

# Short-term impact of the COVID-19 pandemic on a population-based screening program for colorectal cancer in Catalonia (Spain)

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## Research Article

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# Abstract

## Background

By mid-March 2020, colorectal cancer (CRC) screening program in Catalonia was suspended at all levels. Our goal was to assess the short-term impact of the COVID-19 pandemic at a FIT-based CRC screening hub in the metropolitan area of Barcelona.

## Methods

Short-term impact was measured in individuals invited between 1 January and 12 March 2020: screening participation, colonoscopy adherence, interval from positive test result to colonoscopy and psychological distress.

## Results

Lockdown with the first wave of COVID-19 caused 111,000 individuals to defer their screening invitations. Participation among invitees between January - March 2020 was 39.3% (95% CI: 38.9–39.7), a decrease of 5% in comparison with the 41.4% (95% CI: 41.2–41.6) participation in 2019. Adherence to colonoscopy decreased from 89.3% (95% CI: 88.4–90.2) in 2019 to 81.4% (95% CI: 78.9–83.7) in the first quarter of 2020. The mean time to colonoscopy after resumption was 128.7 days (CI 95%: 125.3–132.2). Irrespective of test results, factors associated with higher levels of distress were a greater perceived risk of CRC and greater impairment of emotional wellbeing due to COVID-19.

## Conclusions

The short-term impact of COVID-19 on CRC screening seems to have been modest, with a slight decrease in participation, a moderate decrease in colonoscopy adherence, and lengthened waiting times. However, a marked impact on future CRC incidence and deaths could be expected. Thus, it is critical to revert participation and colonoscopy adherence rates to that previously achieved while reducing the 5-month delay in screening invitations.

## Background

The Director General of the World Health Organization (WHO) on March 11, 2020, declared the novel coronavirus disease 2019 (COVID-19) as a global pandemic [1]. In Catalonia (Spain), after the first confirmed case on 24 February 2020, the rapid spread of the COVID-19 pandemic struck the health system capacity [2]. One of the health services most severely impacted by COVID-19 was cancer screening. By mid-March, the organized colorectal cancer (CRC) screening program in Catalonia

suspended new invitations to screen and deferred diagnostic colonoscopies for individuals with a positive FIT result.

The potential effects of screening disruption can be immediate, mid- or long-term. Short-term effects could have an impact on participation and adherence to diagnostic colonoscopy, which is due to participants' fear of hospital attendance, and further delays in performing colonoscopy that arise because of hospital overcrowding. A recent study in Northern Taiwan observed a decreased FIT screening uptake rate and diagnostic colonoscopy rate after a positive FIT result since the outbreak of COVID-19 [3]. Among the expected medium- and long-term effects are the impact on CRC diagnoses and mortality. The time between a positive FIT result and colonoscopy completion is essential to reduce both the risk of CRC and the stage at diagnosis. A recent meta-analytical model highlighted the effects on advanced CRC and mortality of colonoscopy delay beyond 6 and 12 months, respectively, in a FIT-based CRC screening program in Italy [4].

Whereas different levels of psychological distress exist during different steps of a FIT-based CRC screening, the pause of the CRC screening program by COVID-19 could have had a harmful effect on the emotional health of participants who had their screening episode deferred. Vermeer et al. recently published a study showing that adverse psychological distress was higher just after being informed of a positive FIT result but that psychological distress was significantly lower just before undergoing colonoscopy [5].

In this study, we aimed to assess the short-term impact of COVID-19 by comparing data from January to March 2020 with data from 2019 on participation, adherence and time delays in diagnostic colonoscopy in a FIT-based CRC screening hub in the metropolitan area of Barcelona. We also examined perceived stress levels in participants with a positive FIT result who were discontinued from the CRC screening process by March 2020.

## Methods

### Setting and screening procedure

The CRC screening hub of the Catalan Institute of Oncology is one of the largest hubs in Catalonia, covering a target population of approximately 495,000 men and women aged 50–69 years in the metropolitan area of Barcelona. A cutoff of 20 µg Hb/g feces is used to determine positivity on the FIT, and those with a positive test result are referred for diagnostic colonoscopy. Participants with a negative FIT result receive a recommendation letter for biennial screening while individuals with a positive FIT receive a result letter within 7 days. In parallel, endoscopic units of reference hospitals are informed about individuals with a positive FIT result through the CRC screening computer system. Nurses contact participants up to four times by phone for a pre-colonoscopy interview, where the participant's risks are assessed and instructions are given for colonoscopy bowel preparation. When a participant cannot be

contacted, a registered letter is sent with a recommendation for a diagnostic colonoscopy (Supplementary Figure).

## **Pause and recovery strategies of the CRC screening program**

On March 12, 2020, invitations to CRC screening in the metropolitan area of Barcelona were paused, and on March 16, 2020, diagnostic colonoscopies from the CRC screening process were discontinued being resumed 50 days later according to regional recommendations for activity resumption during the COVID-19 pandemic [6]. Individuals with a FIT result of 160 µg Hb/g feces and higher were prioritized to schedule colonoscopy, followed by results between 80 and 160 µg Hb/g feces.

At the end of July 2020, when FIT kit pick-up and delivery at community pharmacies resumed, a new strategy of SMS reminders was used to prompt participation in CRC screening.

With the resumption of screening invitations in September 2020, the FIT cutoff point was changed to 31 µg Hb/g feces to avoid overloading endoscopic units as the COVID-19 pandemic was still ongoing.

## **Data source and sample size**

Individuals invited for CRC screening in the metropolitan area of Barcelona between January 1 and March 12, 2020, were extracted from the CRC screening database to assess participation and colonoscopy adherence. Individuals with a positive FIT result whose screening process was paused on March 16 were selected to assess the time to diagnostic colonoscopy. These participants were categorized according to their colonoscopy status: pending or rescheduled colonoscopy.

Individuals with a positive FIT result whose screening process was paused on March 16, 2020, and who scheduled a colonoscopy between June and September 2020 were invited to participate in a telephone survey to assess psychological distress before colonoscopy in the context of the COVID-19 outbreak. Concurrently, a control group with negative FIT results matched by sex, age group (50–59 and 60–69 years), and primary healthcare area of residence in a 1:1 ratio was interviewed. Based on previous studies [7], we expected Perceived Stress Scale (PSS) scores across groups to be at a mean of 11.9, with a standard deviation (SD) of 6.14. With an alpha of 0.05, we calculated that a minimum sample size of 370 individuals (185 in each group) would give us 80% power to detect a 2-point between-group difference in PSS score. Anticipating a 20% refusal rate, we planned to approach a total of 450 individuals with a positive FIT result.

## **Outcomes**

Participation was measured as the number of individuals with a FIT result divided by the total invitees.

Colonoscopy adherence was calculated as the number of individuals with a colonoscopy result divided by the total number of individuals with a positive FIT result.

Time to diagnostic colonoscopy was the interval in days between the FIT-positive result date and colonoscopy performance date.

Psychological distress was measured with the Spanish version of the Perceived Stress Scale-10 (PSS-10) as used by Remor et al [8]. A PSS-10 total score from 0 to 40 was obtained by summing all 10 items. Higher scores indicate a higher level of perceived stress. To calculate distress from the PSS-10 scale, we excluded observations with any missing values, and therefore we performed a sensitivity analysis to test the robustness of the results under a reasonable worst-case scenario.

Distress levels were recoded into two categories based on the second tertile within the control group; that is scores under or equal to 13 or above 13. In addition, this cutoff was consistent with other studies that classified low self-perceived stress scores ranging from 0 to 13 and moderate/high self-perceived stress scores ranging from 14 to 40 [9, 10].

## **Other control variables**

Other variables considered were: sex, age categorized into two groups (50–59 and 60–69 years), previous screening (yes/no), quantitative FIT result categorized into three groups (20-79.9, 80-159.9, and  $\geq 160$   $\mu\text{g}$  Hb/g feces), primary healthcare area of reference and deprivation score index (DS; a marker of area-level deprivation based on primary healthcare areas of Catalonia) [11, 12]. For the analysis, DS index was recoded into a 3-category variable using the cutoff points of the tertiles of the Catalan distribution to enable comparisons between individuals living in the most and least deprived areas.

Additionally, variables in the survey included marital status, meaning/understanding of the FIT result, perceived risk of CRC compared to same-aged persons work status affected by COVID-19, personal or nearby COVID-19 diagnosis and emotional well-being affected by COVID-19. .

## **Data analysis**

Participation and colonoscopy adherence rates with 95% confidence intervals (CIs) were calculated for individuals invited to participate between January 1, 2020 and March 2020 and were compared with data of those invited in 2019. A time-to-event analysis was conducted from the FIT result date and the first colonoscopy scheduled date. Time to diagnostic colonoscopy was described using Kaplan-Meier estimates, and differences between the colonoscopy group (pending vs. rescheduled) and the FIT quantitative group were compared using the log-rank test.

A descriptive analysis of the characteristics and COVID-19 screening and distress-related data of the interviewed participants according to FIT result was performed. Continuous variables were compared between the two groups using the Mann-Whitney U test, while categorical variables were compared using the chi-square test. Univariable and multivariable logistic regression models were used to examine factors associated with higher levels of psychological distress ( $> 13$ ), and odds ratios (ORs) and their 95% confidence intervals (CIs) were reported.

The statistical analysis was performed using Stata 15 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

## Results

About 30% of the target population was affected by a 5-month pause in our CRC screening program due to the lockdown during the first wave of the COVID-19 pandemic, with approximately 111,000 individuals not being invited to CRC screening (Fig. 1). Between January 1 and March 12, 2020, 14,389 out of a 55,846 people invited had completed FIT kit screening (25.8%), and from the resumption to the end of 2020, a further total of 7,562 people completed a FIT kit (13.5%) (Fig. 1). Out of 29,297 individuals eligible to receive an SMS, 22,022 SMSs were successfully delivered.

Half of the individuals who received an SMS to complete and return the FIT kit did so (742/1,465), in comparison with 39.1% of the people among whom SMS delivery failed (115/298). Among people who received an SMS reminder invitation, participation reached 13% (2,765/20,557) compared to 6.6% (462/6,981) in those for whom the SMS delivery failed.

Figure 2 shows the main outcomes of invitees during this period to CRC screening compared to the previous year. The participation of individuals invited during the first quarter of 2020 was 39.3% (95% CI: 38.9–39.7), which represents a significant decrease of 5% in comparison with the 41.4% (95% CI: 41.2–41.6) participation observed in 2019. Adherence to colonoscopy significantly decreased from 89.3% (95% CI: 88.4–90.2) in 2019 to 81.4% (95% CI: 78.9–83.7) in the first quarter of 2020.

At the time of the pause, 839 participants with a positive FIT result discontinued the CRC screening process in our area: (Fig. 1). The mean time to colonoscopy after resumption was 128.7 days (CI 95%: 125.3–132.2), with 0.7% of colonoscopies performed before 60 days. Figure 3 shows the Kaplan-Meier curves for colonoscopy performance by colonoscopy status and FIT-positive score results. Colonoscopy performance time was significantly lower among the pending group, and among individuals with higher FIT score result ( $p < 0.001$ ).

Between June 2020 and September 2020, 310 (36.9%) of the 839 individuals with a positive FIT result and with a colonoscopy to be scheduled were invited to participate in the survey. Overall, 229/310 (73.9%) individuals consented and completed the survey. In parallel, 219/298 individuals with a negative FIT result responded. Table 1 shows the characteristics of the interviewed individuals according to FIT result. The percentage of the FIT-positive group who interpreted the meaning of their FIT results as very likely/almost certainly having CRC was significantly higher than that of the group with a negative FIT result. Individuals who had a positive FIT result perceived their CRC risk relative to a person of the same age, and the current CRC risk perception risk was higher than that of individuals with negative FIT results. However, no difference in levels of psychological distress was found for individuals scheduled for colonoscopy with positive FIT results compared to control group. Irrespective of FIT results, factors associated with higher psychological distress levels in participants of our CRC cancer screening program are shown in Table 2. After adjusting by sex, age, DS and for potential confounding factors, having poorer

emotional well-being during the COVID-19 pandemic, and having more perceived CRC risk compared to same-aged persons were associated with increased levels of psychological distress among participants in a CRC screening program in the context of the COVID-19 pandemic.

Table 1  
Characteristics of individuals interviewed during the first wave of the COVID-19 pandemic according to FIT result

	Positive FIT result		Control (FIT negative)		
	N	%	N	%	p
<b>Sex</b>					
Men	107	46.7	100	45.7	<i>0.822</i>
Women	122	53.3	119	54.3	
<b>DS index (0-100)</b>					
1st tertile	32	14.0	30	13.7	<i>0.989</i>
2nd tertile	102	44.5	99	45.2	
3rd tertile	95	41.5	90	41.1	
<b>Age</b>					
50–59 years	105	45.9	101	46.1	<i>0.955</i>
60–69 years	124	54.1	118	53.9	
<b>Marital Status</b>					
Married	167	72.9	169	77.2	<i>0.337</i>
Not married	61	26.6	50	22.8	
<b>Work status affected by COVID-19</b>					
No	187	81.7	181	82.6	<i>0.785</i>
Yes	42	18.3	38	17.4	
<b>Personal/nearby COVID-19 diagnosis</b>					
No	132	57.6	137	62.6	<i>0.342</i>
Yes	95	41.5	82	37.4	
<b>FIT result meaning</b>					
Definitely no CRC/very unlikely	104	45.4	108	49.3	<i>0.000</i>
Unlikely	60	26.2	80	36.5	
Likely/certain	48	21.0	10	4.6	

<sup>a</sup>*IQR = interquartile range;* <sup>b</sup>*some variables do not sum to the total sample size because of missing values*



	Positive FIT result		Control (FIT negative)		
Comparative perceived CRC risk					
About the same	162	70.7	153	69.9	0.065
Higher	36	15.7	24	11.0	
Lower	18	7.9	30	13.7	
Emotional well-being affected by COVID-19					
Not at all/only a little	100	43.7	99	45.2	0.811
To some extent	95	41.5	87	39.7	
Rather much/very much	30	13.1	33	15.1	
Psychological distress, median (IQR <sup>a</sup> )	11 (6–16)		10 (6–16)		0.439
Psychological distress level					
Low (≤ 13)	123	53.7	140	63.9	0.169
Moderate/High (> 13)	74	32.3	63	28.8	
Total <sup>b</sup>	229		219		
<sup>a</sup> IQR = interquartile range; <sup>b</sup> some variables do not sum to the total sample size because of missing values					

Table 2

Factors associated with high levels of psychological distress in participants of CRC screening during the first wave of the COVID-19 pandemic

Psychological Distress Level					
	Low ( $\leq 13$ )	Moderate/High (> 13)	aOR*	95%CI	p
	n (%)	n (%)			
<b>Sex</b>					
Men	133 (50.6)	55 (40.1)	1		
Women	130 (49.4)	82 (59.9)	1.60	1.05–2.46	0.03
<b>DS index (0-100)</b>					
1st tertile	36 (13.7)	19 (13.9)	1		
2nd tertile	120 (45.6)	56 (40.9)	0.87	0.44–1.63	0.57
3rd tertile	107 (40.7)	62 (45.3)	0.98	0.57–2.06	
<b>Age</b>					
50–59 years	123 (46.8)	69 (50.4)	1		
60–69 years	140 (53.2)	68 (49.6)	0.84	0.55–1.29	0.42
<b>Marital Status</b>					
Married	204 (77.9)	96 (70.1)	1		
Not married	58 (22.1)	41 (29.9)	1.39	0.87–2.24	0.17
<b>Work status affected by COVID-19</b>					
No	213 (81)	115 (83.9)	1		

*\*Minimal adjusted model by sex, age, and DS index; After adjusting the model by sex, age, DS index, and variables with  $p < 0.1$  variables associated with psychological distress were emotional well-being affected by COVID-19 (Not at all/only a little: reference category; To some extent: aOR: 2.42; 95%CI: 1.43–4.12; Rather much/very much: aOR: 5.79; 95%CI: 2.79–12.02) and Comparative perceived CRC risk (About the same: reference category; Higher: aOR: 2.52; 95%CI: 1.28–4.96; Lower: aOR: 0.81; 95%CI: 0.35–1.88); 48 individuals excluded (32 among the FIT positive and 16 among the FIT negative) because of 1 or more missing values in the PSS.*

Psychological Distress Level					
Yes	50 (19)	22 (16.1)	0.74	0.42–1.3	0.30
<b>Personal/nearby COVID-19 diagnosis</b>					
No	152 (58.2)	80 (58.4)	1		
Yes	109 (41.8)	57 (41.6)	1	0.65–1.52	0.99
<b>FIT screening result</b>					
Negative	140 (53.2)	63 (46)	1		
Positive	123 (46.8)	74 (54)	1.34	0.88–2.04	0.17
<b>FIT result meaning</b>					
Definitely no CRC/very unlikely	130 (53.7)	50 (39.4)	1		
Unlikely	83 (34.3)	51 (40.2)	1.70	1.04–2.76	0.04
Likely/certain	29 (12)	26 (20.5)	2.26	1.2–4.23	
<b>Comparative perceived CRC risk</b>					
About the same	196 (78.1)	91 (68.9)	1		0.02
Higher	25 (10)	30 (22.7)	2.44	1.35–4.41	
Lower	30 (12)	11 (8.3)	0.79	0.38–1.64	
<b>Emotional well-being affected by COVID-19</b>					
Not at all/only a little	145 (55.3)	39 (28.7)	1		

*\*Minimal adjusted model by sex, age, and DS index; After adjusting the model by sex, age, DS index, and variables with  $p < 0.1$  variables associated with psychological distress were emotional well-being affected by COVID-19 (Not at all/only a little: reference category; To some extent: aOR: 2.42; 95%CI: 1.43–4.12; Rather much/very much: aOR: 5.79; 95%CI: 2.79–12.02) and Comparative perceived CRC risk (About the same: reference category; Higher: aOR: 2.52; 95%CI: 1.28–4.96; Lower: aOR: 0.81; 95%CI: 0.35–1.88); 48 individuals excluded (32 among the FIT positive and 16 among the FIT negative) because of 1 or more missing values in the PSS.*

Psychological Distress Level					
To some extent	95 (36.3)	66 (48.5)	2.51	1.55–4.05	0.00
Rather much/very much	22 (8.4)	31 (22.8)	4.90	2.53–9.49	
<i>*Minimal adjusted model by sex, age, and DS index; After adjusting the model by sex, age, DS index, and variables with <math>p &lt; 0.1</math> variables associated with psychological distress were emotional well-being affected by COVID-19 (Not at all/only a little: reference category; To some extent: aOR: 2.42; 95%CI: 1.43–4.12; Rather much/very much: aOR: 5.79; 95%CI: 2.79–12.02) and Comparative perceived CRC risk (About the same: reference category; Higher: aOR: 2.52; 95%CI: 1.28–4.96; Lower: aOR: 0.81; 95%CI: 0.35–1.88); 48 individuals excluded (32 among the FIT positive and 16 among the FIT negative) because of 1 or more missing values in the PSS.</i>					

## Discussion

This analysis of the short-term effects of the lockdown during the first wave of the COVID-19 pandemic on a programmatic FIT-based CRC screening showed a temporary decrease in participation but a large decrease in adherence to diagnostic colonoscopy. The mean time to the performance of colonoscopy for individuals with FIT-positive disrupted by the pause of CRC screening rose threefold compared to the mean in the previous year. While no differences in distress levels were found in individuals with a positive FIT result pending colonoscopy compared to individuals with a negative FIT result during the lockdown, greater perceptions of emotional well-being affected by COVID-19 were associated with increased levels of psychological distress in CRC screening participants.

The global decreases of 5% in participation among invitees during the first quarter of 2020 compared to previous years are in line with a recent study conducted in Northern Taiwan, where a slight decrease of 3.5% in the FIT screening uptake rate was observed during the first wave of COVID-19 compared to that in previous years [3]. Participation rates since resuming seem to be recovered. However, the COVID-19 era could bring an opportunity to programs with low participation rates (< 45%) to implement innovations such as social media campaigns to boost cancer screening participation [13, 14]. In this sense, our findings show that participation among individuals who received SMS reminders after resumption of screening was twice as high as in individuals where SMS failed.

A major concern from our study is the decrease observed in colonoscopy adherence rates among individuals invited during the first quarter of 2020 when compared to the previous year. Individuals with a positive FIT result have a high risk of advanced neoplasm; therefore, a decrease in diagnostic colonoscopy adherence can result in worse health outcomes [15, 16]. Fear of contracting COVID-19 in health care settings has been widely reported; specifically, in the context of screening, previous studies have shown that 50% of colonoscopies after a positive FIT result were refused because of fear of contracting COVID-19 during the first wave [3]. We are unable to determine whether the decrease in colonoscopy adherence was due to the endoscopic units (fewer attempts to locate patients) and/or was due to the individuals' fear of being infected by the COVID. The work of ensuring that individuals

understand the importance of the positive FIT result and the reassurance that the colonoscopy procedure will be performed safely is key in conducting a FIT-based CRC screening program.

As expected, the mean time to performance of the colonoscopy among FIT-positive individuals affected by the pause of the program was three times longer than usual. When resuming colonoscopies, we established a prioritization criterion stratified by fecal hemoglobin concentration levels, which is strongly associated with the likelihood of having advanced neoplasm at colonoscopy. To safeguard the capacity of the endoscopy units during the next outbreaks of COVID-19, the program increased the FIT cutoff point to 31 µg Hb/g feces, thus decreasing the number of screening colonoscopies by 25%. A negative consequence to be monitored is the expected loss of 6% of CRC diagnoses and 20% of high-risk adenomas.

Our findings show that in comparison to individuals with a negative FIT result, individuals with a positive FIT result did not report increased levels of psychological distress preceding colonoscopy. Although distress levels may be elevated if individuals do not fully understand the meaning of the screening test results, no differences in distress levels were found in our study. Among all interviewees, the levels of distress were higher in those individuals, whose emotional well-being was greatly interfered with by the COVID-19 pandemic, illustrating the associated fear and the competing health risks during the first wave. Previous studies have shown increased psychological distress levels after a positive FIT result and that levels of distress decreased after a confirmatory diagnostic procedure; therefore, it is imperative to guarantee that the time between procedures is as short as possible [5, 17].

The limitations of the study include potential selection bias. When evaluating psychological distress, we only considered individuals with a scheduled colonoscopy in June-September 2020. A total of 120 individuals did not undergo colonoscopy in our endoscopic units. Of those, approximately 34% underwent colonoscopy at a private center, 25% could not be reached by the endoscopy nurse, and 41% refused their colonoscopy. We cannot rule out that individuals who refused to undergo colonoscopy had a higher level of psychological distress than their counterparts who agreed to receive a colonoscopy. If any, the effect size would be small.

During the first wave of COVID-19, nearly a quarter of our target population was not invited due to the pause of CRC screening (approximately 111,000 individuals). From those, around 45,500 individuals would have completed the FIT at home, of which 5.1 % would have had a FIT-positive screening, and around 3.8% of those will have CRC. This equates to 88 undiagnosed CRC cases due to the screening pause. Additionally, more than 943 people will have advanced adenomas undetected, with a 2.6 to 4.2% [18] annually transition to CRC if not removed. To minimize the long-term impact of the COVID-19 pandemic on CRC screening, strategies should be implemented to reduce the screening backlog while considering endoscopic capacity constraints. A range of strategies are possible, from skipping one screening round for those affected by the pause to implementing catch-up. In the latter case, it would be important to shorten recovery time as much as possible, for instance, by increasing FIT positivity threshold [19–21]. To maximize diagnostic yield with limited endoscopic capacity, we could also consider

prioritizing colonoscopies after a FIT positive result rather than post-polypectomy surveillance colonoscopies due to their greater benefits [22].

The efforts of the COVID-19 and Cancer Global Modelling Consortium (ccgmc.org) to simulate different scenarios of recovery strategies for cancer screening are noteworthy. However, real-world data could be useful to validate the calibrated models in different settings to facilitate decision-makers to choose the best recovery strategy for their screening programs.

## Declarations

### Ethics approval and consent to participate

The Colorectal Cancer Screening Program in Catalonia follows Public Health laws and the Organic Law on Data Protection [23]. The screening program accomplishes the specific protocol based on the existing guidelines [24]. The study of the impact of COVID-19 on psychological distress in CRC screening participants, including the consent procedure, was approved by the Ethics Committees of the University Bellvitge Hospital (approval number PR236/20). All participants provided verbal informed consent, which was noted by the trained interviewer before starting the survey. The study was performed in accordance with Good Clinical Practice and the Declaration of Helsinki.

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### CRedit Authorship Contributions:

Núria Vives (Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Writing—original draft, Writing—review & editing); Gemma Binefa (Conceptualization, Methodology , Writing—review & editing); Carmen Vidal (Conceptualization, Methodology , Writing—review & editing); Núria Milà (Conceptualization, Methodology , Writing—review & editing); Rafael Muñoz (Investigation); Virtudes Guardiola (Investigation); Olga Rial (Investigation); Montse Garcia (Conceptualization, Formal analysis, Methodology, Supervision, Writing—original draft, Writing—review & editing)

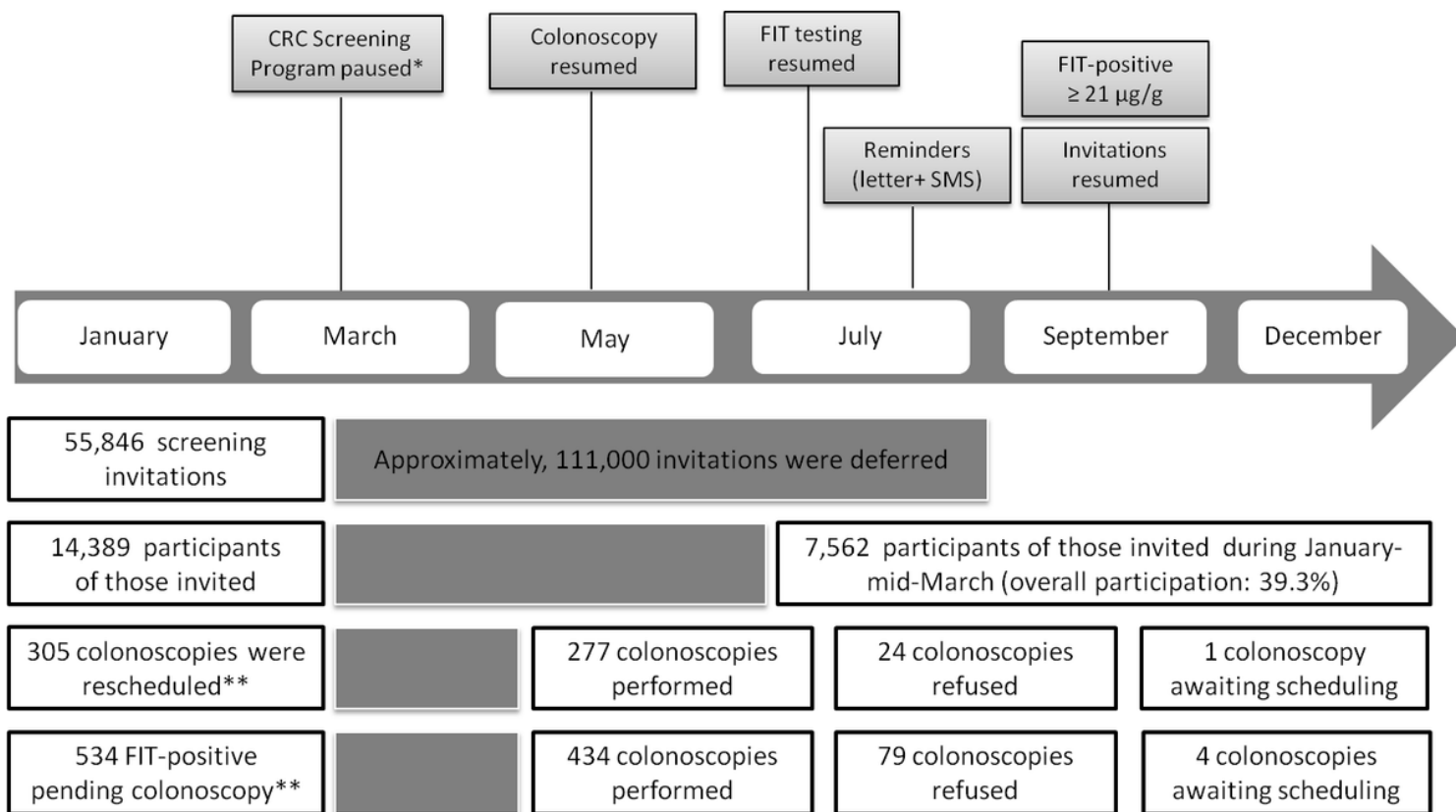
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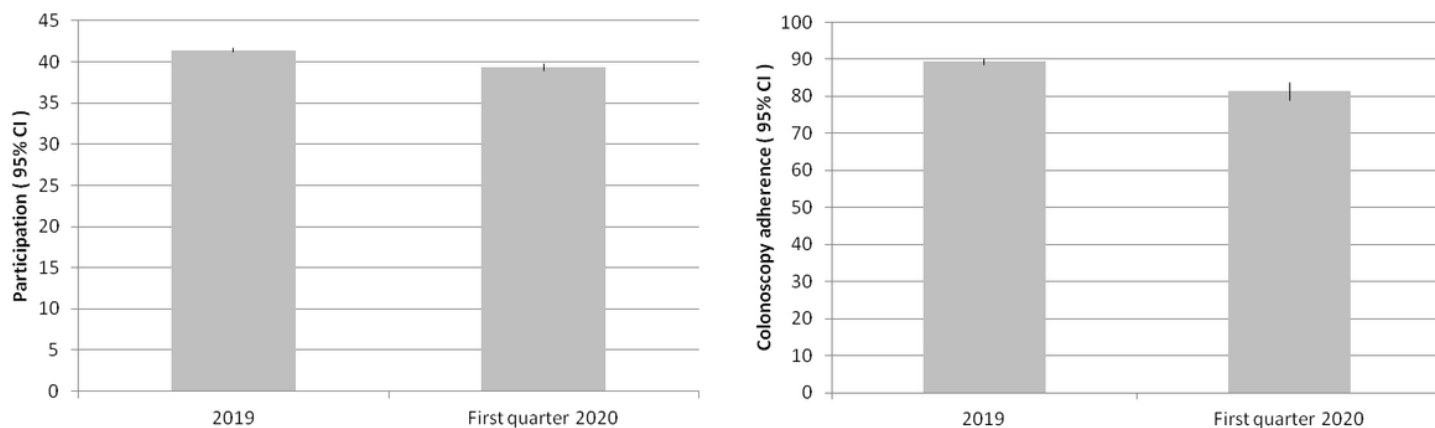
## Figures





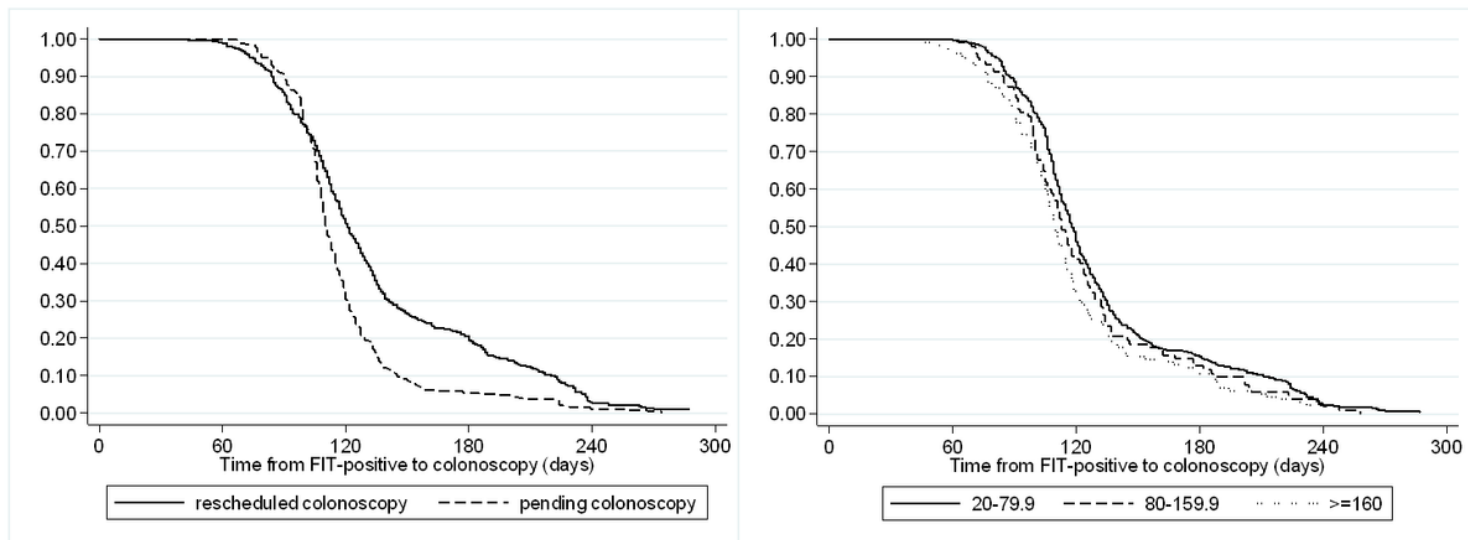
**Figure 1**

Flowchart of CRC screening in the metropolitan area of Barcelona at the onset of the COVID-19 pandemic  
 \*Invitations, FIT distribution and colonoscopies; \*\*N=20 non referred to colonoscopy



**Figure 2**

The impact of the CRC screening program pause on participation and colonoscopy adherence in the metropolitan area of Barcelona



**Figure 3**

Time to the performance of colonoscopy by colonoscopy status and FIT-positive result levels

## Supplementary Files

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