A mobile app to improve adherence to colorectal cancer screening and post polypectomy surveillance guidelines

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Abstract

Background Despite significant advances in prevention and early detection, colorectal cancer (CRC) is a leading cause of cancer mortality worldwide. Inadequate adherence and/or lack of knowledge of guidelines have shown to prevent adequate screening and surveillance recommendations and hinder effective screening programs.

Objective Evaluate the implementation and real-world impact of a mobile app designed to optimize CRC screening and surveillance in accordance to recently updated guidelines.

Methods A mobile app including ergonomic algorithms integrating all pertinent guideline information was created by a group of experts. Data were collected from Catalonia healthcare professionals using the app between February 2023 and May 2024. Users' characteristics, consultation types, and patient data were analyzed to assess app's implementation, usage patterns, and impact on CRC screening and surveillance outcomes.

Results A total of 12,481 consultations were recorded; 3,054 (24.4%) screening and 9,427 (75.6%) post-polypectomy surveillance consultations. The app was increasingly and repeatedly used by professionals during the study period (72% retention rate). Among screening consultations, 2,082 (68.2%) patients were classified as average risk, suggesting the use of fecal occult blood test (FOBT) instead of colonoscopy. Among surveillance consultations, the app advised deferring follow-up colonoscopies and using FOBT instead in 4,748 (50%) patients based on negative index colonoscopy or the presence of low-risk polyps. Standard surveillance with colonoscopy at 3 years was recommended for 3,224 (34.1%) patients and intensive surveillance, requiring a colonoscopy at 1 year, was indicated for 749 (7.9%) patients.

Conclusions A CRC screening and surveillance mobile app showed remarkable acceptance and uptake among healthcare professionals. Proper implementation of updated guidelines aided by the use of the app could significantly reduce the number of unnecessary screening and post-polypectomy surveillance colonoscopies, as well as help identifying high risk patients who require intensive surveillance.

Clinical trial Not applicable.

Keywords Screening, Colon cancer, Prevention programs, Colorectal cancer, Mobile app

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Introduction

Colorectal cancer (CRC) is the second leading cause of cancer death worldwide [1]. In 2023, 42,721 new cases of CRC were diagnosed, and 15,038 patients died in Spain [2]. Despite these concerning numbers of CRC, its incidence and mortality have been decreasing for decades due to advancements in cancer prevention and earlier diagnosis [3, 4].

Multiple screening options are available for the prevention and early diagnosis of CRC. The most commonly used methods are testing for occult blood (FOBT) and endoscopic screening with colonoscopy [5]. Colonoscopy has shown the highest sensitivity and specificity for detecting preneoplastic lesions [5, 6], making it a crucial tool in CRC prevention programs. However, significant overuse and underuse of colonoscopy have been reported in multiple studies [7–10], which can undermine the effectiveness of these programs and lead to inefficient use of resources. Overutilization in low-risk patients often results in unnecessary procedures that do not benefit these individuals and can saturate endoscopy units, taking away capacity from high-risk patients who would benefit the most. This issue is frequently related to limited knowledge and lack of adherence to CRC screening and post-polypectomy surveillance guidelines [11, 12].

In Spain, an organized fecal immunochemical test (FIT)-based screening program targets asymptomatic individuals aged 50–69, while CRC and post-polypectomy surveillance follow the guidelines of national gastrointestinal societies. In Catalonia, the Digestive Disease Catalan Society published an updated 2021 algorithm with the aim of reducing colonoscopy overuse by focusing on high-risk groups, such as patients with personal or familial history of CRC, or the presence of adenomas that require surveillance (see supplemental Fig. 1). To enhance adherence to the new guidelines, a mobile decision support system, Captyva Catalonia, was developed.

The aim of this study was to evaluate the implementation of the mobile app among healthcare professionals and to analyze real-world data on app usage and patient screening outcomes in Catalonia.

Materials and methods

Study design and population

This study is a real-world evidence study that analyzed secondary data generated from the use of the Captyva mobile app. Data were collected from Catalonia healthcare professionals using the app between February 2023 and May 2024. The analysis focused on evaluating the implementation of the app and assessing its impact on CRC screening practice. An independent institutional review board (IRB) approved this study, and the written informed consent was waived by the IRB owing to the study's retrospective nature.

Captyva mobile app

The Captyva mobile app was initially developed in Argentina in 2019 with support from the Endoscopic Society of Buenos Aires (ENDIBA) and the National Institute of Cancer (INC), demonstrating significant improvements in the uptake of CRC screening and surveillance guidelines among physicians [11]. These results led the Digestive Society of Catalonia to customize the platform for regional use.

The adaptation involved forming a board of local experts, including specialized nurses and gastroenterologists, who reviewed and extracted relevant information from the updated Catalan guidelines. This information was used to develop screening and surveillance algorithms tailored to the new guidelines. Ergonomic algorithms were designed to integrate all pertinent guideline information, ensuring effective decision-making in CRC screening and post-polypectomy surveillance. The development of Captyva Catalonia involved close collaboration with a team of programmers and experts in user experience and usability, who tested the app's functionality and accuracy alongside the expert board.

The implementation of the Captyva app was not linked to any financial reimbursements for healthcare professionals. Its use was entirely voluntary to improve adherence to CRC screening and surveillance guidelines. All patient information entered into the app remained anonymous, and no personally identifiable data were collected or stored. The app functioned as a real-time decision-making tool without retaining any patient records, ensuring full compliance with data protection and privacy regulations.

The application uses decision-making algorithms which aid professionals in giving appropriate recommendations. In the screening function, the app enables to stratify patients according to their individual CRC risk and determine the appropriate timing and type of study for initiating screening tests (colonoscopy or FIT-based population screening program). In surveillance mode, the app offers guidance on when to schedule the next study, considering factors such as patient's medical history, previous colonoscopy, and pathology results, in line with Catalonia guidelines recommendations (Fig. 1).

Promotion and awareness of the app

Healthcare professionals were informed about the app through multiple channels, including professional societies' newsletters, workshops, and educational sessions conducted by the Catalan Society of Digestology. The app was also introduced during national and regional gastroenterology conferences and through direct communication within hospital and primary care networks. Additionally, educational materials, including digitalized instructional videos illustrating the use of the app, were
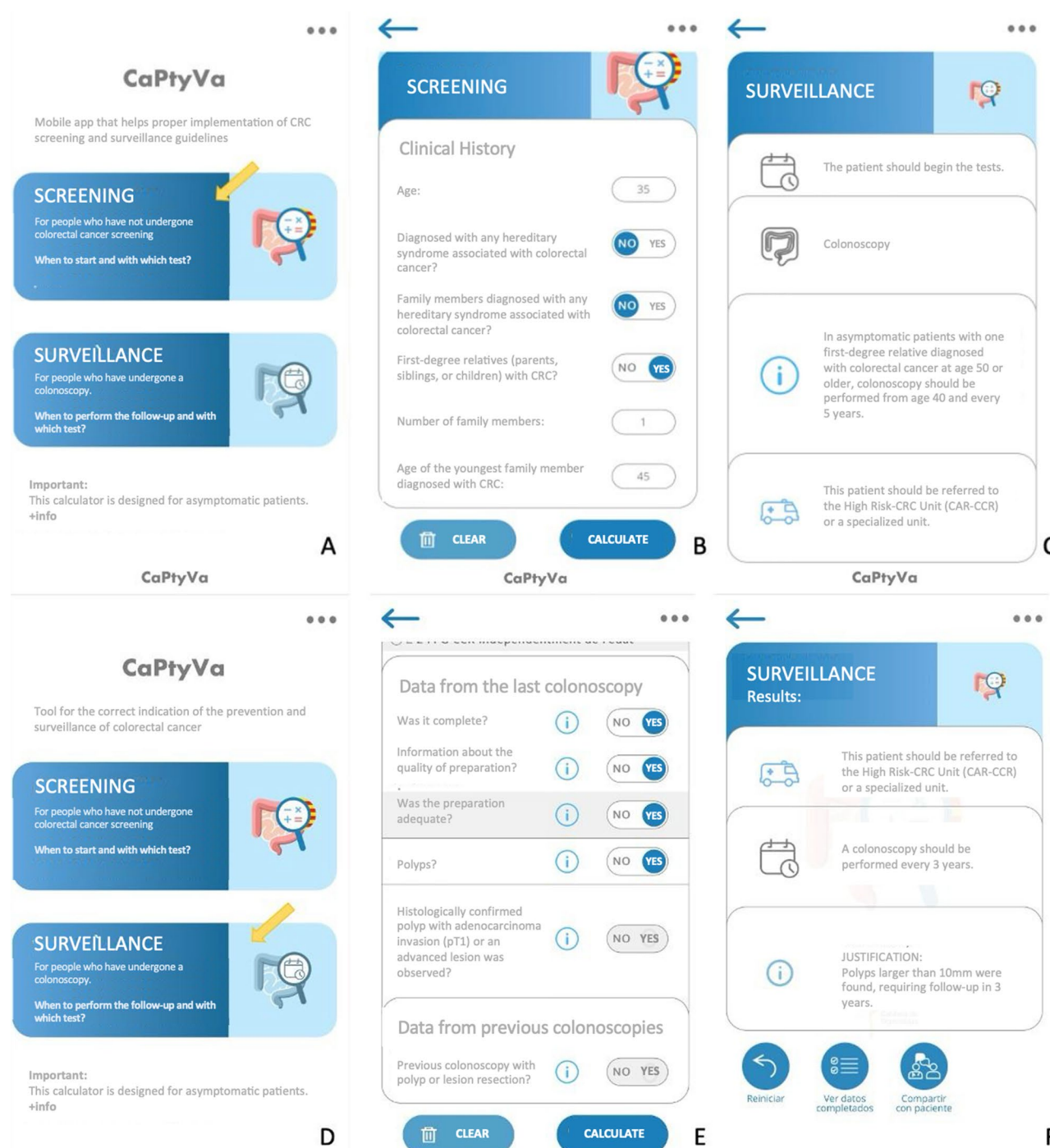
Fig. 1 a, **b,c** App screenshots showing the main menu, the screening function data loader, and the screening query results. **d**,**e**,**f** the main menu, the surveillance functions data loader, and the surveillance function query results

disseminated through the Catalan Society of Digestology to further support training and implementation.

Variables and outcomes

The following variables were recorded in the app: characteristics of users (age, specialty and work setting), number and type (i.e., screening or surveillance mode) of

consultation during the study period, data from patients such as age, personal/familial history of CRC and/or Lynch Syndrome and/or Familial adenomatous polyposis (FAP) syndrome, and/or necessity of consultation to a high-risk patient specialized unit.

For screening initiation, patients were stratified into average- and high-risk categories based on their age,

personal or familial history of CRC, Lynch syndrome, and/or FAP. For post-polypectomy surveillance, factors such as familial history of CRC, characteristics of polyps found during the index colonoscopy, histopathological results of such polyps, and quality of index colonoscopy were all considered to determine surveillance interval recommendations.

Colonoscopy quality metrics were also assessed (cecal intubation, bowel preparation, polyps' retrieval rate). High-quality colonoscopy was defined as a complete colonoscopy (cecal intubation) with satisfactory colonic preparation (Boston score > 2 in each colonic segment).

Polyps' characteristics were retrieved from the app consultations and subsequently analyzed. Advanced lesions included adenomas or serrated lesions ≥10 mm or lesions with high-grade dysplasia or with a villous component.

The main outcome was to examine the implementation of a mobile app containing updated CRC screening and post-polypectomy surveillance guidelines among healthcare professionals. The secondary outcome was to analyze the real-world data obtained with the use of the app regarding characteristics of users, type of consultations, colonoscopy findings and characteristics and potential colonoscopy saving.

The retention rate of the mobile app, calculated by dividing the number of users with repeated use by the total number of users and then multiplying by 100, was also measured to determine usability and adoption of the app.

Statistical analysis

Descriptive statistics were used to summarize the data. For continuous variables, the mean, minimum, and maximum values were calculated. For categorical variables, frequencies (n) and percentages were computed. The data were stratified by risk groups (i.e., low- and high-risk), and descriptive statistics were provided for each group.

Results

During the study period, 12,481 consultations were recorded; 3,054 (24.4%) were screening consultations, and 9,427 (75.6%) were post-polypectomy surveillance consultations. The cumulative number of app consultations is shown in Fig. 2. We found a high retention rate of 72% after downloading the app, reflecting strong usability and adherence.

Characteristics of users

The main characteristics of the users of the Captyva Catalonia app are detailed in Table 1. The majority (65.5%) were females between the ages of 20 and 60. In terms of healthcare provider types, 88.6% were physicians and 4.7% were nurses. Within the physician group, 20.1% specialized in gastroenterology, followed by 7.3% in primary health care, and 55% of the users did not specify the specialty. Most professionals have been practicing their specialty for more than 20 years and the vast majority worked in public settings (87.3%).

CRC screening consultations

The mean age of patients entered for consultation was 50.6 (23–85) years; 128 (4.2%) had a personal history of

Number of consultations per day and total consultations
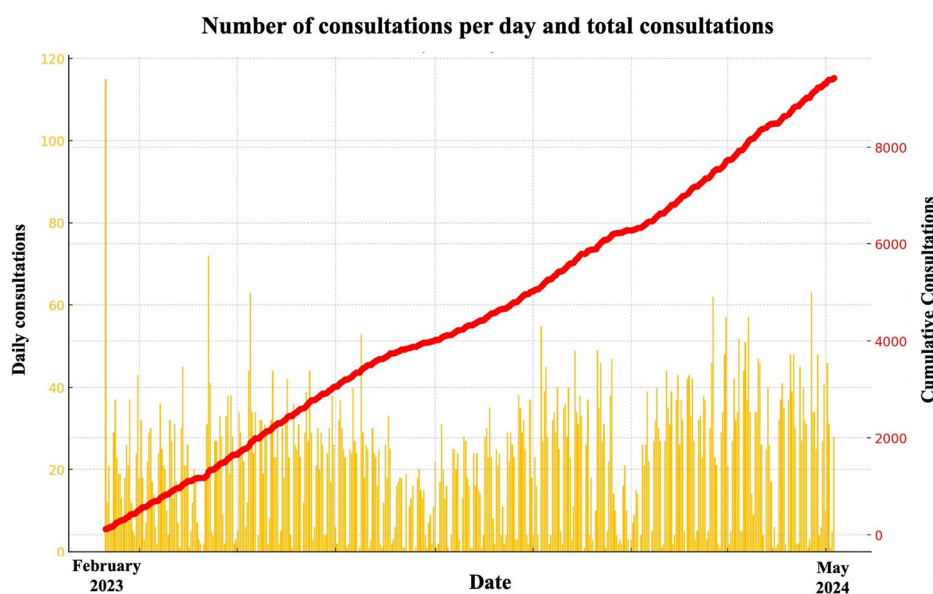
Fig. 2 Use of the app by healthcare professionals over the analyzed period. (Screening and surveillance post-polypectomy consultations)

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Table 1 Characteristics of the users

	Users
	n = 3,704
Gender	
• Female	2,427 (65.5)
• Male	1,247 (33.6)
• Binary	22 (0.6)
• No Specify	8 (0.2)
Age	
• 20–30 y	680 (18.3)
• 31–40 y	880 (23.7)
• 41–50 y	869 (23.4)
• 51–60 y	864 (23.3)
• >61 y	411 (11.0)
Type of healthcare providers	
• Physicians	3,284 (88.6)
• Nurses	177 (4.7)
• Not specified	242 (6.5)
Physician specialty	
• Gastroenterology	747 (20.1)
• Primary Health Care	272 (7.3)
• Internal Medicine	135 (3.6)
• General Surgery	91 (2.4)
• Others/Not specified	2039 (55)
Time practicing the specialty	
• < 5 y	924 (24.9)
• 5–10 y	696 (18.7)
• 11–20 y	719 (19.4)
• > 20 y	1,365 (36.8)
Current practice setting	
• Private	239 (6.4)
• Public	3,235 (87.3)
• Public and Private	230 (6.2)

Table 2 Characteristics of the screening and surveillance consultations

	Screening Colonoscopy
	n = 3,054
Mean age, *(range) years*	50.6 (23–85)
Family history of first-degree CRC, *n (%)*	1,858 (60)
< 50 y, n (%)	400 (13)
> 50 y, n (%)	1,458 (47)
More than two relatives with CRC, *n (%)*	422 (13)
Personal history of Lynch/FAP syndrome, *n (%)*	128 (4.2)
Family history of Lynch/FAP syndrome, *n (%)*	436 (14)
High risk patients, *n (%)*	972 (31.8)
Patients overdue for screening initiation	324(10,6)
Mean number of years overdue for screening, *years*	17,5
	Surveillance Colonoscopy Consultation
	n = 9,428
Family history of CRC, *n (%)*	2,582 (27.4)
< 50 years old	318 (12.3)
> 50 years old	535 (20.7)
Second-degree relative with CRC, n (%)	1,729 (67)
Polyps' characteristics in index colonoscopy	
- Sum of detected Polyps', *n*	26,581
- Polyps mean size, *mm (range)*	8,4 (1–70)
Colonoscopy with adenomas:	
- At least 1 adenoma, n (%)	8,314 (88)
- > 5 Adenomas, n (%)	808 (8)
- Villous component / High grade dysplasia, n (%)	1,314 (14)
Colonoscopy with Serrated lesions:	
- At least 1 Serrated lesion, n (%)	5,248 (55)
- Serrated lesion with Dysplasia, n (%)	391 (6.1)
Advanced Lesions	
- Colonoscopy with at least 1 Advanced Lesion[1], n (%)	3,076 (32)
Adenocarcinoma detection / irresectable lesion, *n (%)*	197 (2)
Colonoscopies with complete polyp resection	7,230 (94.5)
Piecemeal resection technique, *n (%)*	131(1.8)

FAP: Familial Adenomatous Polyposis, CRC: Colorectal Cancer

[1]Advanced Lesion: Advanced adenoma (≥ 10 mm, villous component or high-grade dysplasia) // Advanced serrated lesions (≥ 10 mm or dysplasia)

Lynch/FAP syndrome, 400 (13%) had a first-degree relative with CRC before the age of 50, and 422 (13%) had two or more relatives with CRC at any age. According to the risk stratification performed by the Captyva app's algorithms, 68.2% of patients had average CRC risk and consequently were eligible for FOBT within the organized screening program; 31.8% of patients were classified as high-risk and thereby a colonoscopy was recommended as the first screening method. In all consultations where patients were categorized as high-risk, a referral to a specialized unit was suggested.

A total of 324 (10.6%) individuals were overdue to begin their CRC screening with a mean delayed time of 17.5 (1–66) years (Table 2).

CRC post-polypectomy surveillance consultations
The mean age of patients was 62.7 (20–93) years and 2,582 (27.4%) had a family history of CRC. A high-quality index colonoscopy was found in 8,813 (93.4%) patients (Fig. 3).

In the index colonoscopy, the characteristics of polyps were as follows: a total of 26,581 polyps were detected with a mean size of 8.4 mm (range 1–70 mm). Among these, 88% of the colonoscopies revealed at least one adenoma, with 8% of patients having more than five adenomas. Villous component or high-grade dysplasia was present in 14% of the consultations. Serrated lesions were identified in 55% of the colonoscopies, with 6.1% of the consultations presenting dysplasia. Overall, advanced lesions were found in 32% of the cases. Adenocarcinoma or irresectable lesions were detected in 2% of the colonoscopies. The polyp retrieval rate was high at 94.5%, with piecemeal resection performed in 1.8% of the cases.

Quality of Colonoscopies
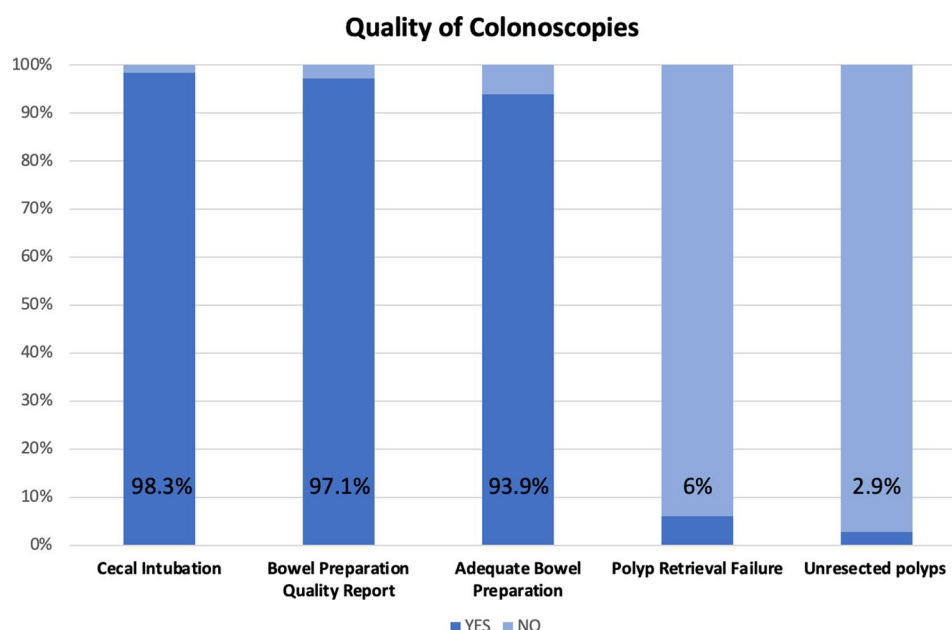
Fig. 3 Quality of colonoscopies

Post-polypectomy surveillance interval recommendation

After analyzing the 9,427 (75.6%) surveillance consultations, 4,748 patients (50%) did not require further surveillance due to their low-risk status (based on the app's risk stratification), and 438 patients (4.6%) were exempt from further surveillance due to age > 80 years. Standard surveillance, involving a colonoscopy at 3 years, was recommended for 3,224 patients (34.1%), while intensive surveillance, requiring a colonoscopy at 1 year, was indicated for 749 patients (7.9%). Additionally, 3.4% of consultations should repeat the colonoscopy for quality reasons.
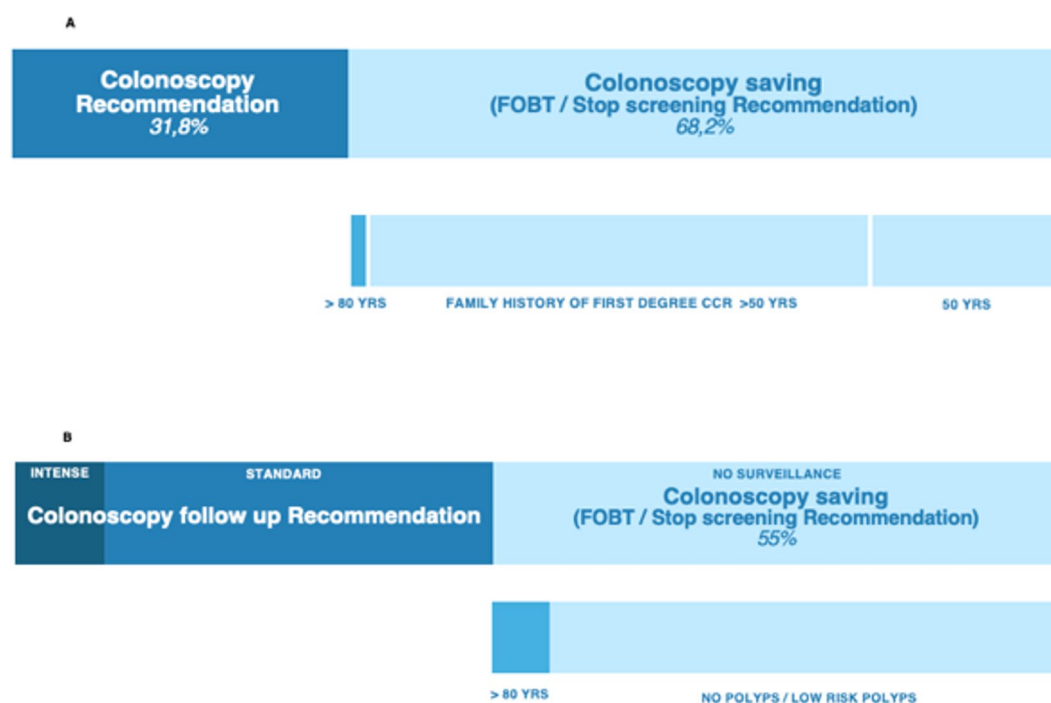
Potential colonoscopy savings

Based on the updated guidelines, the Captyva app recommended avoiding screening colonoscopies for 2,082 patient consultations (68.2%) classified as average risk, suggesting instead the use of FOBT in the setting of the population-based screening program. Additionally, 53 consultations (1.7%) were advised against screening colonoscopy due to the patient's advanced age (> 80 years old), with no further screening recommended (Fig. 4A). For post-polypectomy surveillance, the app advised deferring follow-up colonoscopies and using FOBT instead in 4,748 consultations (50%) based on negative index colonoscopy or the presence of low-risk polyps. The app also recommended against additional surveillance in 438 consultations (4.6%) due to advanced age (Fig. 4B).

Discussion

The main outcome of our study was to evaluate the implementation of a mobile app containing updated CRC screening and surveillance guidelines among healthcare professionals. We found that: (a) the app was used by a high number of healthcare professionals and had a high retention rate; (b) the app was mostly used for post-polypectomy surveillance purposes; (c) in 68.2% and 54.6% of patients the app recommended to avoid colonoscopy for CRC screening and surveillance, respectively, based on their risk stratification; and (d) a high-quality index colonoscopy was found in the vast majority of patients.

Although CRC represents a major global health burden, it can be effectively prevented by timely screening and surveillance studies. Understanding knowledge gaps and barriers for screening programs implementations is critical for improving compliance with guidelines. A recent study analyzed the level of CRC screening knowledge in a nationwide US cohort of physicians and showed that only 22% and 37% correctly answered all screening and surveillance items, respectively [14]. Another study reported deficiencies in adherence to surveillance guidelines among US gastroenterologists, with 40% of them failing to correctly answer clinical hypothetical scenarios. Remarkably, 12% of gastroenterologists admitted difficulty recalling guidelines [15]. Mobile technologies had an important and rapidly growing role in patient care and could help mitigating these deficiencies [16]. In fact, almost 90% of participants of a previous study stated that they would use a smartphone-based app for assistance in giving appropriate guideline-concordant recommendations for CRC screening and surveillance [14]. In line

Fig. 4 Potential colonoscopy savings among Captyva screening (**A**) and surveillance consultations (**B**)

with these findings, our study demonstrated that a large number of healthcare professionals used the app, and its retention rate was indeed high (over 70%).

Despite the well-established benefits of CRC screening interventions, participation rates in many European regions remain below recommended levels. Our study revealed that approximately 10% of patients had overdue screening colonoscopies, with an average delay of 17.5 years. Similarly, data from Spain indicate that only about 30% of individuals aged 50 to 69 have undergone CRC screening, which is significantly lower than the European Union's recommended minimum participation rate of 65% [17]. Moreover, a study analyzing the evolution of FIT uptake in Spain from 2017 to 2020 reported a participation rate of 38.01%, which remains below the levels considered acceptable [18].

Moreover, during the COVID-19 global pandemic, CRC screening rates declined by 64% which could lead to an increase in CRC morbidity and mortality [19]. Therefore, it is a critical time to develop novel strategies to improve screening rates. The Captyva mobile app allows for accurate risk stratification based on patients' characteristics, personal and familial history, which helps professionals provide appropriate recommendations on when and how initiate CRC screening.

Although considerable attention has been given to the underuse of CRC screening studies [7, 8], the potential overuse of screening and surveillance colonoscopy should not be underestimated. Surveillance examinations account for up to 40% of all colonoscopies, and incorrect surveillance accounts for one-third of the workload in CRC screening programs in the USA [20, 21]. This is particularly relevant in healthcare systems with limited availability to such study as the region of Catalonia. Moreover, overuse of colonoscopy not only strains healthcare resources but also exposes patients to unnecessary risks associated with the procedure. Colonoscopy, while generally safe, carries potential complications such as bowel perforation and major bleeding. Serious complications occur in approximately 25 out of every 10,000 colonoscopies performed [22]. Moreover, less severe but more common adverse effects include discomfort from bowel preparation, minor bleeding, and lost days of work [23]. Therefore, ensuring appropriate use of colonoscopy is crucial to minimize preventable harms to patients. A previous study analyzed a national database of Medicare patients in the US undergoing screening colonoscopy and found that 24% of patients with a negative colonoscopy repeated the study in fewer than 7-years without any clear rational indication [24]. A US survey study conducted by the National Cancer Institute among 349 gastroenterologists also revealed that up to 62% of specialists performed colonoscopies too frequently [25]. A screening population-based intervention should clearly consider not only prevalence of the disease, but also available economic and medical resources. The absence of robust studies establishing cost-effectiveness of screening interventions has been a key factor delaying the initiation of CRC screening programs throughout the country [26]. In our study in Catalonia, the correct implementation of

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the updated guidelines using the mobile app has shown that a large percentage of patients could avoid colonoscopy as screening/surveillance study (69% savings in screening colonoscopies and 54.6% savings in post-polypectomy surveillance colonoscopies). Therefore, the use of this mobile app would serve as an attractive strategy to increase knowledge and improve adherence to guidelines, and thereby lead to a more efficient use of healthcare resources. It is important to recognize that this analysis is based on app usage data, and actual adherence to these guidelines by healthcare providers may vary.

A key component of every screening program is also the quality of colonoscopy. A high-quality study reduces CRC incidence, helps determining the optimal surveillance interval, and ultimately improves affordability of healthcare resources [27, 28]. Bonnington et al. found that a high-quality initial colonoscopy followed by subsequent surveillance reduced the risk of missed and/or metachronous CRC, with the greatest benefit related to the initial colonoscopy. Furthermore, patients with a single adenoma ≥ 10 mm had a low likelihood (6.1%) of having additional adenomas found on surveillance follow-up, leading to the possibility of avoiding surveillance colonoscopies in a select group of patients [29]. In our study, a high-quality index colonoscopy was identified in the vast majority of patients (93.4%). A reliable index colonoscopy could potentially lead to more permissive surveillance recommendations with less use of colonoscopies.

This study has limitations that should be acknowledged. Mainly, this was a retrospective analysis of self-reported data from users of the mobile app, which can be affected by selection and recall bias. In addition, app users were healthcare professionals from Catalonia, and thereby the results may not be representative of other regions or countries.

Conclusions
The Captyva mobile app containing the updated CRC screening and surveillance guidelines from the Catalan Society of Digestology has good acceptance and uptake from healthcare professionals. Adequate implementation of the updated guidelines could significantly reduce the number of unnecessary screening and surveillance colonoscopies in Catalonia.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12876-025-03796-0.

Supplementary Material 1

Declarations

Ethics approval and consent to participate
Waived due to retrospective nature and deidentified information.

Consent for publication
No.

Competing interests
The authors declare no competing interests.

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