



Original Article

Effectiveness of a tailored communication intervention on colonoscopy uptake for first-degree relatives of colorectal cancer patients: A randomized controlled trial



Yang Bai^{a,*}, Cho Lee Wong^b, Xiaolin Peng^c, Kai Chow Choi^b, Winnie K.W. So^b

^a School of Nursing, Sun Yat-Sen University, Guangzhou, China

^b The Nettersole School of Nursing, The Chinese University of Hong Kong, Hong Kong SAR, China

^c Shenzhen Nanshan Center for Chronic Disease Control, Shenzhen, China

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ABSTRACT

Objective: To evaluate the effect of a WeChat tailored communication intervention on colonoscopy uptake and health beliefs in Chinese first-degree relatives (FDRs) of colorectal cancer patients.

Methods: This study employed a single-blinded randomized controlled trial. A total of 188 eligible FDRs were recruited and randomly assigned to the tailored intervention group or control group. Health beliefs were assessed at 1 (T1) and 3 months (T2) postintervention. The colonoscopy uptake was verified by medical records at T2. Data were analyzed using binary logistic regression and generalized estimating equation models.

Results: Compared with the participants in the control group, those in the intervention group had a significant improvement in terms of colonoscopy uptake (OR = 2.752, 95% CI: 1.428–5.303, $P < 0.01$), perceived susceptibility (T1: $\beta = 0.298$, 95% CI: 0.052–0.402, $P < 0.05$; T2: $\beta = 0.251$, 95% CI: 0.078–0.424, $P < 0.001$) and cues to action (T1: $\beta = 0.0264$, 95% CI: 0.138–0.389, $P < 0.001$; T2: $\beta = 0.327$, 95% CI: 0.195–0.459, $P < 0.001$) and a significant reduction in perceived barriers (T1: $\beta = -0.237$, 95% CI: -0.360–0.115, $P < 0.01$; T2: $\beta = -0.196$, 95% CI: -0.331–0.062, $P < 0.01$).

Conclusions: This study broadens the application of tailored communication using novel channels in the context of screening in the at-risk Chinese population. The results provide insights on how to improve the intervention by modifying its components and communication channels.

Introduction

Colorectal cancer (CRC) is a public health problem that significantly contributes to the global burden of cancer.¹ With economic transition and population ageing, a steady increase in CRC incidence has been observed in China over the past three decades, resulting in nearly one-tenth of the global CRC burden.² Individuals who are first-degree relatives (FDRs, refers to parents, siblings or children) of people with CRC have a 2 to 4-fold higher risk of developing CRC than others.³ Approximately 25% of people with CRC have at least one FDR with the same disease.⁴ Fortunately, screening individuals without symptoms is effective in reducing the risk of death from CRC.

Colonoscopy is an optimal screening choice for the at-risk population as it allows for the removal of polyps and adenomas in addition to the detection of early-stage cancer.⁵ Several studies have demonstrated that

screening colonoscopy was associated with a reduction of 68% to 70% in CRC mortality.^{6,7} It is recommended that individuals with a positive family history of CRC (FDRs with early-onset CRC or multiple FDRs with the disease) be screened with colonoscopy at a relatively younger age. The mainstream screening guidelines for CRC recommend people with one FDR who has been diagnosed with CRC before age 60 or with two or more FDRs who have CRC at any age receive colonoscopy at age 40 or 10 years before the age of the youngest patient in the family, with a screening interval of 5 years.^{8,9}

CRC screening programs that provide colonoscopy for the FDRs of people with CRC have been implemented worldwide.⁸ For example, the government of China has initiated the population-based Cancer Screening Program in Urban China.⁹ Risk-stratified strategies are used and subsequent colonoscopy provided for identified FDRs of people with CRC. Despite the available screening programs, the colonoscopy

* Corresponding author.

E-mail address: baiy36@mail.sysu.edu.cn (Y. Bai).

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screening rate of FDRs around the world remains low, with only 14% to 40% of adults with at least one FDR diagnosed with CRC undergoing colonoscopy screening.^{10,11} In China, the situation is even worse, as less than 20% of people received recommended colonoscopy screening despite screening being covered by insurance.^{12–14} The low participation rate is a global problem that threatens the effectiveness of screening programs for the at-risk population.¹⁵

The possible reason for low screening rates may be related to the lack of familial risk assessment and risk-appropriate recommendations.^{16,17} Tailored communication intervention has been consistently demonstrated effective in risk communication and encouraging the adoption of preventive health behaviors.^{18,19} It is a theory-informed and data-driven approach that customizes messages on the basis of individuals' responses to behavior change theory-driven factors related to the outcome of interest.²⁰ Our research team conducted a systematic review and meta-analysis to synthesize the effectiveness and essential components of tailored communication on colonoscopy screening rates among the FDRs of patients with CRC.²¹ Four randomized controlled trials (RCTs) involving the 1303 FDRs of patients with CRC were retrieved, showing that the health belief model (HBM)-based tailored communication delivering both written and verbal messages are effective in promoting colonoscopy screening among FDRs of CRC patients (OR = 2.39, 95% CI: 1.78–3.21, $P < 0.01$). The HBM is a conceptual framework that has been widely used in predicting and explaining cancer screening behaviors,^{22–24} which consist of perceived susceptibility, severity, barriers, benefits, and self-efficacy. This model indicates that individuals with a high perception of susceptibility to developing a disease, severity of a disease, benefits, and self-efficacy of health prevention behaviors, and a low level of barrier perceptions are more likely to take preventive action.¹³ Based on the above mechanism of HBM to achieve behavior change, tailored communication regarding increased risk and screening recommendations would assess individuals' perceptions and provide messages tailored to the individuals' responses to these variables. Additionally, tailored strategies, such as drawing attention by conveying the message is specifically for "you", have been used to enhance persuasiveness when developing tailored messages. This personally relevant approach will increase the likelihood of the message being read and cognitively processed by the individual, ultimately increasing the chance of behavioral change.²⁵

Although tailored communication is successful in persuading individuals to adopt colonoscopy screening behaviors, the message tailoring process is complicated, including individual assessment, selecting tailored messages based on assessment results and delivering them to each person through the communication channel. Printed materials have been the most commonly used channel in previous studies.²¹ However, the tailoring process was not simplified because the printed material-based program (1) covers multiple steps (eg, input, print, and mail), (2) is difficult to update, and (3) makes it difficult to receive feedback from the target audience. The growth of internet access via smartphones provides increased opportunities to address these limitations through various applications. For instance, WeChat is the most popular all-in-one communication application in China; it provides a wide range of functions, such as text messaging, voice messaging, and mobile payment. A recent survey conducted in China showed that WeChat is the most frequently used means of obtaining health information.²⁶ However, evidence regarding the efficacy and feasibility of this novel channel-based tailored communication is not clear. In addition, previous studies examined variables derived from the HBM as mediators but ignored the premise of mediating effect—did the intervention components achieve changes in health beliefs? Is the reason for not being a mediator because the variable did not mediate the relationship between intervention and colonoscopy screening behavior or that the intervention did not achieve changes? Examining if the intervention components can achieve the anticipated effect on psychosocial variables based on the theoretical framework could provide critical

information for intervention development, but they have been seldomly reported.

Therefore, our research team developed a three-session WeChat tailored communication intervention based on the HBM.²⁷ The present study aimed to examine the effect of the developed intervention on colonoscopy uptake and health beliefs in Chinese FDRs of CRC patients. The following research hypotheses were tested among FDRs of people with CRC. Compared with the individuals in the control group, those in the intervention group showed the following:

1. Significant improvement in the uptake of colonoscopy at 3 months postintervention;
2. Significant improvement in the perceived susceptibility of developing CRC, perceived severity of CRC, perceived benefits of colonoscopy, perceived self-efficacy to undergo colonoscopy, and cues to action to receive colonoscopy at 1 and 3 months postintervention;
3. Significant reduction in the perceived barriers to colonoscopy at 1 and 3 months postintervention.

Methods

Study design

This study was a single-blinded, two-group RCT conducted at a tertiary hospital and 23 community centers in Shenzhen, China, from March 2019 to September 2019 (Registration No. ChiCTR1900020656).

Two approaches were considered to prevent contamination²⁸: (1) cluster RCT by assigning participants from the same family to the same arm, and (2) individual RCT by recruiting only one FDR from each family. A cluster RCT pilot study was conducted, and it showed that the family and FDR ratio was 1:1.05.²⁹ The low quantity reflected that most of the families recruited in the pilot study had the ability to invite only one FDR. This phenomenon may be due to Shenzhen's status as an immigrant city. Many young people choose to work in this city. Thus, family clustering is not evident. In addition, estimating the intracluster correlation coefficient by using only a few clusters with more than one participant is not applicable. The intracluster correlation coefficient is a quantity reflecting the degree of clustering, and it is used in sample size calculation for a cluster RCT.³⁰ Therefore, an individual RCT was employed in the present study for practicality, statistical calculation, and contamination prevention. Each FDR was randomly assigned to the intervention group or control group at 1:1 ratio by using a sequence of block randomization numbers for assigning numbers equally to each group. A randomly mixed block size of 4 to 8 was utilized to avoid predicting the next assignment. A statistician with no clinical involvement in the trial prepared the random allocation cards by using computer-generated random numbers. The original random allocation sequences were kept by the independent researcher, and they were not accessible to any of the investigators. The details of the group allocation were concealed in a sequentially numbered series of opaque, sealed, and stapled envelopes.

The time points for postintervention measurements were 1 and 3 months. They were determined based on the results from the systematic review.²¹ The shortest time in which significant effects were revealed was 3 months for colonoscopy acceptance. Repeated postintervention measures for psychosocial variables could eliminate the effects of individual differences among respondents.

Participants

FDRs of people with CRC were recruited by using convenience sampling. The inclusion criteria were as follows: (1) age 40 to 75 years or 10 years before the age at which the relative was diagnosed, (2) individuals with one FDR with CRC age <60 years or with two or more FDRs with CRC at any age, (3) have not had a colonoscopy within 5 years, (4) access to WeChat themselves or through close family members living in the same household, and (5) able to read and speak Chinese. The exclusion

criteria were as follows: (1) a history of cancer or inflammatory bowel disease, (2) recent participation in another study or previous participation in cancer risk counseling or study, and (3) doctor-diagnosed psychiatric illness.

Sample size

The sample size assuming individual randomization was calculated by using the power analysis approach.³¹ In accordance with the results of the meta-analysis conducted by the research team,²¹ the ratio of those who did not complete colonoscopy screening versus those who did complete colonoscopy screening was determined (20.8% and 38.8%, respectively, OR = 2.39). By using power analysis software G*Power 3.1, the sample size of $N = 156$ (78 per arm) gives a two-arm cluster RCT with 80% power to detect a between-group difference of 20% at 5% level of significance. At least 188 participants needed to be recruited to allow for a 20% loss to follow up.

Interventions

The health belief model-based WeChat tailored communication intervention

Based on the mechanism of the HBM to achieve behavioral change, the tailored communication intervention in this study ensures a high level of susceptibility, severity, benefits, self-efficacy, and cue-to-action perceptions and a low level of barrier perception. The details on how to use the HBM to generate decision rules, tailored messages, and delivery plans have been introduced elsewhere.²⁷ This intervention consists of three sessions, namely, two written message sessions and one verbal message session. All the sessions were completed within 1 month. In session 1, an online tailored assessment tool was developed to assess the health beliefs of the HBM. Through this tool, the participants could input their demographic information, family history, and response to instruments measuring health beliefs regarding CRC and colonoscopy screening. Then, the instrument could present the corresponding tailored message automatically on the basis of the assessment. Within 1 week, in accordance with the personal assessment in session 1, a voice call counseling that explained the written messages and answered the participants' questions in session 1 was delivered as session 2. Finally, the summary of the tailored message was sent to the participants to strengthen their perception of CRC risk and to screen the information within 1 week as session 3. The summary mainly focused on the participants' family history, screening suggestions, and prominent problems reflected in the first two sessions. All these sessions were sent to the participants through WeChat. The tailored communication sessions were conducted by the researcher, a registered nurse who had 1 year's experience in CRC screening education, to maintain the consistency of the intervention. An intervention protocol and a logbook checklist were developed to (1) facilitate the standardized tailoring process by clearly defining the essential components, the components that could be modified, and the extent to which modification could be made; (2) record the implementation of each session, such as whether the session was sent to the participants, the start time, the completed time, whether the session was completed, the reason for noncompletion and so on. Before the intervention was implemented in the full-scale study, the researcher piloted the intervention with 21 FDRs, and good protocol compliance was observed.²⁹

e-brochure standard information

The participants in both groups received an e-brochure on CRC and CRC screening through WeChat. This brochure was developed by the current CRC mass screening program, and it involves standard information, such as (1) risk factors for CRC, including family history, (2) current CRC screening recommendations, and (3) a free colonoscopy program in community settings.

Outcome measures

Social demographic characteristics

Before randomization, a self-designed basic information sheet was used to collect sociodemographic data, including age, gender, marital status, and educational level.

Primary outcome: colonoscopy uptake

At 3 months postintervention, the participants were asked if they had received a colonoscopy. Medical records were collected for those who had undergone colonoscopy. Only the completed colonoscopies verified on the basis of medical records were counted and involved in the data analysis.

Secondary outcome: health beliefs of CRC and colonoscopy screening

The Revised CRC Perception and Screening Instrument was applied to measure four concepts derived from the HBM toward colonoscopy screening behavior: perceived susceptibility of CRC, perceived severity of CRC, perceived barriers of colonoscopy screening and perceived benefits of colonoscopy screening. Each item was rated using a 5-point Likert-type scale (from 1 = strongly disagree to 5 = strongly agree). The score for each subscale was computed by averaging the corresponding items. A high score in each subscale indicated a high level of perception. This 38-item instrument has been validated in a sample of FDRs of patients with CRC and it demonstrated acceptable reliability, with Cronbach's alpha ranging from 0.74 to 0.87.³² The results of construct validity supported the application of the original four-factor HBM for the 38-item Revised CRC Perception and Screening instrument.

Secondary outcome: self-efficacy

Self-efficacy in obtaining colonoscopy was measured using the four-item simplified Chinese version of the self-efficacy questionnaire. This questionnaire was developed by Wagner et al to assess the self-efficacy for participating in CRC screening.³³ It was translated into simplified Chinese, adapted for colonoscopy testing and indicated satisfactory reliability, with a Cronbach's alpha of 0.77.¹³ The items are rated on a 5-point scale (from 1 = strongly disagree to 5 = strongly agree). The score for self-efficacy was computed by averaging the corresponding items (ranging from 1 to 5). The total score ranged from 4 to 20, with a high score indicating high self-efficacy to participate in CRC screening.

Secondary outcome: cues to action

The cue to action for CRC screening questionnaire measures three types of action cues: family history of CRC, physician's recommendation and health insurance coverage.³⁴ The items were rated on a 5-point scale (from 1 = strongly disagree to 5 = strongly agree). The score for cues to action was computed by averaging the corresponding items (ranging from 1 to 5), with a high score indicating a high cue to action.

Data collection

The FDRs of people with CRC are from the healthy population, so that finding them directly in clinical or community settings is difficult. Therefore, telephone recruitment was used in this study. The contact information of FDRs of people with CRC was obtained mainly through four approaches: (1) people with CRC identified from cancer registration records, (2) people with CRC identified in clinical wards, (3) the current CRC screening program, and (4) dissemination of recruitment posters and messages. Potential CRC survivors were identified by reviewing the registration records and hospital admission records of people with CRC. Eligible CRC survivors were contacted to refer their FDRs. The researcher provided an introduction and information about this study and asked patients (1) to provide family history information, (2) to help convey information to their FDRs, and (3) to provide contact information of their FDRs who are over age 40 or 10 years of age before the age at which the CRC patient was diagnosed. After the contact information of FDRs was

obtained from people with CRC and current screening program records, eligible FDRs were invited to participate in this study.

Data from both intervention and control groups were collected through online questionnaires at three time points: baseline (T0), 1-month postintervention (T1), and 3 months postintervention (T2). The online questionnaires were sent to the participants through WeChat. The online questionnaires were produced by the online survey tool Sojump (<http://www.sojump.com>). Sojump is currently the largest free professional online survey platform that provides services, including questionnaire design, data collection, custom reporting, and data analysis.³⁵ Responses were captured electronically via direct answers on the online survey platform. After verbal consent was obtained by telephone, participants were asked to complete online questionnaires (RCRCPS, Self-Efficacy Questionnaire, Cues to Action Questionnaire, and the Demographic Questionnaire) through WeChat. Then, the participants were randomized to either the intervention group or the control group. An e-brochure on CRC and screening were sent to all the participants. In addition, FDRs randomized to the intervention group received the intervention consisting of three sessions that provided tailored cancer and screening messages on the response of personal assessment. The tailored communication sessions were conducted by the researcher with 1 year's work experience in an oncology unit and community center for consistency of the intervention. Before the intervention in the full-scale study was implemented, the researcher piloted the intervention with 10 FDRs. The postintervention data collection was conducted through WeChat by using online questionnaires. RCRCPS, Self-Efficacy, and Cues to Action Questionnaires were administered to FDRs at (T1) and 3 months (T2) after the intervention was completed. WeChat messages were sent if participants did not complete the questionnaires in 3 days, followed by a voice call through WeChat if they still did not reply to the text messages. The use of colonoscopy screening was measured by reviewing and collecting medical records.

Data analysis

Data analyses were performed using IBM SPSS statistics (version 25). All statistical tests were two-tailed with a 5% level of statistical significance. Descriptive statistics was used to describe the demographic characteristics and outcomes at each time point. The principle of intention-to-treat analysis was utilized for data analysis. Two-sample independent *t*-tests (quantitative data) and χ^2 test (categorical data) were used to examine whether the participants were comparable between the intervention and control groups. A *P*-value of 0.10 was used to identify covariates from the baseline difference. The primary outcome of colonoscopy rate was measured at 3 months postintervention. χ^2 and logistic regression are appropriate approaches for measuring the difference in discontinuous data between groups.³⁶ If unbalanced results were found in baseline between intervention and control groups, binary logistic regression was applied to control the covariate. For health belief variables derived from the HBM, measured at baseline, 1 month and 3 months after the intervention, the generalized estimating equation was adopted to test the effects of tailored communication intervention on HBM variables at different data collection time points. The identified covariates were adjusted in the generalized estimating equation (GEE) model for the examination of the effects of the tailored communication intervention.

Ethical considerations

Data collection commenced after obtaining ethical approval from the Joint Chinese University of Hong Kong-New Territories East Cluster Clinical Research Ethics Committee (CREC Ref. No.: 2018.368) and an ethics approval letter from the study setting (1120180013). Information on the purpose and process of this study were provided to the participants. Given that the participants may live in different communities and they were contacted only through telephone and WeChat, obtaining a

written verification from them was not practical. Instead, verbal consent was obtained from the FDRs of patients with CRC before data collection procedures and the study. The written consent was added on the first page of the online tailored assessment tool. When a participant agreed to participate in the study, the online tailored assessment tool turned to the main message page. The individuals invited to participate in the study were assured that their participation was voluntary and they could withdraw from the study at any time. The FDRs who participated in this study were informed that no additional fee would be collected. After they finished the online questionnaire assessment at baseline, 1 month and 3 months after the intervention, they received an incentive (Chinese Yuan ¥10 \approx United States Dollar \$1.54) each time through WeChat. The participants were assured of the confidentiality of personal information and the security of data.

Results

Recruitment and attrition

As presented in the CONSORT flow diagram (Fig. 1), a total of 2093 FDRs of people with CRC were contacted for eligibility screening. Among the 330 participants who met the inclusion criteria, 188 consented to participate in this study. A total of 36 participants discontinued their participation before the final data collection endpoint. The attrition rates of the intervention and control groups were 17.0% ($n = 16$) and 21.3% ($n = 20$), respectively, with an overall attrition rate of 19.1%.

Baseline characteristics of participants

The mean age of FDRs was 49.62, with a standard deviation of 9.12 and a range of 24 to 70 years. The majority of the involved FDRs were married ($n = 76$, 93.6%), and 110 (58.5%) were female. Most of the participants ($n = 173$, 92.0%) were covered by health insurance, with 148 (78.7%) covered by social security insurance. More than 70% of the FDRs received secondary education or below. Regarding family history, only four (2.1%) FDRs had two relatives affected with CRC. Most of the FDRs ($n = 164$, 87.1%) involved in this study were children of original cancer cases. Only 16.5% of FDRs had previous CRC screening in more than 5 years, with the majority receiving colonoscopy ($n = 157$, 83.5%). The baseline characteristics of the participants stratified by groups are presented in Tables 1 and 2. For baseline characteristic comparison between the intervention and control groups, only a significant difference was found in screening behavior (Table 1). No significant difference in baseline characteristics was found between the individuals who completed the intervention and those who did not (Table 2). Therefore, the screening behavior of FDRs measured at baseline was controlled when the data on the effects of tailored communication intervention were analyzed.

Effect of tailored intervention on outcome variables

Primary outcome: uptake of colonoscopy

At 3 months postintervention, 64 participants received colonoscopy, with 41 (43.6%) in the intervention group and 23 (24.5%) in the control group. As shown in Table 3, the study groups demonstrated a unique statistically significant contribution to the model, with an odds ratio (OR) of 2.752 and a confidence interval (CI) of 1.428–5.303. This finding indicated that the FDRs in the intervention group were over 2.752 times more likely to report colonoscopy screening behavior than those in the control group, controlling for all other factors in the model.

Secondary outcome: health beliefs of CRC and colonoscopy screening

The identified covariate was adjusted in the GEE model for the examination of the effects of tailored communication intervention on secondary outcomes. In terms of health beliefs of CRC and colonoscopy screening, the GEE model indicated a significant improvement in perceived susceptibility at 1 month ($\beta = 0.298$, 95% CI: 0.052–0.402, *P*

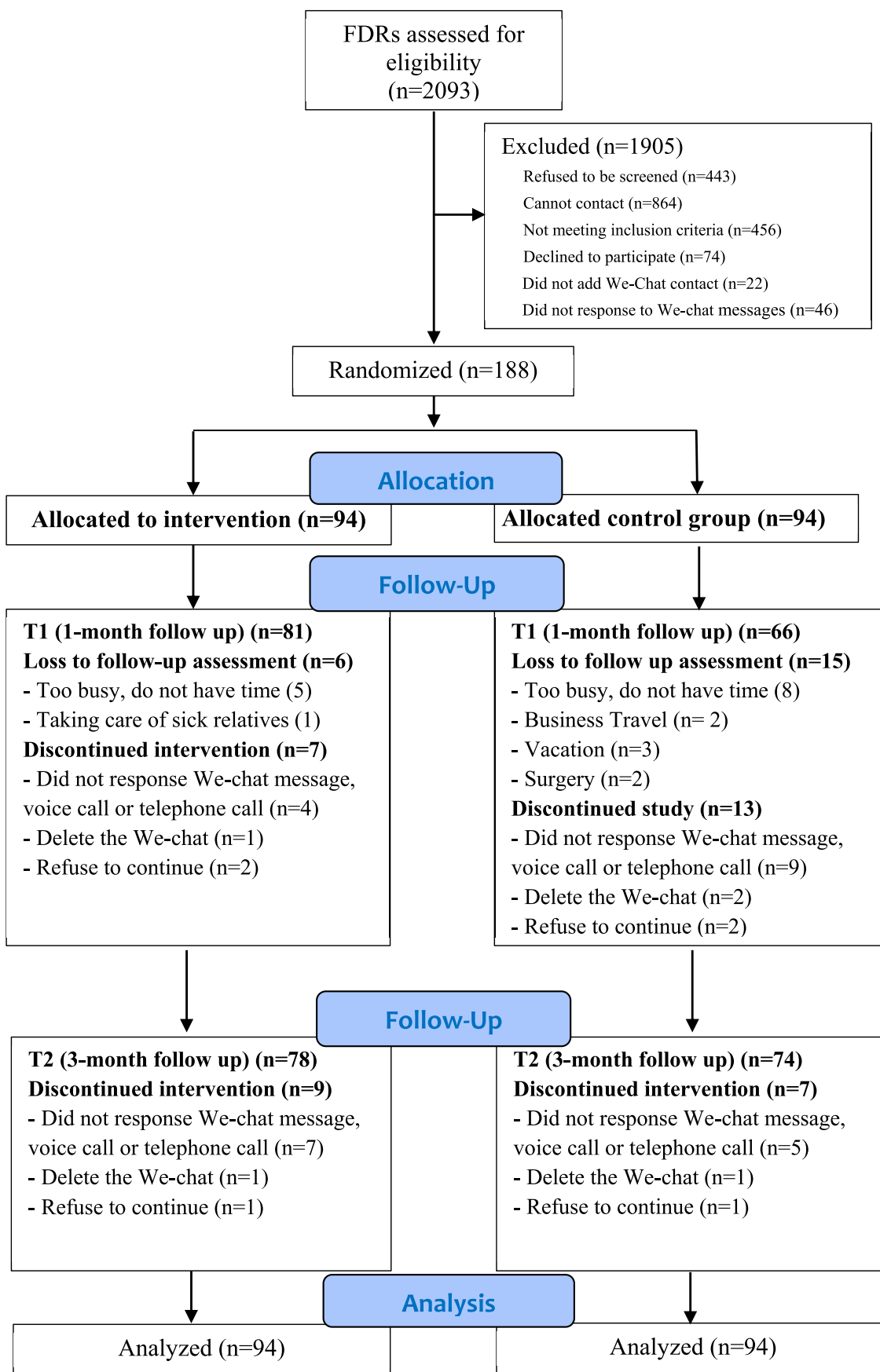


Fig. 1. Flow diagram of participant recruitment.

Table 1
Comparison of demographic characteristics and outcome variables between intervention (n = 94) and control groups (n = 94).

Variables	Overall	Intervention group	Control group	P
Age (years) (range: 28–70) ^a	49.62 ± 9.12	48.65 ± 9.18	50.59 ± 9.02	0.15
Gender				0.08
Female	110 (58.5)	49	61	
Male	78 (41.5)	45	33	
Marital status				^b 0.76
Married	176 (93.6)	87	89	
Single/Divorced/Widow	12 (6.4)	7	5	
Insurance				0.79
Public	148 (78.7)	70	78	
Private	40 (11.3)	16	9	
Education				0.18
Secondary or below (≤ 12 years)	142 (75.6)	75	67	
Tertiary or above (> 12 years)	46 (24.5)	19	27	
Screening behaviors				^b 0.003*
No previous CRC screening behavior more than 5 years	157 (83.5)	86	71	
Colonoscopy	29 (15.4)	7	22	
Stool-based test	2 (1.1)	1	1	
Number of CRC patients				^b 1.00
1	184 (97.9)	92	92	
2	4 (2.1)	2	2	
Relationship with CRC patients				0.66
Children	164 (87.1)	81	83	
Siblings	24 (12.9)	13	11	
Perceived susceptibility (RCRCPS) ^a	2.88 ± 0.65	2.88 ± 0.76	2.89 ± 0.49	0.91
Perceived severity (RCRCPS) ^a	3.16 ± 0.68	3.20 ± 0.75	3.20 ± 0.59	0.90
Perceived benefits (RCRCPS) ^a	4.21 ± 0.51	4.22 ± 0.59	4.20 ± 0.41	0.84
Perceived barriers (RCRCPS) ^a	2.66 ± 0.56	2.65 ± 0.56	2.67 ± 0.55	0.80
Self-efficacy (Self-efficacy Scale) ^a	4.06 ± 0.44	4.10 ± 0.44	4.02 ± 0.45	0.18
Cues to action (Cues to action Questionnaire) ^a	4.00 ± 0.39	3.93 ± 0.29	4.04 ± 0.46	0.07

CRC, colorectal cancer; RCRCPS, Revised Colorectal Cancer and Perception instrument.

^a Presented as mean and standard deviation, and tested by t-test; otherwise, presented by n (%), tested by χ^2 test.

^b Fisher exact test.

< 0.05) and 3 months postintervention ($\beta = 0.251$, 95% CI, 0.078–0.424, $P < 0.001$), perceived barriers at 1 month ($\beta = -0.237$, 95% CI: -0.360 to -0.115, $P < 0.01$) and 3 months postintervention ($\beta = -0.196$, 95% CI: -0.331 to -0.062, $P < 0.01$), action cues at both 1 month ($\beta = 0.264$, 95% CI: 0.138–0.389, $P < 0.001$) and 3 months postintervention ($\beta = 0.327$, 95% CI: 0.195–0.459, $P < 0.001$). Nonsignificant effects were observed in perceived severity at 1 month ($\beta = 0.094$, 95% CI: -0.043 to -0.231, $P = 0.178$) and 3 months postintervention ($\beta = 0.066$, 95% CI: -0.109 to -0.241, $P = 0.462$), benefits at 1 month ($\beta = 0.066$, 95% CI: -0.070 to -0.203, $P = 0.339$) and 3 months postintervention ($\beta = 0.084$, 95% CI: -0.065 to -0.232, $P = 0.269$), and self-efficacy at both 1 month

Table 2
Comparison of demographic characteristics and outcome variables between those who completed the study (n = 152) and who did not (n = 36).

Variables	Overall	Completed the study	Discontinued the study	P
Number (percentage)	188	152 (80.85%)	36 (19.15%)	–
Age (years) (range: 28–70) ^a	49.62 ± 9.12	49.12 ± 9.42	50.10 ± 8.51	0.47
Gender				0.69
Female	110 (58.5)	90	20	
Male	78 (41.5)	62	16	
Marital status				^b 0.47
Married	176 (93.6)	141	35	
Single/Divorced/Widow	12 (6.4)	11	1	
Insurance				^b 0.79
Public	148 (78.7)	117	31	
Private	40 (11.3)	21	4	
Education				0.54
Secondary or below (≤ 12 years)	142 (75.6)	115	27	
Tertiary or above (> 12 years)	46 (24.5)	37	9	
Screening behaviors				^b 0.80
No previous CRC screening behavior more than 5 years	157 (83.5)	126	31	
Colonoscopy	29 (15.4)	25	4	
Stool-based test	2 (1.1)	1	1	
Number of CRC patients				^b 1.00
1	184 (97.9)	148	36	
2	4 (2.1)	4	0	
Relationship with CRC patients				^b 0.79
Children	164 (87.1)	133	31	
Siblings	24 (12.9)	19	5	
Perceived susceptibility (RCRCPS) ^a	2.88 ± 0.65	2.88 ± 0.61	2.89 ± 0.81	0.96
Perceived severity (RCRCPS) ^a	3.16 ± 0.68	3.17 ± 0.69	3.27 ± 0.61	0.41
Perceived benefits (RCRCPS) ^a	4.21 ± 0.51	4.21 ± 0.51	4.24 ± 0.50	0.72
Perceived barriers (RCRCPS) ^a	2.66 ± 0.56	2.65 ± 0.58	2.70 ± 0.43	0.67
Self-efficacy (Self-efficacy Scale) ^a	4.06 ± 0.44	4.05 ± 0.45	4.07 ± 0.40	0.85
Cues to action (Cues to action Questionnaire) ^a	4.00 ± 0.39	4.00 ± 0.41	3.94 ± 0.29	0.50

^a Presented as mean and standard deviation, and tested by t-test; otherwise, presented by n (%), tested by χ^2 test.

^b Fisher exact test.

Table 3
Logistic regression predicting use of colonoscopy screening.

	B	S.E.	Wald	df	P	OR (95% CI)
Previous screening behavior	-0.737	0.431	2.932	1	0.087	0.478 (0.206–1.113)
Group	1.012	0.335	9.145	1	0.005	2.752 (1.428–5.303)
Contrast	-0.595	0.384	2.405	1	0.424	0.552

OR, Odds ratio; CI, confidence interval.

($\beta = 0.117$, 95% CI: -0.007 to -0.240 , $P = 0.064$) and 3 months ($\beta = 0.056$, 95% CI: -0.064 to -0.176 , $P = 0.360$) postintervention. Although the participants in the intervention group showed a trend of improvement across the study period, the change was not statistically significant compared with that in the control group. Table 4 shows the GEE results for comparison of health beliefs.

Discussion

The increased risk of developing CRC and the low screening rate after recommended colonoscopy among FDRs threaten their health. Although the efficiency of tailored communication in enhancing preventive behavior (eg, smoking cessation, dietary changes, and mammography screening) has been widely established,^{16,17} its effectiveness and feasibility for the at-risk population have received limited attention through novel channels. The present study filled this knowledge gap by employing an HBM-based WeChat tailored communication intervention and examining its effectiveness in enhancing the use of colonoscopy screening.

Effects of tailored intervention on uptake of colonoscopy

The study findings showed that the intervention group demonstrated significant improvement in the use of colonoscopy screening (OR: 2.75, 95% CI: 1.43–5.30, $P < 0.05$). This finding is consistent with colonoscopy screening behavior benefits reported in previous studies for FDRs of CRC patients.^{38–40} The present study developed a 3-session WeChat-based tailored communication protocol to achieve a greater effect compared to the pooled effect in previous studies.²¹ The improved effect size in the present study may be explained by two possible reasons. First, tailored communication via WeChat is useful for overcoming barriers in traditional print and telephone-delivered interventions reported in previous studies,^{38–41} including the lack of flexible response, feedback, and difficulty in monitoring the progress. The reading, messaging, and reporting services provided by WeChat promoted the participation in CRC screening communication and FDRs' understanding of increased risks and screening options. The second possible reason may be due to focusing on theoretical mediators that lead to behavior change. Noar et al¹⁹ reported that the effectiveness of tailored messages might be improved by focusing on specific mediators. Although previous studies involved mediators in tailored variables, they selected two or three behavior change theories as their basis, and such arrangements might request participants extract useful messages from a lot of information.^{38–41} The present study focuses on the variables derived from the HBM.

Effects of tailored intervention on health beliefs derived from the health belief model

To our knowledge, this is the first study to investigate the effect of tailored communication on health beliefs among FDRs of CRC patients.

The perceived susceptibility of CRC among FDRs in the intervention group significantly improved compared with that in the control group at T1 and T2. The significant effect on susceptibility perception is consistent with the results of a study conducted by Rawl et al,⁴² in which African Americans at average risk in the intervention group received a web-based tailored program comprising videos and reading materials for improving CRC screening. Rawl et al⁴⁰ reviewed participants' personal CRC risk factors and provided risk-appropriate screening recommendations. Animations of polyps growing, charts and images illustrating changes in CRC risk, and relevant images were used to describe the risk graphically. In the present study, two risk factors (age and family history) were reviewed, and appropriate screening recommendations were provided. The data on the increased risk and morbidity were provided to help participants understand the risk correctly. These findings suggested that messages tailored by using data, charts, or image presentations are useful to help people understand their increased risk of developing CRC. A significant improvement in susceptibility perception could be achieved after 1 month of tailored communication intervention, and the perception improvement could be sustained for over 3 months.

The perceived barriers to colonoscopy screening in the intervention group significantly decreased compared with that in the control group. The positive effect of tailored communication intervention on barrier perception is inconsistent with the results of a previous study,⁴² wherein messages were sent to participants only to overcome each barrier. On the contrary, the tailored messages in the present study were delivered in accordance with the participants' selection of the top three barrier items. The approach of selecting the top three barriers is more concise and focused than the messages for each barrier. Customizing messages according to participant selection could be viewed as personally relevant. Participants may be likely to read and ultimately have a low perception of barriers. This scenario suggested that tailored messages based on participant selection have efficacy in decreasing barriers.

Although the perceived severity of CRC among the participants in the intervention group improved across the study period, the change was not statistically significant. Epidemiology information on CRC and its clinical and social consequences, such as influences on family life and social relationships, was introduced in the present study. It might be difficult to increase the severity perception by simply providing relevant

Table 4
Generalized estimating equation analysis for comparison of health beliefs.

	Group effect		Time effect		Group*time effect	
	β (95% CI)	P	β (95% CI)	P	(95% CI)	P
Perceived susceptibility						
T1	-0.023 (-0.215–0.169)	0.814	-0.025 (-0.137–0.087)	0.666	0.298 (0.052–0.402)	0.011*
T2			-0.056 (-0.168–0.056)	0.324	0.251 (0.078–0.424)	<0.001**
Perceived severity						
T1	-0.018 (-0.218–0.182)	0.858	0.014 (-0.073–0.100)	0.758	0.094 (-0.043–0.231)	0.178
T2			-0.002 (-0.107–0.103)	0.975	0.066 (-0.109–0.241)	0.462
Perceived benefits						
T1	0.046 (-0.096–0.189)	0.524	0.028 (-0.048–0.105)	0.470	0.066 (-0.070–0.203)	0.339
T2			0.009 (-0.080–0.099)	0.842	0.084 (-0.065–0.232)	0.269
Perceived barriers						
T1	-0.077 (-0.234–0.079)	0.334	0.057 (-0.025–0.139)	0.170	-0.237 (-0.360–0.115)	0.004**
T2			-0.059 (-0.145–0.027)	0.178	-0.196 (-0.331–0.062)	0.002**
Self-efficacy						
T1	0.122 (-0.003–0.248)	0.056	0.009 (-0.078–0.095)	0.845	0.117 (-0.007–0.240)	0.064
T2			-0.014 (-0.110–0.082)	0.776	0.056 (-0.064–0.176)	0.360
Cues to action						
T1	-0.069 (-0.177–0.039)	0.213	-0.033 (-0.126–0.061)	0.492	0.264 (0.138–0.389)	<0.001***
T2			-0.057 (-0.157–0.043)	0.264	0.327 (0.195–0.459)	<0.001***

T1: 1 month postintervention; T2: 3 months postintervention; All statistical tests were 2-tailed; $P < 0.05$ is considered statistically significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

information. More persuasive approaches should be explored and tested in future studies. An HBM-based CRC educational program reported a significant increase in perceived severity at 3 months postintervention.⁴³ In this study, a 64-year-old patient with CRC was invited to share the symptoms, consequences, and damages of the disease. Case reports may impress people more easily and have the potential to raise the perception of severity. Given FDRs of people with CRC already have CRC cases around them, encouraging the disease discussion between FDRs and CRC cases may also be a promising strategy, but it is worth noting that cultural factors may affect how family members discuss health and illness.⁴⁴ In traditional culture, death is regarded as a negative life event,⁴⁵ possibly resulting in avoidance of any discussion on severe diseases, such as cancer-related information (eg, diagnosis, symptoms of illness, and negative consequences) that reminds them of death. Therefore, cultural belief-related strategies to promote communication between CRC patients and their families should also be explored and utilized.

Given that more than 15% of participants achieved the highest score on perceived benefits and self-efficacy in the baseline data, the results may involve ceiling effects when detecting any improvement in the benefits and self-efficacy perception, and they may yield nonsignificant results.^{46,47} Selecting participants based on their level of perceptions and excluding those with higher levels of perceived benefits and self-efficacy at enrolment are suggested in future studies.

Limitations

Although the participants were recruited from various centers, such as community centers and clinical settings, a high level of education and family income was found in the study sample. In addition, this study was restricted to those who have access to WeChat and living in Shenzhen in order to receive a free colonoscopy. The use of the convenience sampling method and the practical reasons may reduce the representativeness of the sample and the generalization of the study findings to less-developed or rural areas. Normally, studies aiming to recruit FDRs could invite parents, siblings, and children. However, Shenzhen city is an immigrant city, in which many families have only one FDR living in this city that we could recruit, and most of them were children of CRC patients. Therefore, the results may not be representative of other immigrant cities. In addition, only the short-term (3-month) effects of tailored communication intervention on the use of colonoscopy were examined. The long-term effects of the program (eg, 6 months) were not explored. Therefore, conclusions regarding the effectiveness of the tailored intervention over long periods could not be drawn.

Implications for nursing research, practice, and policy

The finding of this study further demonstrated that tailored health messages are promising in behavioral change areas, including cancer screening behavior. Therefore, integrating tailored communication with the current practices in cancer screening promotion is suggested. Tailoring is complex and time-consuming. Thus, to simplify the tailoring process and enhance its efficiency, mobile app-based channels, such as WeChat, are suggested as the delivery channel for tailored communication to promote screening in healthcare and public health settings.

Although the national CRC screening program in China provides free or insurance-reimbursed screening tests, the screening rate remains low.¹² In addition to supporting the cost of tests and insurance coverage, support for screening promotion interventions may further enhance the effectiveness of cancer prevention and detection programs. Support through healthcare system policy is crucial to promote the successful incorporation of tailored communication programs for people at increased risk of cancer. Local governments could empower various institutions through clear regulations and guidance, such as professional training, to support tailored communication activities.

Conclusions

This study indicated the positive effects of the HBM-based WeChat tailored communication intervention on the use of colonoscopy screening in the FDRs of people with CRC. The findings also supported the efficacy of tailored messages on improving the perceived susceptibility and cues to action and reducing perceived barriers. This study broadened the application of tailored communication using novel channels in the context of Chinese screening for the at-risk population. The results provided insights on how to improve the intervention by modifying intervention components and communication channels.

Authors' contributors

Conceived and designed the analysis: Yang Bai. Collected the data: Yang Bai and Xiaolin Peng. Performed the analysis: Yang Bai and Kai Chow Choi. Wrote the paper: Yang Bai, Cho Lee Wong, and Winnie K.W. SO.

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Declaration of competing interest

None declared.

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Ethics statement

This study was approved by the Joint Chinese University of Hong Kong-New Territories East Cluster Clinical Research Ethics Committee (CREC Ref. No.: 2018.368)

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