90% of bowel cancers are treatable if detected early, doing this test will greatly reduce your risk of dying from bowel cancer' (BCT: '*Information about health consequences*') with the FOBT kit. This was also the highest for both those that did return their last FOBT kit, 79.67%, and for those that did not return their last FOBT kit, 54.95%. The example intervention that had the lowest percentage of positive responses overall, 20.47%, was delivering the message 'You are more likely to do something if you have a plan! Write down exactly where you are going to keep the kit, when you are going to complete the kit, where you are going to store the samples and when you are going to return the kit' (BCT: '*Action planning*') with the FOBT kit.

The three example interventions that had the highest percentage of positive responses within each HAPA factor can be seen in the supporting information (Figure S7). The example intervention within each HAPA factor that had the highest percentage of positive responses overall was as follows: providing 'A leaflet simply and clearly explaining how to complete each stage of the FOBT screening process' (BCT: '*Instruction on how to perform a behaviour*', HAPA factor: '*action self-efficacy*'), 63.17%; delivering the message '90% of bowel cancers are treatable if detected early, doing this test will greatly reduce your risk of dying from bowel cancer' (BCT: '*Information about health consequences*'; HAPA factor: '*positive outcome expectancies*'), 72.25%; delivering the message 'Only 2 out of 100 people who complete this FOBT kit will be referred to have further testing, such as a colonoscopy. The vast majority of people who complete the FOBT kit require no further testing' (BCT: '*Information about health consequences*'; HAPA factor: '*negative outcome expectancies*'), 47.51%; delivering the message 'Bowel cancer is one of Australia's most common cancers, even more so for people over 50. Early detection is your best chance of survival' (BCT: '*Information about health consequences*'; HAPA factor: '*risk perception*'), 71.20%; and giving the prompt of 'If you have not completed and returned the FOBT kit within two weeks, receiving a text message containing feedback that you have not completed and returned the FOBT kit' (BCT: '*Feedback on behaviour*'; HAPA factor: '*planning*'), 62.83%.

DISCUSSION

The findings from this study pose substantial clinical implications for mail-out bowel cancer screening programmes. Two important discoveries to emerge from our study are as follows: (1) the HAPA model is an appropriate framework for describing and measuring the psychological and behavioural process involved in participating in mail-out bowel cancer screening programmes and (2) there are several interventions that were perceived to facilitate FOBT screening participation by a large proportion of end-users. These positively rated interventions warrant further investigation as they may induce a positive change relating to each factor

within the HAPA model and therefore have great potential to increase participation rates for mail-out bowel cancer screening programmes.

The findings from the PAMS scale suggest that using the HAPA model can explain half of the variation in FOBT participation, meaning positive and negative outcome expectancies, action self-efficacy, planning and, to a lesser extent, risk perception, play an important role in mail-out bowel cancer screening behaviour. Furthermore, these results are consistent with the notion that participation in mail-out bowel cancer screening involves both a motivational stage and volitional stage (Goodwin et al., 2020; Myers, Goodwin, Ralph, et al., 2020). The current findings represent the early stages of a co-design process for developing appropriate interventions. Future research using methods such as focus groups and consumer workshops will strengthen this approach. The findings from the UR-MSI scale indicate that providing information regarding the invitee's elevated risks of bowel cancer, sending text message-based reminders and providing alternative locations to return their FOBT kit should be incorporated into mail-out FOBT screening programmes to increase participation. However, for interventions to have the greatest effect on participation rates, a multifaceted approach that targets all aspects of the HAPA model is likely required (Dsouza et al., 2021; Glanz & Bishop, 2010). A summary of a multifaceted consumer-informed behaviour change strategy based on the current findings is shown in Figure 2.

Forming FOBT screening intentions

The results of the PAMS scale indicate that multiple factors directly impact on an increased intention to participate. These include the following: (1) participants' belief in the positive
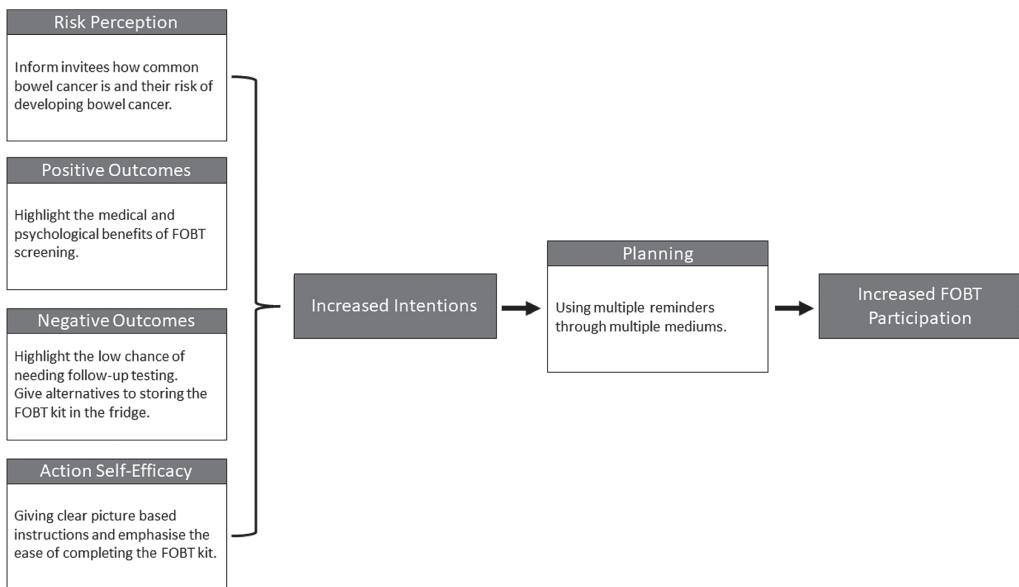
FIGURE 2 Summary of consumer informed interventions that target all factors within the health action process approach (HAPA) model to promote faecal occult blood test (FOBT) screening participation

health outcomes from completing their FOBT kit, (2) their confidence in their ability to complete the FOBT kit and (3) their negative beliefs about the outcomes of screening. Interestingly, once these factors have been taken into consideration, the participant's perception of the risks associated with bowel cancer had little to no direct impact on forming intentions to return their completed FOBT kit.

The diminished direct impact that risk perception has on forming intentions to perform a health behaviour is a common finding in the application of the HAPA model (Zhang et al., 2019). Within the HAPA model, risk perception is thought to be a key driver in the initial formation of behavioural intentions and so despite the statistically nonsignificant effects, they are thought to be vital for an individual to begin contemplating issues regarding the remaining motivational factors (Schwarzer et al., 2011). Therefore, interventions aiming to increase participatory intention in mail-out bowel cancer screening programmes should benefit from incorporating multiple strategies that target all motivational factors.

For this specific context, risk perception may have a particularly complicated pattern of effects that would need to be considered if it were to be used in a behaviour change intervention. For example, some individuals' risk perception of bowel cancer may act in the natural manner of increasing screening intention. For others there may be a fear of receiving a cancer diagnosis, meaning an increased level of risk perception may reduce their intention to participate (Hall et al., 2015). These opposing effects may account for the small to nonexistent effect found in this study.

The results from the UR-MSI scale found that intervention strategies with the highest percentage of positive responses that would impact key motivational factors were those that (a) clearly highlighted the medical and psychological benefits of FOBT participation, (b) increased the invitee's confidence by providing clear picture-based instructions or (c) reduced aversive perceptions of FOBT screening by giving alternative FOBT storage options and noting the low chance of follow-up testing being required after FOBT participation. These typically involved sending messages and adding provisions to the existing kit. The exact phrasing of some items may require revision. For example, the item 'Concerned about your health? People often have a sense of relief when they get their result saying everything is all clear', will need further ethical consideration as not everyone will receive a negative FOBT result.

Of note, one of the UR-MSI interventions that had the highest percentage of positive responses overall communicated the increased risk of bowel cancer for those over the age of 50. However, when similar risk perception strategies have been used in isolation (i.e. with no other behaviour change strategies present), no significant difference in participation was found (Cole et al., 2007; King et al., 1994). This indicates that while interventions that focus on increasing the invitee's level of risk perception are commonly perceived as beneficial, in isolation they are unlikely to affect participation rates and such strategies need to be used in conjunction with other strategies to increase participation rates.

Transitioning from high intentions to FOBT participation

As with many health behaviours, there is an intention-behaviour gap whereby people with high intentions to perform a health behaviour often do not perform that health behaviour (Rhodes & de Bruijn, 2013). Our findings suggest that the degree to which one plans to complete and return their FOBT kit is a key mediating factor that bridges a person's intentions and their actualised behaviour of completing and returning their FOBT kit. This finding is in line with other

applications of the HAPA model to explain variations in health behaviours (Zhang et al., 2019) and is also in line with previous qualitative work that showed a substantial proportion of many invitees do indeed intend to participate in the mail-out screening programme but forget or procrastinate (Goodwin et al., 2020; Hall et al., 2015). As such, in addition to fostering strong behavioural intentions, intervention strategies are needed to facilitate the invitee's transition from the motivational phase to the volitional phase of FOBT screening.

The interventions with the highest percentage of positive ratings that aimed to promote effective planning involved sending some form of reminder to complete the FOBT kit to the invitee (e.g. a reminder text message). A crucial aspect of any effective action plan involves setting reminders (Hagger & Luszczynska, 2014), and these reminder-type interventions would make this aspect of action planning an automatic feature of the FOBT invitation process. This contrasts with the planning interventions, which had a lower percentage of positive responses, that would require the invitee to be responsible for the effective planning (e.g. using sticky note reminders or completing an action plan themselves at home). Although a lack of planning often results in those wishing to complete their FOBT kit procrastinating and ultimately forgetting to complete their kit (Chapple et al., 2008; Goodwin et al., 2020; Hall et al., 2015), a successful strategy to promote effective planning has yet to be established. As one of the lowest endorsed interventions promoted the use of action planning, future research should investigate ways of educating invitees on the benefits that effective action planning can have in reducing procrastination and forgetfulness. If invitees are not willing to engage with planning interventions to the extent needed for them to be effective, future research should investigate if multiple reminders (possibly through multiple mediums) or interventions to personalise reminders (e.g. platforms for participants to create their own automated reminder schedules) can be a more effective strategy as these results indicate that invitees already have positive attitudes towards reminder-type interventions overall.

Traditionally in the HAPA model, there is an additional component of planning known as coping planning: the planning one may engage in to overcome foreseeable setbacks and plausible future events that may interfere with their plan (Schwarzer et al., 2011). It is thought that coping planning is more related to maintaining engagement in a health behaviour, whereas action planning (i.e. the how, when and where specifics as measured in this study) is more related to the initial uptake of a health behaviour (Schwarzer et al., 2011). Previous studies have also only focused on action planning and found it to be a sufficient mediator between behavioural intentions and uptake of a one off preventative health behaviour (i.e. receiving the flu vaccine) that does not require maintenance (Ernsting et al., 2013). Future studies should investigate if coping planning does or does not play a role in one off-health behaviours that generally do not require a maintenance phase to add to the discriminate validity of these two related constructs.

As a final note, our interpretations of the HAPA model were based on its application for a comparable 'once-off' behaviour (i.e. flu-vaccination; Ernsting et al., 2013), and some social-cognitive factors were not measured as part of this study (e.g. coping planning and barriers and resources). Including these components, or components from other health models, in future studies may help explain additional variation in FOBT screening participation above and beyond what is explained in the current study.

Strengths and limitations

To the authors' knowledge, this is the first study to apply the HAPA model in the context of mail-out FOBT screening. This is a valuable addition to the growing body of literature finding

that the HAPA model can be used to describe a wide range of health behaviours (Zhang et al., 2019). This was also the first study to translate and assess attitudes towards various BCTs via example interventions in the context of mail-out FOBT screening. The study findings are also likely to have high ecological validity in health systems similar to Australia's.

However, some limitations need to be considered. This study was a cross-sectional survey meaning there is a potential for a retrospective bias to influence the result and follow-up research will be needed to further validate the causal relationships between the factors within the HAPA model. Additionally, following the instructions for item generation given by Schwarzer et al. (2003), and using a natural tense for the participant to consider when responding, did result in some items being presented in future tense (e.g. '*How do you estimate the likelihood that you will ever suffer from bowel cancer?*') and other items being presented in past tense (e.g. '*The last time I received an FOBT kit I had a plan for where I was going to keep the kit*'). Future longitudinal studies will be better suited to assess the temporal nature of these relationships (e.g. intention predicting future screening). Further content validation from the end-user (i.e. participants of the survey) could be conducted in the future to strengthen the validity of the PAMS and UR-MSI scales.

Only through large-scale randomised control trials can the true effectiveness of the UR-MSI interventions be assessed. Additionally, the UR-MSI items were grouped according to the plausible HAPA factor they are likely to affect; if future trials use these interventions, they should also measure HAPA-related factors (e.g. risk perception or self-efficacy) to assess if the intended change in these factors take place as a result of the intervention or if change is bought about through other mechanisms (Glanz & Bishop, 2010). If such interventions were to increase screening participation, further studies will be needed to realise the implication of the increased number of false negative or positive results.

The web-based design of the survey may also limit the implications of these findings for low socio-economic groups or those with low information technology literacy. It should be noted that participation in this study was completely voluntary, and as such, a self-selection bias cannot be ruled out which may reduce the generalisability of the findings. Finally, future research should investigate if these findings differ for populations that have lower screening rates such as males, younger invitees and people who live in low socio-economic areas.

Conclusion

To increase participation in mail-out FOBT screening programmes, interventions need to be implemented to facilitate the complete process of FOBT screening. Messaging currently used within the invitation process should be analysed to assess what motivational components already exist and add messaging such that all motivational factors are addressed. Efforts should also be made to apply strategies that facilitate the invitee's transition from high intentions into action. While it is currently unclear what an engaging and useable action planning intervention would be comprised of to aid this transition, policymakers and health researchers should implement more reminders through multiple mediums to reduce the impact forgetfulness has on FOBT screening participation. Finally, given the autonomous nature of these screening programmes, it is vital that interventions are comprised of strategies that invitees immediately perceive as being beneficial or helpful such that they engage with the intervention. Taking these measures should address the main influential factors that relate to the process of FOBT screening and thereby increase participation rates.

ACKNOWLEDGEMENTS

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICS STATEMENT

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

DATA AVAILABILITY STATEMENT

Data will be made available upon reasonable request

ORCID

Larry Myers https://orcid.org/0000-0002-2956-3224

REFERENCES

Ananda, S., Wong, H., Faragher, I., Jones, I. T., Steele, M., Kosmider, S., Desai, J., Tie, J., Field, K., Wong, R., Tran, B., Bae, S., & Gibbs, P. (2016). Survival impact of the Australian National Bowel Cancer Screening Programme. *Internal Medicine Journal*, *46*(2), 166–171. https://doi.org/10.1111/imj.12916

Australian Bureau of Statistics. (2016a). Australian statistical geography standard (ASGS). https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS)

Australian Bureau of Statistics. (2016b). SEIFA. https://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa

Australian Institute of Health and Welfare. (2021). National Bowel Cancer Screening Program monitoring report 2021. AIHW. https://www.aihw.gov.au/reports/cancer-screening/nbcsp-monitoring-report-2021/summary

Benton, S. C., Butler, P., Allen, K., Chesters, M., Rickard, S., Stanley, S., Roope, R., Vulkan, D., & Duffy, S. W. (2017). GP participation in increasing uptake in a national bowel cancer screening programme: The PEARL project. *British Journal of Cancer*, *116*(12), 1551–1557. https://doi.org/10.1038/bjc.2017.129

Chapple, A., Ziebland, S., Hewitson, P., & McPherson, A. (2008). What affects the uptake of screening for bowel cancer using a faecal occult blood test (FOBt): A qualitative study. *Social Science & Medicine*, *66*(12), 2425–2435. https://doi.org/10.1016/j.socscimed.2008.02.009

Cole, S. R., Smith, A., Wilson, C., Turnbull, D., Esterman, A., & Young, G. P. (2007). An advance notification letter increases participation in colorectal cancer screening. *Journal of Medical Screening*, *14*(2), 73–75. https://doi.org/10.1258/096914107781261927

DeSmet, A., Bourdeaudhuij, I. D., Chastin, S., Crombez, G., Maddison, R., & Cardon, G. (2019). Adults' preferences for behavior change techniques and engagement features in a Mobile app to promote 24-hour movement behaviors: Cross-sectional survey study. *JMIR mHealth and uHealth*, *7*(12), e15707. https://doi.org/10.2196/15707

Dsouza, J. P., den Broucke, S. V., Pattanshetty, S., & Dhoore, W. (2021). The application of health behavior theories to promote cervical cancer screening uptake. *Public Health Nursing*, *38*, 1039–1079. https://doi.org/10.1111/phn.12944

Ernsting, A., Gellert, P., Schneider, M., & Lippke, S. (2013). A mediator model to predict workplace influenza vaccination behaviour—An application of the health action process approach. *Psychology & Health*, *28*(5), 579–592. https://doi.org/10.1080/08870446.2012.753072

Gana, K., & Broc, G. (2019). *Structural Equation Modeling With Lavaan*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/usq/detail.action?docID=5630282

Glanz, K., & Bishop, D. B. (2010). The role of behavioral science theory in development and implementation of public health interventions. *Annual Review of Public Health*, *31*(1), 399–418. https://doi.org/10.1146/annurev.publhealth.012809.103604

Goodwin, B. C., Ireland, M. J., March, S., Myers, L., Crawford-Williams, F., Chambers, S. K., Aitken, J. F., & Dunn, J. (2019). Strategies for increasing participation in mail-out colorectal cancer screening programs: A systematic review and meta-analysis. *Systematic Reviews*, *8*(1), 1–11. https://doi.org/10.1186/s13643-019-1170-x

Goodwin, B. C., March, S., Crawford-Williams, F., Chambers, S. K., & Dunn, J. (2020). "I'm not doing that." An in-depth examination of nonparticipation in mail-out bowel cancer screening programs. *Translational Behavioral Medicine*, *10*(6), 1515–1524.

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology. Health and Well-Being*, *6*(1), 1–47. https://doi.org/10.1111/aphw.12017

Hall, N. J., Rubin, G. P., Dobson, C., Weller, D., Wardle, J., Ritchie, M., & Rees, C. J. (2015). Attitudes and beliefs of non-participants in a population-based screening programme for colorectal cancer. *Health Expectations*, *18*(5), 1645–1657. https://doi.org/10.1111/hex.12157

Hayes, A. F., & Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. But .... *Communication Methods and Measures*, *14*(1), 1–24. https://doi.org/10.1080/19312458.2020.1718629

Johnston, M., Carey, R. N., Connell Bohlen, L. E., Johnston, D. W., Rothman, A. J., de Bruin, M., Kelly, M. P., Groarke, H., & Michie, S. (2021). Development of an online tool for linking behavior change techniques and mechanisms of action based on triangulation of findings from literature synthesis and expert consensus. *Translational Behavioral Medicine*, *11*(5), 1049–1065. https://doi.org/10.1093/tbm/ibaa050

Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2021). 'semTools' useful tools for structural quation modeling. https://CRAN.R-project.org/package=semTools

King, J., Fairbrother, G., Thompson, C., & Morris, D. L. (1994). Influence of socioeconomic status, ethnicity and an educational brochure on compliance with a postal faecal occult blood test. *Australian Journal of Public Health*, *18*(1), 87–92. https://doi.org/10.1111/j.1753-6405.1994.tb00201.x

Lew, J.-B., St John, D. J. B., Xu, X.-M., Greuter, M. J., Caruana, M., Cenin, D. R., He, E., Saville, M., Grogan, P., & Coupé, V. M. (2017). Long-term evaluation of benefits, harms, and cost-effectiveness of the National Bowel Cancer Screening Program in Australia: A modelling study. *The Lancet Public Health*, *2*(7), e331–e340. https://doi.org/10.1016/S2468-2667(17)30105-6

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, *39*(1), 99–128. https://doi.org/10.1207/s15327906mbr3901_4

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J., & Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, *46*(1), 81–95. https://doi.org/10.1007/s12160-013-9486-6

Myers, L., Goodwin, B., March, S., & Dunn, J. (2020). Ways to use interventions to increase participation in mail-out bowel cancer screening: A systematic review and meta-analysis. *Translational Behavioral Medicine*, *10*(2), 384–393. https://doi.org/10.1093/tbm/ibz081

Myers, L., Goodwin, B., Ralph, N., Castro, O., & March, S. (2020). Implementation strategies for interventions aiming to increase participation in mail-out bowel cancer screening programmes: A realist review. *Frontiers in Oncology*, *10*, 1799. https://doi.org/10.3389/fonc.2020.543732

Navarro, M., Nicolas, A., Ferrandez, A., & Lanas, A. (2017). Colorectal cancer population screening programs worldwide in 2016: An update. *World Journal of Gastroenterology*, *23*(20), 3632–3642. https://doi.org/10.3748/wjg.v23.i20.3632

Qualtrics. (2020). https://www.qualtrics.com

R Core Team. (2020). R: A Language and Environment for Statistical Computing. R foundation for Statistical Computing. https://www.R-project.org/

Rhodes, R. E., & de Bruijn, G.-J. (2013). How big is the physical activity intention–behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology*, *18*(2), 296–309. https://doi.org/10.1111/bjhp.12032

Rosseel, Y. (n.d.). Lavaan: An R package for structural equation modeling and more version 0.5-12 (BETA). 37.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology*, *57*(1), 1–29. https://doi.org/10.1111/j.1464-0597.2007.00325.x

Schwarzer, R., Lippke, S., & Luszczynska, A. (2011). Mechanisms of health behavior change in persons with chronic illness or disability: The health action process approach (HAPA). *Rehabilitation Psychology*, *56*(3), 161–170. https://doi.org/10.1037/a0024509

Schwarzer, R., & Luszczynska, A. (2008). How to overcome health-compromising behaviors. *European Psychologist*, *13*(2), 141–151. https://doi.org/10.1027/1016-9040.13.2.141

Schwarzer, R., & Luszczynska, A. (n.d.). Perceived self-efficacy. Division of cancer control and population sciences. Retrieved July 23, 2021, from https://cancercontrol.cancer.gov/brp/research/constructs/self-efficacy

Schwarzer, R., Schüz, B., Ziegelmann, J. P., Lippke, S., Luszczynska, A., & Scholz, U. (2007). Adoption and maintenance of four health behaviors: Theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. *Annals of Behavioral Medicine*, *33*(2), 156–166. https://doi.org/10.1007/BF02879897

Schwarzer, R., Sniehotta, F. F., Lippke, S., Luszczynska, A., Scholz, U., Schüz, B., Wegner, M., & Ziegelmann, J. P. (2003). On the assessment and analysis of variables in the health action process approach conducting an investigation. https://doi.org/10.5167/UZH-102499

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*(3), 209–249. https://doi.org/10.3322/caac.21660

Wickham, H. (n.d.-a-a-a). A grammar of data manipulation (1.0.6) [computer software].

Wickham, H. (n.d.-b-b-b). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag. https://ggplot2.tidyverse.org

Yardley, L., Morrison, L., Bradbury, K., & Muller, I. (2015). The person-based approach to intervention development: Application to digital health-related behavior change interventions. *Journal of Medical Internet Research*, *17*(1), e4055. https://doi.org/10.2196/jmir.4055

Zamanzadeh, V., Ghahramanian, A., Rassouli, M., Abbaszadeh, A., Alavi-Majd, H., & Nikanfar, A.-R. (2015). Design and implementation content validity study: Development of an instrument for measuring patient-centered communication. *Journal of Caring Sciences*, *4*(2), 165–178. https://doi.org/10.15171/jcs.2015.017

Zhang, C.-Q., Zhang, R., Schwarzer, R., & Hagger, M. S. (2019). A meta-analysis of the health action process approach. *Health Psychology*, *38*(7), 623–637. https://doi.org/10.1037/hea0000728

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.