

# **Effectiveness and acceptability of targeted text message reminders in colorectal cancer screening: a randomised controlled trial (M-TICS study)**

Nuria Vives, Noemie Travier, Albert Farre, Gemma Binefa, Carmen Vidal, Maria Jose Pérez-Lacasta, Gemma Ibáñez-Sanz, Ena Niño de Guzmán, Jon Aritz Panera, Montse Garcia, M-TICS research group

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# Effectiveness and acceptability of targeted text message reminders in colorectal cancer screening: a randomised controlled trial (M-TICS study)

Nuria Vives<sup>1,2</sup> MD, MPH; Noemie Travier<sup>1,2</sup> PhD; Albert Farre<sup>3</sup> PhD; Gemma Binefa<sup>1,2,4</sup> PhD; Carmen Vidal<sup>1,2,4</sup> MD, MPH; Maria Jose Pérez-Lacasta<sup>5,6</sup> DBA; Gemma Ibáñez-Sanz<sup>7,8</sup> PhD; Ena Niño de Guzmán<sup>1,2</sup> PhD; Jon Aritz Panera<sup>1,2</sup> BMATH; Montse Garcia<sup>1,2,4</sup> PhD; M-TICS research group<sup>1</sup>

<sup>1</sup>Cancer Screening Unit, Institut Català d'Oncologia (ICO) L'Hospitalet de Llobregat ES

<sup>2</sup>Early Detection of Cancer Group, Epidemiology, Public Health, Cancer Prevention and Palliative Care Program, Institut d'Investigació Biomèdica de Bellvitge (IDIBELL) L'Hospitalet de Llobregat ES

<sup>3</sup>School of Health Sciences, University of Dundee Dundee GB

<sup>4</sup>Ciber Salud Pública (CIBERESP), Instituto Salud Carlos III Madrid ES

<sup>5</sup>Department of Economics, University Rovira i Virgili Reus ES

<sup>6</sup>Research Group on Economic Evaluation and Health (GRAES) Reus ES

<sup>7</sup>Gastroenterology Department, Bellvitge University Hospital L'Hospitalet de Llobregat ES

<sup>8</sup>Colorectal Cancer Group, ONCOBELL Program, Bellvitge Biomedical Research Institute L'Hospitalet de Llobregat ES

## Corresponding Author:

Montse Garcia PhD

Cancer Screening Unit, Institut Català d'Oncologia (ICO)

Gran via de l'Hospitalet 199-203

L'Hospitalet de Llobregat

ES

## Abstract

**Background:** Mobile phone text message reminders to increase colorectal cancer (CRC) screening participation have shown moderate effects.

**Objective:** This study assessed effectiveness and acceptability of targeted text message reminders for those who picked up but did not return their screening kit at pharmacy within 14 days in a CRC screening program in Catalonia, Spain

**Methods:** We performed a randomised control trial in the screening hub of the metropolitan area of Barcelona that covers 502,348 adults aged 50-69 years. In total, 9,369 individuals were randomised in a 1:1 ratio to receive either a text message reminder or no reminder. Main primary outcome was FIT completion rate within 126 days from FIT kit pick-up (intention-to-treat-analysis). A telephone survey assessed acceptability and appropriateness of the intervention. Cost-effectiveness of adding a text message reminder to FIT completion was also performed.

**Results:** FIT completion rate was 77.7% in control arm and 82.6% in text message arm. Higher participation rates in intervention arm were reported independent of sex, age, socioeconomic level, and screening profiles. 89.2% of interviewees considered it important and useful to receive text message reminders to FIT completion, and 93.4% preferred text messages to postal letters.

**Conclusions:** Adding text message reminders to the standard procedure significantly increased FIT kit return rates and was considered acceptable and appropriate. The SMS plus letter reminder to complete and return the FIT kit was a cost-effective strategy. Clinical Trial: Registration Number NCT04343950 (04/09/2020) at clinicaltrials.gov

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## Original Manuscript

Effectiveness and acceptability of targeted text message reminders in colorectal cancer screening:  
a randomised controlled trial (M-TICS study)

**Abstract:**

**Background:** Mobile phone text message reminders have the potential to improve colorectal cancer (CRC) screening participation rates.

**Objective:** This study assessed effectiveness and acceptability of adding targeted text message reminder to the standard procedure for those who picked up but did not return their screening kit at pharmacy within 14 days in a CRC screening program in Catalonia, Spain.

**Methods:** We performed a randomised control trial among individuals aged 50-69 years invited to screening who picked up a FIT kit at pharmacy but did not return it within 14 days. The intervention group (n=4,563) received a text message reminder on 14 day of kit pick up, and the control group (n=4,806) received no reminder. A 30-day reminder letter was sent to both groups if necessary. Main primary outcome was FIT completion rate within 30, 60, and 126 days from FIT kit pick-up (intention-to-treat-analysis). A telephone survey assessed acceptability and appropriateness of the intervention. Cost-effectiveness of adding a text message reminder to FIT completion was also performed.

**Results:** Intervention group had higher FIT completion rates compared to the control group at 30 (64.2% vs 53.7%,  $P<.001$ ), 60 (78.6% vs 72.0%,  $P<.001$ ), and 126 (82.6% vs 77.7%,  $P<.001$ ) days. Participation rates were higher in the intervention arm independent of sex, age, socioeconomic level, and previous screening behaviour. 89.2% of interviewees considered it important and useful to receive text message reminders to FIT completion, and 93.4% preferred text messages to postal letters. We observed a reduction of 2.2 euros per participant gained in the intervention arm for invitation costs compared to the control arm.

**Conclusions:** Adding a text message reminder to the standard procedure significantly increased FIT kit return rates and was a cost-effective strategy. Text messages were also proved to be an acceptable and appropriate communication channel for cancer screening programmes.

**Registration:** Clinicaltrials.gov NCT04343950,  
<https://www.clinicaltrials.gov/study/NCT04343950> (04/09/2020).

**Keywords:** text message; mobile health; colorectal cancer screening; participation.

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## Introduction

Decreasing the burden of colorectal cancer (CRC) is a public health priority in most high-income countries [1]. In 2020, CRC was the third most common cancer in men and the second most common in women in Europe, with approximately 191,053 new cases in men and 150,366 in women. Moreover, CRC was also the second leading cause of cancer death in men, accounting for 87,185 deaths, and the third in women, with 68,920 deaths [2]. Although different screening strategies exist, CRC screening programmes using self-administered faecal occult blood test kits effectively reduce CRC mortality [3]. The Council of the European Union has recently published a new EU approach to cancer screening, replacing Council Recommendation 2003/878/EC. The new approach recommends a quantitative faecal immunochemical test (FIT) as the preferred test for CRC screening (2022/C 473/01) [4]. Participation in colorectal screening programmes varies substantially throughout Europe, from 11.6% to 67.7% [5]. To boost participation, the European Quality Guidelines for Quality Assurance in CRC screening and diagnosis recommends a reminder letter mailed to all non-attenders and states that although more effective than other modalities, phone reminders may not be cost-effective [6]. Moreover, new strategies and communication channels for improving participation among the target population of such programmes need to be investigated.

Mobile phone text messages are the most commonly used mHealth Technology [7]. They offer instant transmission without being intrusive and lower costs compared to other communication channels [8,9]. Text message reminders have shown effectiveness in increasing mammography attendance in Breast Cancer Screening, and the European Commission Initiative for Breast Cancer now recommends its implementation in screening programs [10]. In CRC screening, text message reminders to improve participation have shown moderate effects [7,9,11–13].

Catalonia (Spain) launched its CRC screening programme in 2000, which provides free screening for men and women aged 50–69 years using a FIT. The programme is operated by eleven screening hubs, most using a pharmacy-based model to distribute and collect the FIT kits [14]. Although global participation remains low among individuals who pick up the FIT kit at the pharmacy, compliance with FIT completion is high (93.5%) [15]. However, a non-negligible percentage of individuals who collect the FIT kit at the pharmacy do not return it (6.5%). The design of a targeted intervention that considers individual stages of change is more effective than a single intervention that does not take into account specific population needs [16]. The Precaution Adoption Process Model (PAPM) is a useful framework for understanding CRC screening behaviour because it recognises different types of non-participants, such as those who are unaware, unengaged, undecided, decided not to get screened, or decided to get screened. The PAPM also emphasises

the importance of turning intention into action, which is why reminders may be an effective intervention in bridging the intention-behaviour gap [17].

Implementing a text message intervention targeting individuals who decided to take action by going to the pharmacy to pick up a FIT kit may optimise the return rate and indirectly increase the overall participation in CRC screening.

This study assessed the effectiveness and acceptability of targeted text message reminders for individuals who picked up but did not return their FIT kit within 14 days. Furthermore, a simple cost-effectiveness analysis of adding an SMS reminder to FIT completion was performed.

## Methods

### Design

A randomised controlled trial was conducted between 30 June and 5 November 2021 to compare the effectiveness of adding a text message FIT return reminder to the standard FIT reminder procedure (a letter sent by postal mail). This trial is part of the M-TICS Study, with the protocol previously published [18] according to the SPIRIT statement [19]. Embedded in the trial was a process evaluation using a telephone questionnaire exploring the acceptability of the intervention on a sample of trial participants.

### Setting

The Catalan Institute of Oncology manages the screening hub of the Northern and Southern metropolitan areas of Barcelona, which is part of the Catalan CRC screening programme (Spain). The hub covers a target population of 502,348 men and women aged 50–69 years (1 January 2020) from the Northern and Southern Metropolitan Areas of Barcelona. The hub identifies individuals due for screening from the Central Register of Insured Persons of the Catalan Health Service. All eligible individuals receive an invitation letter to pick up a FIT kit at any pharmacy participating in the CRC programme. In the sixth week, a reminder invitation letter is sent to non-respondents. Individuals who picked up but did not return their FIT kit after 30 days receive an additional reminder letter to complete and return it. Community pharmacies send completed FIT kits to their allocated laboratory to be processed. Individuals with positive FIT results are offered a diagnostic colonoscopy.

### Participants and randomisation

Eligible individuals were individuals who picked up but did not return their FIT kit at the pharmacy within 14 days. Simple randomisation was performed to allocate the participants.

The researchers designed an application using JavaScript's built-in Math.random function to select and randomise eligible individuals in a 1:1 ratio to the intervention or control arm. From 30 June 2021 onwards, eligible individuals were randomised to the intervention daily until the target sample size was achieved. Individuals without a registered mobile phone were excluded. Neither study participants nor investigators or data analysts were blinded to the intervention. However, the endpoint of this study did not require subjective judgment.

### Intervention description

Individuals randomly assigned to the intervention arm received a text message reminder to return their FIT kit on day 14 after picking it up. Individuals randomly assigned to the control arm received no text message reminder at this point. In both arms, participants still received the programme's standard reminder letter if they had not completed the FIT kit 30 days after picking it up. Individuals could request a new FIT kit by contacting the screening hub if they had lost it.

Text messages were bidirectional (enabled two-way messaging) with fully automated delivery through a platform. The screening hub staff managed the incoming individual responses. The research team developed the text message based on previous studies that suggested informative, short, and simple messages can increase screening rates [20–22]. It was previously tested in a convenience sample before the trial. The text of the message did not include individual data, and the telephone number of the screening office was provided to resolve any concerns (*Multimedia Appendix 1*).

### Process evaluation

A subset of trial participants from both arms was recruited using consecutive sampling between October and November 2021. Participants were invited to respond to a brief structured telephone survey two weeks after the intervention. All calls were made during office hours (8-15h). The questionnaire comprised nine items addressing the perceived acceptability and appropriateness of the intervention. Those who confirmed receiving the reminder were also asked about the understandability of the text message.

### Outcomes and baseline variables

The primary outcome of this study was the FIT completion rates at different time points of the screening process after the FIT pick up: at 30 days to assess the effect of sending a text message (intervention group) compared to no text message (control group), at 60 days to assess the effect of sending two reminders (text message and reminder letter) in the

intervention group and at 126 days to evaluate the overall participation at the end of the screening episode. Secondary outcome measures were user response time (time to FIT completion) and the number of FIT kits needed to complete a screening episode. Baseline variables were sex, age at the time of invitation, previous round screening behaviour (participant or not), and Catalan tertiles of deprivation score index based on the individual's primary healthcare area) [23].

## Sample size

Calculations were made to detect differences in participation among intervention and control groups. We estimated that 15% of individuals will not have a mobile phone registered, and 10% of phone numbers will be wrongly recorded. Using these estimates and considering a two-sided alpha of 5% and a power of 90%, we established that a sample of 10,174 individuals (5,087 individuals in each group) would be needed to detect a 3% difference in participation between the intervention and control groups (69.4 vs 66.4%). These estimations were based on retrospective data from our screening database (2018). For the process evaluation survey, a sample size of 638 subjects was estimated by considering a population percentage of 85% of text message appropriateness, with a 95% confidence, a precision of  $\pm 3$  per cent point units and assuming that 20% of the individuals could not be contacted.

## Cost-effectiveness of adding an SMS to FIT completion

The intervention arm costs were estimated by calculating the cost of sending an SMS (0.05 €) to individuals who collected the FIT kit but had not completed it at 14 days, plus the cost of sending a letter (0.51 €) at 30 days for individuals who had not yet completed the FIT kit at this point. The costs for the control arm were estimated by calculating the cost of sending a reminder letter to individuals who had not yet responded at 30 days. Incremental costs were therefore determined as the difference between the cost for the intervention arm and the control arm. Participation in CRC cancer screening at 126 days was considered the unit of benefit (effectiveness) in each arm. Therefore, the effect on incremental participation was calculated as the difference in participation between the intervention arm and the comparator arm. The incremental cost-effectiveness ratio (ICER) was defined as the ratio of incremental cost to incremental effect.

## Statistical analyses

Baseline characteristics of the control and intervention arms were compared to identify

imbalances in covariates during randomisation. Continuous variables were analysed using Student's t-test and categorical variables using Chi-square tests. The primary study outcome (FIT completion rate within 30 days, 60 days, and 126 days from FIT pick-up date) was assessed on an intention-to-treat basis. Time-to-event analysis was conducted from the intervention date (date of the text message) and FIT completion date. Time to FIT completion was described using Kaplan-Meier estimates, and differences were tested using the log-rank test. Associations of the assigned arm with FIT completion status were assessed using a Cox proportional hazards model adjusted for the potential confounders, including sex, age, previous screening, and deprivation score index [15,24]. Results were reported as hazard ratios (HRs) and 95% confidence intervals (CIs). Process evaluation survey responses were synthesised using descriptive statistics.

All statistical tests were two-tailed, with  $P < .05$  considered significant. All the analyses were performed using STATA version 17.0 (Stata Corp LP, College Station, Texas).

## Ethical considerations

The study received ethical approval from the Ethics Committee of the Bellvitge University Hospital, L'Hospitalet del Llobregat, Spain (reference PR042/20), which deemed that informed consent from the participants was not needed because the study was embedded in a routine screening service. However, for the telephone survey, verbal informed consent was obtained from each respondent. The study was performed in accordance with Good Clinical Practice and the Declaration of Helsinki. Confidentiality and privacy were ensured by collecting minimal personal information for recruitment purposes, and this information was stored in a password-protected database. All data collected in the trial were de-identified and stored in a password-protected database. There was no compensation for the participants.

## Results

### Characteristics of the study population

Between June and November 2021, 10,369 individuals were enrolled in this study. One thousand individuals (9.6%) with no mobile phone number registered were excluded from the trial. Of the 9,369 individuals included, 4,806 were randomly allocated to the control arm and 4,563 to the text message reminder arm. Text messages failed to be delivered in 100 (2.2%) individuals assigned to the intervention group but were still included in the intention-to-treat analysis. In addition, 11 individuals in the control arm and 15 in the intervention arm

who returned the FIT kit between data extraction and text message delivery were also included (*Figure 1*).

The sample included 4,792 women (51.2%), the mean [SD] age was 57.6 [5.6] years, 5,584 (59.9%) individuals were from a low deprivation area, and 5,248 (56.0%) had a previous screening test. Baseline characteristics were similar in both groups (*Table 1*).

Figure 1. The CONSORT flow diagram of reminder intervention to complete the FIT in a CRC screening programme.

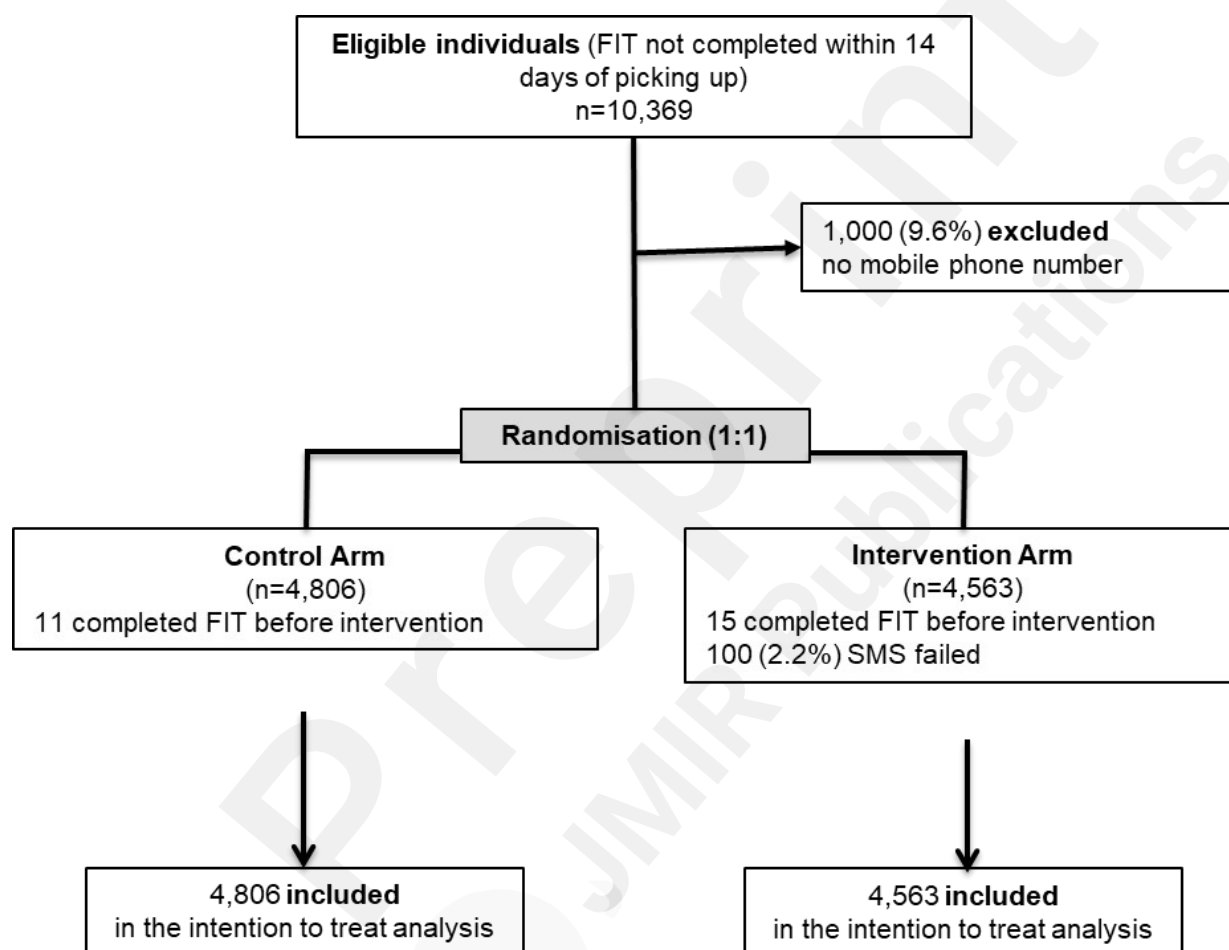


Table 1. Participants' baseline characteristics by trial arm

	Intervention	Control	P value	Total
	n (%)	n (%)		n (%)
Sex				
Female	2,310 (50.6)	2,482 (51.6)	.32	4,792 (51.2)
Male	2,253 (49.4)	2,324 (48.4)		4,577 (48.9)
Age, mean (SD), years	57.6 (5.6)	57.6 (5.6)	.68	57.6 (5.6)
Age groups, years				
50-59	3,084 (67.6)	3,219 (67.0)	.50	6,303 (67.3)
60-69	1,479 (32.4)	1,587 (33.0)		3,066 (32.7)
Deprivation Score				

1st tertile	2,696 (59.1)	2,888 (60.1)	.53	5,584 (59.6)
2nd tertile	1,078 (23.6)	1,124 (23.4)		2,202 (23.5)
3rd tertile	789 (17.3)	794 (16.5)		1,583 (16.9)
Previous screening				
No	2,018 (44.2)	2,103 (43.8)	.65	4,121 (44.0)
Yes	2,545 (55.8)	2,703 (56.2)		5,248 (56.0)
<b>Total</b>	<b>4,563</b>	<b>4,806</b>		<b>9,369</b>

## FIT completion rates

At 30 days of FIT pick-up, a 10% absolute increase in the FIT completion rate was observed in individuals in the intervention arm compared to the control arm (64.2% vs 53.7%, respectively). After accounting for those in both arms who received the standard reminder letter for not returning the FIT kit within 30 days of picking it up, the intervention arm still showed an absolute FIT completion rate increase of 6.6% and 4.8% at 60 days and 126 days, respectively (*Table 2*). Subgroup analysis by sex, age, socioeconomic level, and screening profiles (previously screened/unscreened individuals) consistently showed higher participation rates in the intervention arm (*Multimedia Appendix 2*).

Table 2. FIT completion rates and absolute differences within 30, 60, and 126 days of picking it up at the pharmacy by trial arm.

	<b>Intervention (n=4,563)</b>	<b>Control (n=4,806)</b>	<b>Absolute in FIT completion rate</b>	<b>difference</b>	<b>P value</b>
	n (%)	n (%)	Points (95% CI)		
Within 30 days	2,928 (64.2)	2,580 (53.7)	10.5 (8.5-12.5)		<.001
Within 60 days	3,587 (78.6)	3,461 (72.0)	6.6 (4.9-8.3)		<.001
Within 126 days	3,767 (82.6)	3,736 (77.7)	4.8 (3.2-6.4)		<.001

The Cox proportional hazards regression model adjusted by sociodemographic characteristics demonstrated that the intervention arm was associated with FIT completion (HR: 1.21; 95% CI: 1.16-1.27) (*Table 3*).

Table 3. Cox Proportional Hazards Regression Models of the effect of the SMS reminder adjusted by sociodemographic characteristics at 30, 60, and 126 days of picking the FIT kit up at the pharmacy.

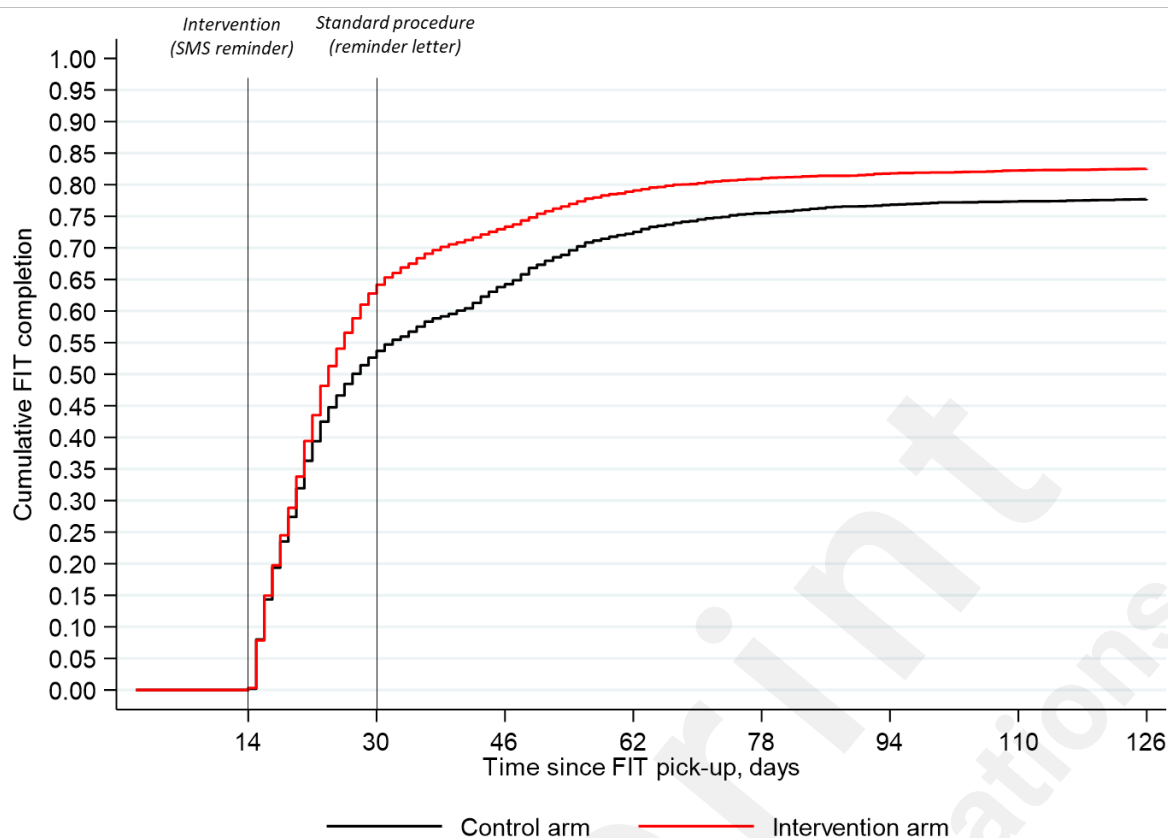
<b>FIT completion within 30 days</b>	<b>FIT completion within 60 days</b>	<b>FIT completion within 126 days</b>
--	--	---

		Adjusted HR (95% CI)	Adjusted HR (95% CI)	Adjusted HR (95% CI)
Intervention				
	Control	Ref.	Ref.	Ref.
	SMS	1.27 (1.21-1.34)	1.23 (1.18-1.29)	1.21 (1.16-1.27)
Sex				
	Male	Ref.	Ref.	Ref.
	Female	1.12 (1.06-1.18)	1.10 (1.05-1.16)	1.10 (1.05-1.15)
Age groups, years				
	50-59	Ref.	Ref.	Ref.
	60-69	1.06 (1.00-1.12)	1.05 (1.00-1.10)	1.04 (0.99-1.09)
Deprivation Score				
	1st tertile	Ref.	Ref.	Ref.
	2nd tertile	1.02 (0.96-1.09)	0.99 (0.94-1.05)	1.00 (0.95-1.06)
	3rd tertile	0.97 (0.90-1.04)	0.97 (0.91-1.04)	0.97 (0.91-1.03)
Previous screening				
	No	Ref.	Ref.	Ref.
	Yes	1.68 (1.59-1.78)	1.76 (1.68-1.85)	1.81 (1.72-1.90)

## Time to FIT completion

The 90th percentile for FIT return time was reduced by seven days in the intervention arm (48 days) compared to the control arm (55 days). *Figure 2* displays the Kaplan-Meier curve on FIT completion by intervention, showing that the time to FIT completion in the intervention arm was significantly shorter than in the control arm ( $P < .001$ ).

Figure 2. Kaplan-Meier curves on the time to FIT completion (days) since pick-up by intervention and control arm.



## Number of FITs

The number of FITs used to complete a screening episode did not differ between the trial and control arms ( $P = .99$ ). Of the 3,736 individuals in the control arm who completed screening, 3,568 (95.5%) used one FIT, and 168 (4.5%) required two FITs. Of the 3,736 individuals in the intervention arm who completed screening, 3,600 (95.6%) used one FIT, and 167 (4.4%) required two FITs.

## Acceptability and appropriateness of the intervention

Of the 646 individuals contacted by phone for the process evaluation survey, 415 (64.2%) were interviewed. The final sample size was smaller than planned ( $n=517$ ) representing an increase of the margin of error from 3% to 3.37%. Most interviewed participants stated they would like to receive text message notifications from the screening programme, particularly if this was a reminder to complete and return their FIT (359/415, 86.5%). Most interviewees reported that receiving a text message reminder to complete and return their FIT was important and useful (339/380, 89.2%), and almost all participants stated that they would prefer to receive the reminder via text message rather than letter (355/380, 93.4%). When asked to confirm if they recently received a text message from the screening program,

about 6 out of 10 respondents assigned to the intervention arm responded affirmatively (132/211). 100% of respondents who received the SMS reported that the content of the message and what they had to do was clear. In addition, almost all respondents reported having understood who was sending the text message (121/132, 91.7%) (*Table 4*).

Table 4. Survey results on the acceptability and appropriateness of receiving an SMS notification from the screening programme.

	<b>Intervention (n=211) n (%)</b>	<b>Control (n=204) n (%)</b>	<b>All (n=415) n (%)</b>
1. Would you like to receive any text message notifications from the CRC screening programme?			
Yes	184 (87.2)	170 (83.3)	354 (85.3)
No	0	5 (2.5)	5 (1.2)
Indifferent	27 (12.8)	29 (14.2)	56 (13.5)
2. In particular, would you like to receive a text message reminding you to return the FIT kit to the pharmacy?			
Yes	186 (88.2)	170 (83.3)	356 (85.8)
No	25 (11.8)	31 (15.2)	56 (13.5)
Indifferent	0	3 (1.5)	3 (0.7)
3. Do you think it would be important to receive a text message to remind you to return the test to the pharmacy? <sup>a</sup>			
Yes	183 (94.3)	163 (87.6)	346 (91.1)
No	11 (5.7)	22 (11.8)	33 (8.7)
Indifferent	0	1 (0.5)	1 (0.3)
4. Do you think it would be useful to receive a text message to remind you to return the test to the pharmacy? <sup>a</sup>			
Yes	183 (94.3)	170 (91.4)	353 (92.9)
No	11 (5.7)	14 (7.5)	25 (6.6)
Indifferent	0	1 (0.5)	1 (0.3)
Missing	0	1 (0.5)	1 (0.3)
5. How would you prefer to be reminded to return the test, by letter or text message? <sup>a</sup>			
Text message	176 (90.7)	158 (84.9)	334 (87.9)
Letter	7 (3.6)	13 (7.0)	20 (5.3)
Indifferent	9 (4.6)	12 (6.5)	21 (5.5)
No reminder	2 (1.0)	1 (0.5)	3 (0.8)
Do not know	0	2 (1.1)	2 (0.5)

6. Have you recently received a reminder to return the FIT kit at the pharmacy?			
Yes, a text message	132 (62.6)	6 (2.9)	138 (33.3)
Yes, a letter	23 (10.9)	21 (10.3)	44 (10.6)
No	48 (22.7)	170 (83.3)	218 (52.5)
Don't remember	8 (3.8)	5 (2.5)	13 (3.1)
Missing	0	2 (1)	2 (0.5)
7. Was the content of the message you received clear? <sup>b</sup>			
Yes	132 (100)		137 (33)
No	0		0
Don't remember	0		1 (0.2)
8. Did you understand what you had to do (was it clear what you had to do)? <sup>b</sup>			
Yes	132 (100)		137 (33)
No	0		0
Don't remember	0		1 (0.2)
9. Was it clear who was sending you the message? <sup>b</sup>			
Yes	121 (91.7)		124 (29.9)
No	7 (5.3)		8 (1.9)
Don't remember	3 (2.3)		5 (1.2)

<sup>a</sup> Individuals who responded negatively to questions 1 and 2 were directed to question 6 onwards ( $n=18$  in the control and  $n=17$  in the intervention arm); <sup>b</sup> Only for individuals that responded affirmatively to question 6.

### Cost-effectiveness of adding an SMS to FIT completion

The cost-effectiveness results are summarised in Table 5. We estimate a reduction of 2.2 euros per participant gained in the intervention arm compared to the standard reminder letter, despite fewer individuals. To extrapolate the results, if every arm had 1,000 individuals, the intervention arm would have a total cost of 2.7 euros less than the control arm, and 48 more individuals would have completed the test. Therefore, the intervention is clearly cost-effective.

Table 5. Cost-effectiveness of the reminders to FIT completion for individuals who picked up the screening test at the pharmacy but did not return it after 14 days

Trial arm	Non-participant s at 14 days n	Text messag e Cost € <sup>a</sup>	Non-participant s at 30 days n	Letter Cost €	Participant s at 126 days n	Total cost €	Cost per extra participan t €
Only letter	4,806	None	2,226	1,135.	3,736	1,135.	

				3		3	
SMS	+					1,066.	
Letter		4,563	232.5	1,635	833.9	3	-2.2

<sup>a</sup> Include a 1,9% text message replies, 0.05 € per text message.

## Discussion

This two-arm randomised controlled trial has shown that targeted text message reminders can be an effective and well-accepted strategy to improve FIT completion rates in population-based CRC screening programmes, particularly among those requiring participants to collect and return FIT kits at community pharmacies.

Our intervention increased the FIT completion rate by 4.8 percentage points at 126 days compared to the control arm. Adding a targeted text message reminder, in addition to the standard letter reminder, for the FIT completion would improve the overall participation in our programme by 0.6 percentage points, given that around 6.5% of invitees pick up but do not finally return the FIT [15]. According to the estimates of one death prevented out of 647 participating individuals over 25 years of screening [25], increasing this percentage point of the screening participation rate in the about 13 million target population in Spain could save the lives of an additional 121 individuals over 25 years. Even without increasing participation, replacing letters with text messages can have a positive effect in reducing costs for the screening programme.

The text message intervention, compared to the control intervention, has additionally resulted in a reduction of seven days in the user's response time to complete the screening of a part of the invitees. This is a crucial result, as the effectiveness of CRC screening is based on the periodic testing by FIT; thus, ensuring a 24-month time sequence between invitations is essential to ensure the benefits of screening [6]. In programmes where people take the test at home, providing a short user response time to complete the test is particularly relevant.

Unexpectedly, sending a text message 14 days after FIT pick-up did not reduce the number of lost kits, and consequently, we did not observe any differences in the number of FITs used between the two arms. In addition, the majority of participants who took part in our process evaluation survey reported that receiving a text message to complete and return their FIT would be important and useful. Almost all our survey respondents also indicated that they preferred this communication channel to the standard postal reminder letters.

Our study's main strengths include a randomised design and prospective data collection, combining effectiveness and acceptability data. One key limitation of the present study is that it was not possible to differentiate the effect of adding a targeted reminder to the standard screening procedure from the effect of delivering this reminder via text message. Another limitation was that the intervention was limited to people with a recorded mobile phone number with the screening programme. Although the percentage of individuals with a recorded mobile phone number with the programme was very high, it is still important to note that people who do not own a mobile phone may be the most vulnerable and with the most difficulties in accessing health services. In such cases, it may be worth exploring alternative technologies, such as automated or interactive voice recordings [26,27].

To the best of our knowledge, this is the first intervention study to test text message reminders specifically targeting population subgroups of a screening program. Two studies conducted in the national screening programs in England and Israel tested different text message reminders, which led to a marginal increase in gFOBT/FIT usage by 0.6% points [9] and 0.7–1.8% points, respectively [28], but these were delivered to the total population of non-participants. Combining a range of targeted interventions addressed to several specific population subgroups instead of all non-participants would have the potential to further increase overall participation with its related potential benefits.

Previous studies have demonstrated that men from lower socioeconomic status tend to have lower participation rates in CRC screening programs [29–31]. However, our research findings show that sending a text message reminder to those at a more advanced stage in adopting screening behaviour can effectively increase participation rates, regardless of their sociodemographic characteristics. The increase in FIT completion rates among the individuals who received the text message intervention was observed irrespective of sex, age group, socioeconomic level, or whether individuals had been previously screened.

CRC screening programmes have traditionally communicated with their target population by letter. However, making better use of available mobile technology is essential for improving cancer screening programmes, optimising economic resources, and reducing the ecological footprint of population-based screening. Our study has shown high levels of perceived acceptability and appropriateness among our study participants, who also indicated that they would prefer to receive notifications from the CRC screening programme via text message rather than a postal letter. Further studies should evaluate the feasibility of using text message reminders alone rather than as an additional intervention to the standard

reminder letters. This could help determine the potential for text message reminders to replace letter-based reminders as the standard procedure for reminders in specific populations.

## Conclusions

Our findings support the use of more than one reminder at different time points to optimise FIT kit return rates in FIT-based screening programmes. Moreover, our results may contribute to efforts to tailor them to specific population subgroups. Therefore, this is an excellent opportunity to implement strategies that use digital technologies, such as sending SMS in screening programs. Although traditionally, the target population received invitations by post, the need to establish other means of communication is becoming increasingly evident. Switching the communication method of a screening program from paper to SMS will reduce both costs and ecological footprint.

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## Conflicts of Interest

The authors declare funding from ISCIII, no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, and no other relationships or activities that could appear to have influenced the submitted work.

## Ethics approval and consent to participate

The M-TICS study was approved by the Ethics Committee of the Bellvitge University Hospital (approval number PR042/20), waiving the requirement to obtain the participant's signature as part of the consent process, as the intervention was a minor variation on the invitation practice. The study has been performed under Good Clinical Practice and the Declaration of Helsinki. The CRC screening programme follows general public health and data protection regulations [32–34] and accomplishes specific protocols based on the existing guidelines [35].

## Data availability

Data underlying reported findings have been deposited in the Universitat de Barcelona

Digital Repository and are publicly available [36].

Multimedia Appendix 1: Content of the text message and reminder letter to return the FIT kit.

Multimedia Appendix 2: FIT completion rate among intervention and control arms by sociodemographic characteristics.

Multimedia Appendix 3: CONSORT-EHEALTH checklist (V 1.6.1).

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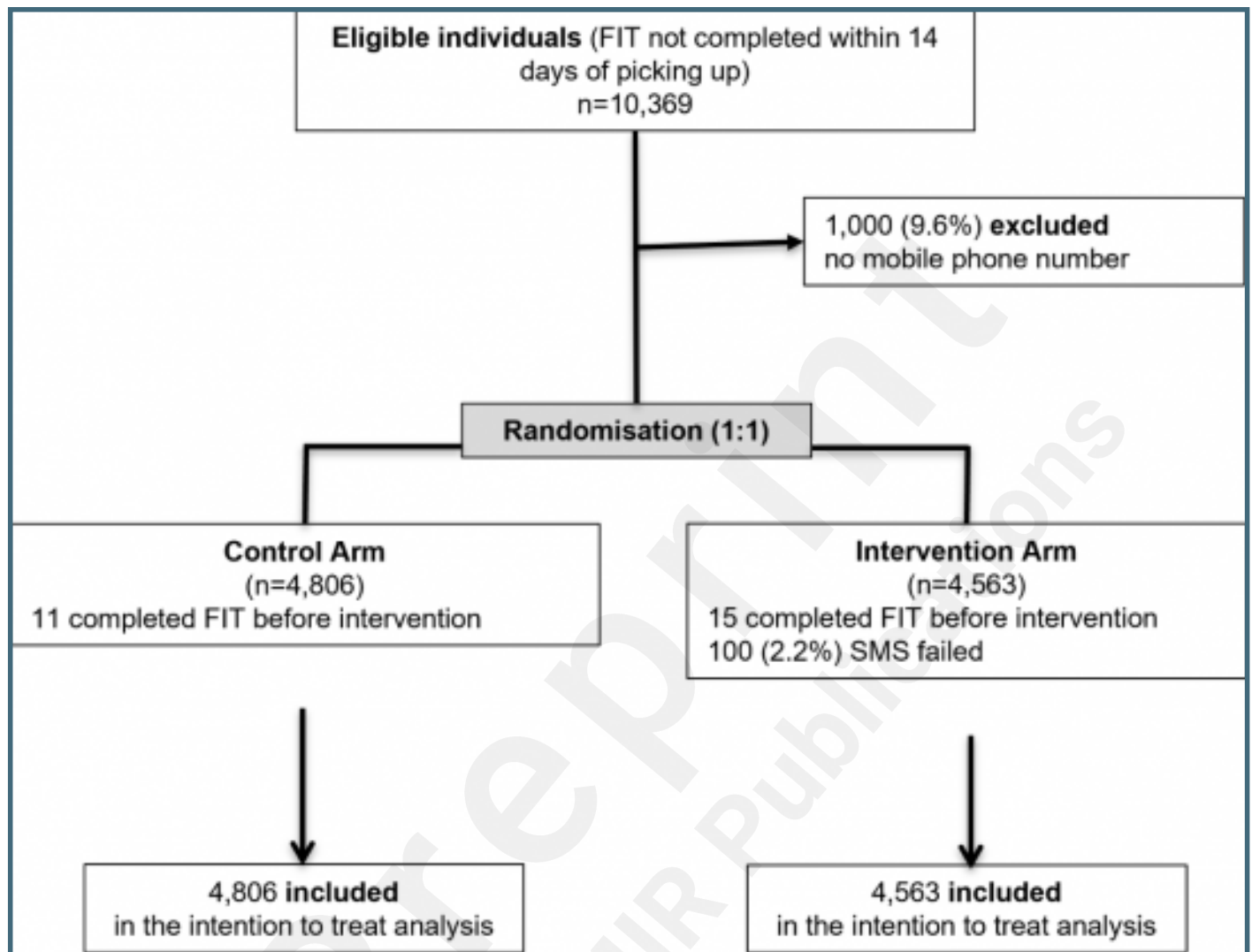
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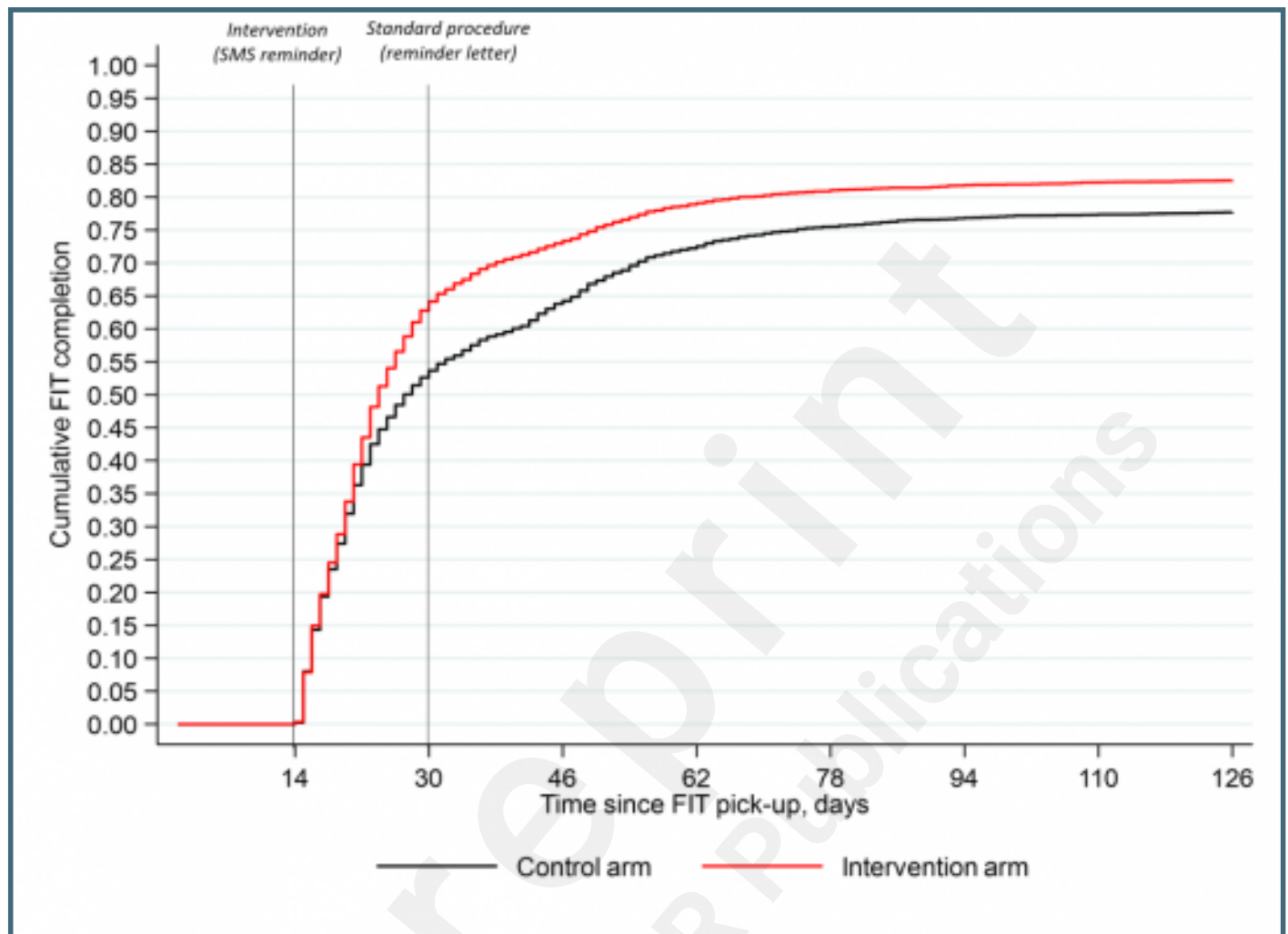
## Supplementary Files

## Figures

The CONSORT Flow diagram of reminder intervention to complete the IT in a colorectal cancer screening programme.



Kaplan-Meier Curves on the time to FIT completion (days) since pick-up by intervention and control arm.



## Multimedia Appendixes

CONSORT-EHEALTH checklist (V 1.6.1).

URL: <http://asset.jmir.pub/assets/679b70f4870b9710dd7c8ba1a4402cbc.pdf>

Content of the text message and reminder letter to return the FIT kit.

URL: <http://asset.jmir.pub/assets/b4f02e53c7a7c030680b1f06755ec415.docx>

FIT completion rate among intervention and control arms by sociodemographic characteristics.

URL: <http://asset.jmir.pub/assets/8bc859ada5596f96bbe032fa3339d74c.docx>



## CONSORT (or other) checklists

CONSORT 2010 checklist of information to include when reporting a randomised trial.

URL: <http://asset.jmir.pub/assets/6857886767cc77e9f104a038532bc928.pdf>