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Factors of willingness to join colorectal cancer screening among Chinese younger adults aged 40–49: a population-based study

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Abstract

Colorectal cancer is a leading cause of cancer-related morbidity and mortality worldwide, with a concerning rise in early-onset colorectal cancer among individuals under 50. This study aims to assess the perceptions and acceptance of colorectal cancer screening among adults aged 40–49 in Hong Kong to inform targeted strategies for addressing the increasing burden of early-onset colorectal cancer in this population. A cross-sectional study was conducted in Hong Kong from April to June 2024, targeting residents aged 40 to 49. An anonymous survey based on the Health Belief Model assessed participants' perceptions and attitudes toward early-onset colorectal cancer screening. Multivariable logistic regression was used to identify factors associated with their willingness to participate in screening. Of 1,029 respondents, 785 expressed a willingness to undergo colorectal cancer screening. Multivariable analysis showed that being married, employed full-time, and having a history of chronic disease were positively associated with a higher willingness to participate. Stronger perceived benefits of colonoscopy, higher self-efficacy, and stronger cues to action also predicted greater willingness. Conversely, poorer self-perceived health, and higher physical and psychological barriers to fecal immunochemical tests and colonoscopies were linked to lower willingness. Adults aged 40–49 in Hong Kong showed a high willingness to participate in colorectal cancer screening, and this willingness was associated with stronger perceived benefits of screening, higher self-efficacy, and stronger cues to action. These findings may inform the future of targeted interventions to enhance screening uptake of colorectal cancer in younger adults.

Keywords: Colorectal cancer, Screening, Health belief model, Younger adults

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Introduction

Colorectal cancer (CRC) is one of the most common causes of cancer-related morbidity and mortality worldwide, accounting for approximately 10% of all new cancer cases, and causing over 900,000 deaths annually, with an estimated 1.9 million new cases diagnosed globally in 2022[1]. While the majority of CRC cases (56.6%) and deaths (46.6%) occur among individuals over 70 years old, there has been a concerning rise in CRC incidence and mortality among younger adults (under 50 years) since the early 1990s[2,3], particularly in high-income countries[4]. This phenomenon, termed early-onset colorectal cancer (EOCRC) has emerged as a distinct clinical entity with unique challenges. In the United States, for instance, the incidence of CRC in adults aged 40–49 years increased by almost 15% from 2000–2002 to 2014–2016[5]. Recent global modeling based on Global Burden of Disease Study (GBD) 2021 data projects that the incidence of EOCRC is expected to continue rising steadily through 2040[6]. Compared to later-onset CRC (LOCRC), EOCRC is more likely to be diagnosed at advanced stages (stage III–IV)[7], and exhibits more aggressive pathology[8]. These trends have also contributed to a rapid rise in CRC-related premature deaths. The growing burden of EOCRC underscores the need for effective prevention and early detection strategies.

Screening plays a pivotal role in reducing CRC incidence and mortality, and secondary prevention through stool-based tests and colonoscopy has proven highly effective[9]. Historically, clinical guidelines recommended regular screening for average-risk individuals aged 50 or older[10,11]. However, in response to the rising incidence of EOCRC, the American Cancer Society (ACS) updated its recommendations in 2018 to begin screening at age 45, supported by modeling analyses identifying this as an efficient and effective strategy[12]. Subsequently, in 2021, the United States Preventive Services Task Force (USPSTF) officially lowered the recommended screening age to 45[5], citing evidence that earlier screening could significantly reduce CRC incidence and mortality in younger populations[13]. These changes reflect growing recognition of the need to address EOCRC, but whether similar recommendations should be adapted in other regions, including Hong Kong, remains uncertain.

In Hong Kong, CRC remains a major public health challenge and one of the leading causes of cancer-related deaths. In 2021, CRC

caused 2,298 deaths, a 20.7% increase from 2011[14]. To combat this burden, the Department of Health (DH) implemented the Colorectal Cancer Screening Programme (CRCSP), subsidizing biennial screening for asymptomatic residents aged 50–75 in the private sector. While the program has achieved notable success, younger adults aged 40–49 remain underserved. Notably, individuals aged 45–49 accounted for as many as 48.4% (125,604/259,700) of EOCRC cases in the United States during 2001–2019, highlighting the need for targeted strategies to address EOCRC in this population[15].

Nevertheless, it is concerning that the acceptance of CRC screening among younger age cohorts remains uncertain or may be suboptimal. For example, in the United States, a nationwide cohort study of 10,221,114 privately insured adults aged 45–49 years reported a CRC screening uptake increase to 1.51% after the 2021 USPSTF recommendation[16]. Similarly, although a study using the US Risk Factor Surveillance System reported a higher participation rate among the younger population, it was deemed unsatisfactory, with a participation rate of 34.5%[17]. This evidence not only underscores the hesitancy among younger demographics to engage in CRC screening, but also indicates the potential risk of unsuccessful early screening and treatment efficacy[18], as delayed diagnoses may prevent them from benefiting from preventive and curative interventions or treatments[18], despite the advances in cancer treatment in the past few decades[19]. Therefore, gaining an in-depth understanding of younger populations' willingness of CRC screening is the key to implementing interventions aimed at alleviating the burden of EOCRC.

Previous research indicated that health beliefs and characteristics play an important role in healthy behavior, such as CRC screening[20]. With this in mind, the Health Belief Model (HBM) has been used extensively to gain insight into the role of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy and cues to action, on health- related behaviors among individuals from various contexts[21,22]. The linkage between the HBM construct and the CRC screening willingness has been well-identified. For instance, the cues to action and the perceived benefit have been shown to be associated with a greater willingness to undergo CRC screening[23], while barriers, such as feelings of embarrassment, limit compliance among potential participants[24,25].

However, despite the growing evidence of EOCRC's aggressive nature and its increasing incidence, no local studies have examined younger adults' knowledge of, or attitudes toward, CRC screening in Hong Kong. Understanding public perceptions is crucial to shaping effective policies, as the success of any preventive program depends on public acceptance and participation. Without evidence on whether individuals aged 40–49 perceive early CRC screening as necessary or acceptable, advancing the screening age may face significant barriers, including resistance or limited uptake. This study aims to fill this knowledge gap by assessing the perceptions and willingness of CRC screening among adults aged 40–49 in Hong Kong. The findings will inform the development of evidence-based policies and strategies to promote the screening of EOCRC.

Materials and methods

Study design

A population-based territory-wide survey was conducted in Hong Kong between April and June 2024 among Hong Kong residents who were aged 40-49 years. Data were collected using Qualtrics, an online survey platform.

Study population

In this study, eligible participants were Hong Kong residents who: (1) were aged 40-49 years; (2) could communicate in Chinese (Cantonese or Putonghua), or English; (3) resided in Hong Kong at the time of the study; and (4) had not received CRC screening previously. To determine the appropriate sample size for the cross-sectional study, we assumed a 70.7% acceptance rate (P) based on data from a previous study[26]. A 95% confidence level and a 3% margin of error (E) were selected. Using the formula: $N = [Z^2 \times P \times (1-P)] / E^2$, a sample size of approximately 887 participants was determined. Considering a dropout rate of 10%, the adjusted total sample size for this study was 986 participants. All eligible participants provided digital informed consent electronically at the beginning of the survey.

Questionnaire

To explore the perspectives of Hong Kong residents aged 40 to 49 regarding the promotion of EOCRC screening and their anticipated participation, the questionnaire used in this study was developed and adapted from a previously published survey instrument by an expert panel comprising epidemiologists, family medicine specialists, and implementation science researchers[20]. The questionnaire featured four sections.

The first section gathered sociodemographic information, including age, gender, educational level and income, marital status, employment status, smoking and alcohol use, chronic disease history, and medical examination habits. Participants' knowledge levels regarding symptoms, risk factors, and screening information of CRC were also collected. For knowledge levels, each response option was coded dichotomously, with a value of 1 for yes and 0 for no. The responses were then summed to calculate a total score for each type of knowledge levels. These scores were further categorized into two levels based on the median of the total scores to reflect the high/low level of knowledge.

The second section measured the six HBM dimensions using a 5-point Likert scale, with responses scored ordinally from 4 (most positive) to 0 (most negative). The domains assessed included perceived susceptibility (two items), reflecting participants' beliefs about their risk of developing CRC, perceived severity (four items) regarding the impact of CRC on personal and family life, perceived benefits (four items) focused on the effectiveness and reliability of screening; and perceived barriers (eight items), divided into health and psychological concerns (e.g., pain and embarrassment), and access barriers (e.g., cost and time) for fecal immunochemical test (FIT) and colonoscopy. Cues to action (nine items) explored factors that could influence participants' decisions to engage in screening, while self-efficacy (two items) measured confidence in performing the desired behaviors. Similarly, the total score for each dimension was calculated by the sum score from each item within the domain. These scores were also further categorized into two levels based on the median of the total scores to reflect the high/low level of perception. Cronbach's alpha of the HBM construct ranged from 0.48 to 0.89 across domains.

The third section evaluated participants' willingness to attend CRC screening under government subsidies of HKD 280. Participants' willingness was measured using a 5-point Likert scale, where responses ranged from 1 (not willing at all) to 5 (very willing). For data analysis, the responses were further categorized into two groups to simplify interpretation and facilitate statistical comparisons. Participants who rated their willingness as 4 (willing) or 5 (very willing) were classified into the 'willing' group, reflecting a positive intention toward screening participation. In contrast, those who rated their willingness as 1 (not willing at all), 2 (somewhat unwilling), or 3 (neutral) were categorized into the 'not willing' group. This dichotomization enabled the

analysis of predictors and differences in willingness across sociodemographic factors and HBM dimensions, while also providing clarity in interpreting associations between willingness and other variables.

Data collection and quality control

A soft launch of the survey was conducted to collect 50 responses, representing 5% of the anticipated sample size. The median survey completion time was approximately 6–7 min. During the data cleaning process, a 'speeding check' was applied, terminating responses completed in less than half the median time, as these were deemed inattentive. Convenience sampling was adopted to reach potential participants, and they were recruited through Qualtrics' questionnaire dashboard and online advertisement. Following the soft launch, the finalized online questionnaire was distributed to 7,576 individuals. After applying the eligibility criteria, 1,049 valid responses were retained for analysis, resulting in a compliance rate of 13.6%. To further ensure data integrity, age verification was conducted through a double-question mechanism. Responses from individuals outside the target age range of 40–49 were excluded, leading to the removal of 18 cases. Additionally, two responses with missing data on willingness to participate in screening were excluded during the analysis phase.

Statistical analysis

Categorical variables were summarized as frequencies and percentages. Descriptive statistics were used to provide an overview of the demographic and HBM-related characteristics of the participants. Chi-square tests were employed to compare these characteristics between participants with different levels of willingness to undergo CRC screening. Univariable and multivariable logistic regressions were conducted to evaluate predictors of participation willingness toward CRC screening. Crude and adjusted odds ratios (CORs & AORs) were presented with 95% confidence interval (CI) and a p value lower than 0.05 was considered statistically significant. To verify the robustness of the results, we treated the data on the HBM dimension as continuous variables, and performed a multivariable logistic regression model as a sensitivity analysis. A mediation model was constructed to examine the mediating roles of self-efficacy and cues to action in the relationship between perceived benefits and willingness to undergo CRC screening. Both the mediator and outcome models were adjusted for covariates including sociodemographic factors (gender, age range, employment status, monthly household income, education level, and marital status), health status factors (self-perceived health status and chronic disease), and lifestyle factors (smoking habit and alcohol history). Mediation effects were estimated using a quasi-Bayesian Monte Carlo simulation approach with 1,000 simulations. The average causal mediation effect (ACME), average direct effect (ADE), total effect, and proportion mediated were reported with corresponding 95% CI. Data cleaning and analysis were conducted using IBM SPSS Statistics 29.0.1.0, and R 4.3.0.

Results

Sociodemographic characteristics

Of the 1,029 responses included in the analysis, 785 individuals (76.3%) expressed willingness to participate in CRC screening (Table 1). Over half of the respondents were female (52.5%), a majority were married (66.9%), and employed full-time (89.4%). Nearly half reported a median monthly household income between HKD 20,000 and 39,999 (45.2%). Regarding health status, 56.1% rated their health as good, while 43.9% considered it poor, with 53.6% reporting a history of chronic disease. Smoking was reported by 35.6% of participants, while 68.6% had a history of alcohol consumption. Statistically significant differences were observed between those willing and unwilling to participate in CRC screening with respect to marital status, employment status, monthly household income, self-perceived health status, chronic disease history, alcohol consumption, and education level (all $p < 0.001$).

Despite 60.1% of respondents holding a tertiary degree or higher, awareness of CRC-related knowledge was generally limited. Specifically, knowledge about CRC symptoms (55.6%), relevant risk factors (53.3%), and CRC screening methods (66.2%) remained suboptimal. A substantial proportion of respondents reported low perceived benefits of FIT (74.6%) and colonoscopy (66.0%). However, perceived physical and psychological barriers to these screening methods were relatively low (FIT: 61.4%; colonoscopy: 56.5%), as were access-related barriers (FIT: 62.3%; colonoscopy: 56.9%).

Unwilling participants were more likely to be unmarried or divorced (45.9% vs 29.2%, $p < 0.001$), employed part-time or unemployed (16.8% vs 8.7%, $p < 0.001$), have lower household incomes (HKD 0–19,999: 32.0% vs 20.6%; HKD 20,000–39,999: 51.2% vs 43.3%, $p < 0.001$). They also tended to have lower educational attainment (secondary or below: 34.0% vs 20.3%, $p < 0.001$), poor self-perceived health status (55.7% vs 40.3%, $p < 0.001$), and lower levels of knowledge about CRC screening (73.4% vs 63.9%, $p = 0.008$). In terms of health and lifestyle, unwilling participants were more likely to report no history of chronic diseases (56.6% vs 43.2%, $p < 0.001$), and no alcohol consumption (41.4% vs 28.3%, $p < 0.001$). Furthermore, unwillingness was associated with lower levels of key health beliefs, including perceived susceptibility (59.4% vs 49.3%, $p = 0.007$), perceived benefits of FIT (86.5% vs 71.0%, $p < 0.001$) and colonoscopy (83.7% vs 60.5%, $p < 0.001$), self-efficacy (90.2% vs 65.1%, $p < 0.001$), cues to action (81.6% vs 47.0%, $p < 0.001$), and perceived severity (63.9% vs 51.8%, $p = 0.001$).

Results of univariable and multivariable logistic regression analysis

Univariable logistic regression analysis identified significant associations between willingness to participate in CRC screening and several sociodemographic factors. These included being married (COR 2.060, 95% CI 1.534–2.767, $p < 0.001$), full-time employment (COR 2.130, 95% CI 1.402–3.234, $p < 0.001$), higher household income (≥ HKD 40,000: COR 3.323, 95% CI 2.174–5.081, $p < 0.001$), and higher educational attainment (tertiary, nondegree: COR 1.578, 95% CI 1.018–2.447, $p = 0.041$; tertiary, degree or above: COR 2.189, 95% CI 1.570–3.052, $p < 0.001$), as compared to their counterparts. Willingness was also positively associated with a history of chronic disease (COR 1.713, 95% CI 1.282–2.289, $p < 0.001$), and alcohol consumption (COR 1.791, 95% CI 1.329–2.414, $p < 0.001$) (Table 2). In addition, higher willingness to participate was linked to greater knowledge of CRC screening methods (COR 1.552, 95% CI 1.128–2.136, $p = 0.007$), higher perceived susceptibility to CRC (COR 1.506, 95% CI 1.126–2.016, $p = 0.006$), and stronger perceived benefits of FIT (COR 2.617, 95% CI 1.758–3.896, $p < 0.001$) and colonoscopy (COR 3.328, 95% CI 2.304–4.809, $p < 0.001$), higher self-efficacy (COR 4.915, 95% CI 3.146–7.679, $p < 0.001$), stronger cues to action (COR 4.985, 95% CI 3.504–7.093, $p < 0.001$), and greater perceived severity of CRC (COR 1.646, 95% CI 1.224–2.215, $p = 0.001$). In contrast, a poor perceived health status was significantly associated with lower willingness to participate in CRC screening (COR 0.535, 95% CI 0.400–0.715, $p < 0.001$).

Table 1. Participant characteristics by willingness to participate in CRC screening.

	Overall	Yes	No	*p*
N	1,029	785 (76.3%)	244 (23.7%)	
Age				
40-44	543 (52.8)	416 (53.0)	127 (52.0)	0.853
45-49	486 (47.2)	369 (47.0)	117 (48.0)	
Gender				
Female	540 (52.5)	409 (52.1)	131 (53.7)	0.719
Male	489 (47.5)	376 (47.9)	113 (46.3)	
Marital status				
Unmarried/divorced	341 (33.1)	229 (29.2)	112 (45.9)	**< 0.001**
Married	688 (66.9)	556 (70.8)	132 (54.1)	
Employment status				
Full-time	920 (89.4)	717 (91.3)	203 (83.2)	**< 0.001**
Part-time/unemployed	109 (10.6)	68 (8.7)	41 (16.8)	
Monthly household income				**< 0.001**
HKD 0–19,999	240 (23.3)	162 (20.6)	78 (32.0)	
HKD 20,000–39,999	465 (45.2)	340 (43.3)	125 (51.2)	
HKD ≥ 40,000	324 (31.5)	283 (36.1)	41 (16.8)	
Educational level				
Secondary or under	242 (23.5)	159 (20.3)	83 (34.0)	**< 0.001**
Tertiary, non-degree	169 (16.4)	127 (16.2)	42 (17.2)	
Tertiary, degree or above	618 (60.1)	499 (63.6)	119 (48.8)	
Self-perceived health status				
Good	577 (56.1)	469 (59.7)	108 (44.3)	**< 0.001**
Poor	452 (43.9)	316 (40.3)	136 (55.7)	
Chronic disease				
No	477 (46.4)	339 (43.2)	138 (56.6)	**< 0.001**
Yes	552 (53.6)	446 (56.8)	106 (43.4)	
Smoking				
No	663 (64.4)	495 (63.1)	168 (68.9)	0.115
Yes	366 (35.6)	290 (36.9)	76 (31.1)	
Alcohol consumption				
No	323 (31.4)	222 (28.3)	101 (41.4)	**< 0.001**
Yes	706 (68.6)	563 (71.7)	143 (58.6)	
Knowledge of CRC symptoms				
Low	572 (55.6)	425 (54.1)	147 (60.2)	0.109
High	457 (44.4)	360 (45.9)	97 (39.8)	
Knowledge of CRC risk factors				
Low	548 (53.3)	407 (51.8)	141 (57.8)	0.121
High	481 (46.7)	378 (48.2)	103 (42.2)	
Knowledge of CRC screening methods				
Low	681 (66.2)	502 (63.9)	179 (73.4)	**0.008**
High	348 (33.8)	283 (36.1)	65 (26.6)	
Perceived susceptibility				
Low	532 (51.7)	387 (49.3)	145 (59.4)	**0.007**
High	497 (48.3)	398 (50.7)	99 (40.6)	
Perceived benefits of FIT				
Low	768 (74.6)	557 (71.0)	211 (86.5)	**< 0.001**
High	261 (25.4)	228 (29.0)	33 (13.5)	
Perceived physical and psychological barriers to FIT				
Low	632 (61.4)	493 (62.8)	139 (57.0)	0.119
High	397 (38.6)	292 (37.2)	105 (43.0)	
Perceived access barrier to FIT				
Low	641 (62.3)	488 (62.2)	153 (62.7)	0.939
High	388 (37.7)	297 (37.8)	91 (37.3)	
Perceived benefits of colonoscopy				
Low	679 (66.0)	475 (60.5)	204 (83.7)	**< 0.001**
High	350 (34.0)	310 (39.5)	40 (16.4)	
Perceived physical and psychological barriers to colonoscopy				
Low	581 (56.5)	447 (56.9)	134 (54.9)	0.629
High	448 (43.5)	338 (43.1)	110 (45.1)	
Perceived access barrier to colonoscopy				
Low	585 (56.9)	439 (55.9)	146 (59.8)	0.315
High	444 (43.1)	346 (44.1)	98 (40.2)	
Self-efficacy				
Low	731 (71.0)	511 (65.1)	220 (90.2)	**< 0.001**
High	298 (29.0)	274 (34.9)	24 (9.8)	
Cues to action				
Low	568 (55.2)	369 (47.0)	199 (81.6)	**< 0.001**
High	461 (44.8)	416 (53.0)	45 (18.4)	
Perceived severity				
Low	563 (54.7)	407 (51.8)	156 (63.9)	**0.001**
High	466 (45.3)	378 (48.2)	88 (36.1)	

FIT: Fecal immunochemical test. 'Yes'/'N' indicates participants' willingness to undergo colorectal cancer (CRC) screening. 'Low'/'High' categories are based on the median values for each dimension of the Health Belief Model (HBM). Bold values indicate statistical significance ($p < 0.05$).

Multivariable logistic regression analysis confirmed that being married (AOR 1.447, 95% CI 1.033–2.028, $p = 0.032$), employed full-time (AOR 1.737, 95% CI 1.046–2.882, $p = 0.033$), and having a history of chronic disease (AOR 1.619, 95% CI 1.146–2.287, $p = 0.006$) were positively associated with a higher willingness to participate in CRC screening. Additionally, stronger perceived benefits of colonoscopy (AOR 1.733, 95% CI 1.069–2.811, $p = 0.026$), higher self-efficacy (AOR 2.628, 95% CI 1.572–4.394, $p < 0.001$), and stronger cues to action (AOR 3.217, 95% CI 2.185–4.737, $p < 0.001$) were linked to higher willingness to participate in CRC screening. In contrast, individuals with poor self-perceived health status (AOR 0.615, 95% CI 0.433–0.873, $p = 0.007$), higher perceived physical and psychological barriers toward FIT (AOR 0.697, 95% CI 0.487–0.999, $p = 0.049$), and higher perceived physical and psychological barriers toward colonoscopy (AOR 0.640, 95% CI 0.452–0.907, $p = 0.012$) were less likely to participate in CRC screening.

Sensitivity analysis and mediation model

The results of the sensitivity analysis are presented in Supplementary Table S1, which were consistent with the main results, thereby further supporting the robustness of the primary finding. Mediation analyses demonstrated that although both self-efficacy and cues to action significantly mediated the association between perceived benefits of colonoscopy and participation willingness, the direct effect still accounts for the majority of the total effect. Specifically, for self-efficacy, the indirect effect was statistically significant (ACME = 0.059, 95% CI: 0.034–0.085, $p < 0.001$), accounting for approximately 39.1% of the total effect. The direct effect remained significant (ADE = 0.090, 95% CI: 0.034–0.146, $p = 0.002$), indicating partial mediation. Similarly, cues to action also showed a significant mediating effect (ACME = 0.030, 95% CI: 0.018–0.045, $p < 0.001$), explaining 21.5% of the total effect. The direct effect of perceived benefits remained significant (ADE = 0.110, 95% CI: 0.061–0.162, $p < 0.001$). Details are presented in Supplementary Table S2.

Discussion

Summary of findings

This study applied the HBM to evaluate the knowledge and attitudes of 1,029 adults aged 40 to 49 in a local Chinese population regarding EOCRC screening, and identified factors influencing participation in screening based on multivariable logistic regression analysis. Our findings highlight that while a substantial proportion of the population demonstrated a positive attitude toward CRC screening (76.3%),

Table 2. Factors associated with willingness to participate in CRC screening: univariable and multivariable logistic regression.

		Crude OR (95% CI)	*p*-Value	Adjusted OR (95% CI)	*p*-Value
Age	40–44	ref	0.796	ref	0.72
	45–49	0.963 (0.722–1.284)		0.942 (0.679–1.306)	
Gender	Male	ref	0.665	ref	0.1
	Female	0.938 (0.704–1.251)		1.334 (0.946–1.881)	
Marital status	Unmarried/divorced	ref	**< 0.001**	ref	**0.032**
	Married	2.060 (1.534–2.767)		1.447 (1.033–2.028)	
Employment status	Part-time/unemployed	ref	**< 0.001**	ref	**0.033**
	Full-time	2.130 (1.402–3.234)		1.737 (1.046–2.882)	
Monthly household income	HKD 0–19,999	ref		ref	
	HKD 20,000–39,999	1.310 (0.933–1.838)	0.119	0.939 (0.611–1.445)	0.775
	HKD ≥ 40,000	3.323 (2.174–5.081)	**< 0.001**	1.686 (0.956–2.972)	0.071
Educational level	Secondary or under	ref		ref	
	Tertiary, non-degree	1.578 (1.018–2.447)	**0.041**	1.199 (0.721–1.992)	0.484
	Tertiary, degree or above	2.189 (1.570–3.052)	**< 0.001**	1.304 (0.847–2.007)	0.228
Self-perceived health status	Good	ref	**< 0.001**	ref	**0.007**
	Poor	0.535 (0.400–0.715)		0.615 (0.433–0.873)	
Chronic disease	No	ref	**< 0.001**	ref	**0.006**
	Yes	1.713 (1.282–2.289)		1.619 (1.146–2.287)	
Smoking	No	ref	0.099	ref	0.846
	Yes	1.295 (0.952–1.761)		1.040 (0.701–1.543)	
Alcohol consumption	No	ref	**< 0.001**	ref	0.102
	Yes	1.791 (1.329–2.414)		1.349 (0.942–1.930)	
Knowledge of CRC symptoms	Low	ref	0.094	ref	0.84
	High	1.284 (0.958–1.720)		0.963 (0.668–1.388)	
Knowledge of CRC risk factors	Low	ref	0.105	ref	0.642
	High	1.271 (0.951–1.699)		1.092 (0.754–1.579)	
Knowledge of CRC screening methods	Low	ref	**0.007**	ref	0.905
	High	1.552 (1.128–2.136)		1.023 (0.702–1.491)	
Perceived susceptibility	Low	ref	**0.006**	ref	0.051
	High	1.506 (1.126–2.016)		1.420 (0.999–2.019)	
Perceived benefits of FIT	Low	ref	**< 0.001**	ref	0.361
	High	2.617 (1.758–3.896)		0.778 (0.455–1.333)	
Perceived physical and psychological barriers to FIT	Low	ref	0.102	ref	**0.049**
	High	0.784 (0.586–1.05)		0.697 (0.487–0.999)	
Perceived access barrier to FIT	Low	ref	0.879	ref	0.762
	High	1.023 (0.76–1.377)		1.068 (0.698–1.636)	
Perceived benefits of colonoscopy	Low	ref	**< 0.001**	ref	**0.026**
	High	3.328 (2.304–4.809)		1.733 (1.069–2.811)	
Perceived physical and psychological barriers to colonoscopy	Low	ref	0.577	ref	**0.012**
	High	0.921 (0.69–1.23)		0.640 (0.452–0.907)	
Perceived access barrier to colonoscopy	Low	ref	0.281	ref	0.572
	High	1.174 (0.877–1.573)		1.126 (0.746–1.698)	
Self-efficacy	Low	ref	**< 0.001**	ref	**< 0.001**
	High	4.915 (3.146–7.679)		2.628 (1.572–4.394)	
Cues to action	Low	ref	**< 0.001**	ref	**< 0.001**
	High	4.985 (3.504–7.093)		3.217 (2.185–4.737)	
Perceived severity	Low	ref	**0.001**	ref	0.488
	High	1.646 (1.224–2.215)		1.132 (0.797–1.609)	

'Yes'/'No' indicates participants' willingness to undergo colorectal cancer (CRC) screening. 'Low'/'High' classifications are determined based on median values for each dimension of the Health Belief Model (HBM). Variables: As defined in Table 1. Outcome: Participation willingness = 1. Bold values indicate statistical significance ($p < 0.05$). CI: confidence interval. FIT: fecal immunochemical test. OR: odds ratio.

knowledge levels remain suboptimal across key domains. Participants who were married, employed full-time, and had a history of chronic disease were more likely to express a willingness to participate in CRC screening. Additionally, a higher willingness was associated with stronger perceived benefits of colonoscopy, higher self-efficacy, and stronger cues to action. Conversely, individuals who perceived their health status as poor, or reported higher perceived physical and psychological barriers to both FIT and colonoscopy were less likely to be willing to participate in CRC screening. These factors, as identified through multivariable regression, may inform the future development of targeted interventions to enhance screening uptake of colorectal cancer in younger adults.

Evidence from previous literature

For younger patients of 40–49 years of age, more than one-third of the primary care providers believed that colonoscopy (39.3%, range across sites: 31.3%–42.8%), and FIT (39.5%, range across sites: 32.5%–41.2%) were effective according to a previous study conducted in the United States[27]. Some studies have reported the positive attitudes toward CRC screening, with 70% in China and 76% in the

US[28,29]. However, negative attitudes were also reported in some studies, especially among participants with limited literacy skills[30,31]. In our study, we reported the highest acceptance rates with 76.3% of respondents being willing to join CRC screening. Our study found significant influence of marital status on the willingness to join CRC screening, with married individuals having a higher intention to join compared to unmarried or divorced individuals. As reported by a previous study, being married was associated with increased utilization of CRC[32]. These findings provided supporting evidence for another previous study that found unmarried patients were more likely to present with cancer in more advanced stages and to die of the disease compared to married counterparts[33].

In this study, employment status was found to be another influential factor of intention to join CRC screening. Consistently, a US study in the context of COVID-19 economic distress reported that unemployed adults had a significantly lower up-to-date prevalence of screening for CRC (41.9% vs 48.5%; $p < 0.001$), a disparity that they attributed primarily to a lack of health insurance[34]. Besides, participants with a chronic disease or alcohol drinking history were found to have a higher willingness to receive CRC screening. A previous study on the National Health Interview Survey also found moderate alcohol drinking (odds ratio [OR] = 1.16, 95%CI = 1.01–1.30) to be positively associated with CRC screening prevalence[35]. However, their study suggested a significantly positive association between smoking history and the CRC screening prevalence, which was not found in this study[35]. The effect of chronic disease on the willingness to take CRC screening was much more complex. A cross-sectional study reported that people with multiple minor chronic diseases were more likely to participate in CRC screening, while those with three or more dominant chronic diseases was associated with lower participation[36]. The household income level was also significantly associated with the willingness to join CRC screening. A previous study in Hong Kong found that individuals with higher monthly household income were more likely to participate in CRC screening, although at a statistically insignificant level[37]. Our study identified that education level was associated with willingness to join CRC screening. Similarly, recent large-scale evidence showed that education level was one of the most important factors of CRC screening participation, with individuals possessing higher educational attainment, demonstrating significantly greater odds of undergoing screening[38]. Furthermore, we found individuals with a good self-perceived health status to be more willing to join CRC screening. However, previous studies reported the opposite finding. A population-based survey found that individuals who perceived their general health as excellent were significantly less likely to undergo CRC screening compared with those reporting poor health[39].

In a previous study, the most commonly reported reason for not participating in the CRC screening program was the perception that screening was unnecessary due to the absence of symptoms, which was reported by both older (30.4%) and younger age (30.6%, $p = 0.400$) groups[40]. It was demonstrated that persons who tend to decline the colonoscopies often report psychological barriers such as fear of pain, embarrassment, and negative expectations about the procedure[41]. From the HBM aspect, Qian & Yuan concluded that among patients with gastrointestinal cancers, lower depression levels, greater social support, and higher vitality were associated with higher self-efficacy[42]. An Iranian study demonstrated that an education-based intervention was linked to enhanced cues to action for CRC screening. These observed improvements were attributed to the encouragement, help, and guidance for screening, encouraging and motivating people by sending reminder messages, and having group discussion and question and answer sessions[43]. One study investigating the perceptions of EOCRC screening among African Americans aged 30–44 found that perceived barriers and perceived benefits were comparable to those aged 50–75. Reported barriers included cost, insurance, limited knowledge, transportation, masculinity concerns (for men), access to provider/services, prolonged life, and early treatment options. Additionally, cue to action and perceived susceptibility were associated with willingness toward EOCRC screening[44].

The HBM is a psychological framework that explains and predicts health-seeking behaviors by focusing on individuals' beliefs and attitudes towards health issues[45]. In our study, the perceived benefits of colonoscopy, higher self-efficacy, and stronger cues to action were important factors of willingness to participate in CRC screening. Previous studies also supported the significance of these factors. For instance, a study in Nebraska found that the perceived benefit of feeling good with regular CRC screening was a positive factor of willingness to participate in CRC screening[46]. Other perceived benefits of CRC screening include reassurance, better control over one's health, a longer life, reduced worry, early detection, and a higher chance of cure[47]. Additionally, self-efficacy, or confidence in participating in CRC screening was positively associated with willingness to participate. A cross-sectional survey in Taiwan demonstrated that higher self-efficacy among health professionals and healthcare volunteers was linked to a higher likelihood of receiving CRC screening[48]. The study also highlighted the mediating role of self-efficacy in the relationship between perceived severity, benefits, and barriers, and the likelihood of screening[48]. As for cues to action, recent research indicated that a physician's recommendation and having health insurance were associated with increased willingness to undergo CRC screening[41,49]. These findings underscore the role of individual beliefs, self-confidence, and external influences in shaping health behaviors related to EOCRC screening. As EOCRC becomes an increasingly important concern, reinforcing these key factors could improve screening uptake and early detection in high-risk populations.

However, although our findings indicate a satisfactory level of willingness to participate in CRC screening among younger age groups, this finding may not reflect participants' actual behavior in the real world. As noted in an earlier study conducted in Hong Kong, although 86.0% of participants indicated a willingness to participate in CRC screening, the actual participation rate was only 14.0%[50]. Similarly, data from the Hong Kong Government-funded CRC screening program indicates that, although participation rates in CRC screening have been rising steadily since the program launch, the screening rate among the eligible population stood at only 15.8% as of 31 December 2024[51], which is consistent with the findings of an earlier study[50]. These discrepancies suggest that this gap between intention and action may have led to an overestimation of actual participation rates at the population level. It is necessary to investigate the mechanisms underlying this discrepancy to reveal its actual impact on early screening.

It is noteworthy that, although the mechanisms underlying these differences remain unclear, it is challenging to overlook the influence of screening methods and strategies. As demonstrated by the findings of a Norwegian prospective randomized trial, the experience with various screening tools—such as sigmoidoscopy and FIT—is a crucial factor in participants' willingness to undergo screening[52]. Likewise, while the widespread adoption of FIT has improved access to screening resources, particularly in areas with limited healthcare resources, its sensitivity has been criticized[53]. This underscores the importance of enhancing screening techniques to increase CRC screening uptake. Additional screening tools, including computed tomography (CT) colonography and validated risk assessment tools such as QCancer, are advantageous alternatives that can address the challenges associated with traditional screening procedures, such as low sensitivity, discomfort, and resource limitations[54–56]. Additionally, with the

advancement of artificial intelligence (AI), a growing body of research has demonstrated the immense potential of integrating AI with imaging technologies for the early detection of cancer[57]. Evidence suggests that AI-assisted colonoscopy significantly improves the detection rate of adenomas compared to conventional colonoscopy[58]. It may therefore be appropriate to consider the further integration of AI-assisted technology in future screening programs, as it holds promise for enhancing the quality of the screening service and detection of inconspicuous polyps.

Limitations

This study has several limitations. First, the use of an online survey introduced potential sampling error, limiting the representativeness of the findings. Second, the cross-sectional design of this study precluded the establishment of causal relationships; the findings can only suggest associations. Third, the survey focused exclusively on a local Chinese population, which restricts the generalizability of the results. Future studies incorporating data from diverse ethnic groups could provide complementary insights. Lastly, this study assessed respondents' stated willingness to participate in CRC screening, which may not fully translate to actual behavior. Social desirability bias may have contributed to an overestimation of willingness, as participants may have conformed to perceived societal expectations.

Implications for practice and research

This study underscores the perceived benefits of screening, higher self-efficacy, and stronger cues to action were identified as key predictors of intention to engage in EOCRC screening. These findings suggest that addressing individuals' perceptions and attitudes could improve screening uptake.

To enhance participation in EOCRC screening, interventions should focus on reinforcing these psychological factors. Educational campaigns should emphasize the tangible benefits of CRC screening, build self-efficacy by boosting confidence in the screening process, and provide clear cues to action, such as physician recommendations and community support. Given the increasing concern over EOCRC, it is essential for health authorities, including the Hong Kong Hospital Authority, to intensify efforts to raise awareness, particularly targeting individuals at higher risk for this condition. Furthermore, interventions should be tailored to reach subgroups with lower willingness to participate in screening, such as unmarried or divorced individuals, part-time workers, those with lower incomes or educational levels, individuals without chronic disease histories, and those with poor self-perceived health. Addressing barriers to participation, such as health-related psychological and practical concerns, will also be essential in increasing screening uptake. Given the study's limitations, further prospective research involving diverse populations across Hong Kong is necessary to validate these findings. Additional studies on the cost-effectiveness of various intervention strategies would provide critical insights for evidence-based policymaking. By reinforcing key psychological factors such as perceived benefits, self-efficacy, and cues to action, we can foster greater participation in EOCRC screening, facilitating its early detection and reducing the associated health burden.

Conclusions

Our study found that adults aged 40 to 49 in Hong Kong exhibited a high willingness to participate in CRC screening. Additionally, the study highlighted that willingness to participate in EOCRC screening was associated with the perceived benefits of screening, self-efficacy, and cues to action. These findings may inform the development of targeted interventions aimed at enhancing the acceptance of EOCRC screening. Further research is needed to confirm these findings and assess the cost-effectiveness of target strategies.

Ethical statements

Ethical approval was obtained from the Survey and Behavioural Research Ethics (No. SBRE-22-0174), The Chinese University of Hong Kong, Hong Kong SAR.

Author contributions

The authors confirm their contributions to this study as follows: study conceptualization and supervision: Huang J, Wong MCS; data curation and formal analysis: Zhong CC, Li Z, Tian W. writing – draft manuscript preparation: Zhong CC, Huang J, Dong R, Yang Z; writing – review and editing: Liu X, Lin J, Hang J, Yuan J, Xu W, Withers M, Chan AT, Wong MCS. All authors reviewed the results and approved the final version of the manuscript.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding authors upon reasonable request.

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Conflict of interest

The authors declare that they have no conflict of interest.

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References

[1] Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, et al. 2024. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians* 74(3):229–263

[2] Murphy CC, Zaki TA. 2024. Changing epidemiology of colorectal cancer—birth cohort effects and emerging risk factors. *Nature Reviews Gastroenterology & Hepatology* 21(1):25–34

[3] Sharma R, Abbasi-Kangevari M, Abd-Rabu R, Abidi H, Abu-Gharbieh E, et al. 2022. Global, regional, and national burden of colorectal cancer and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet Gastroenterology & Hepatology* 7(7):627–647

[4] Akimoto N, Ugai T, Zhong R, Hamada T, Fujiyoshi K, et al. 2021. Rising incidence of early-onset colorectal cancer—a call to action. *Nature Reviews Clinical Oncology* 18(4):230–243

[5] US Preventive Services Task Force. 2021. Screening for colorectal cancer: US preventive services task force recommendation statement. *JAMA* 325(19):1965–1977

[6] Pan H, Tang Y, Zhu H, Sun Y, Chi P, et al. 2025. Global burden, trends, and risk factors of early-onset and late-onset colorectal cancer from 1990 to 2021, with projections to 2040: a population-based study. *BMC Gastroenterology* 25(1):486

[7] Chambers AC, Dixon SW, White P, Williams AC, Thomas MG, et al. 2020. Demographic trends in the incidence of young-onset colorectal cancer: a population-based study. *BJS (British Journal of Surgery)* 107(5):595–605

[8] Patel SG, Karlitz JJ, Yen T, Lieu CH, Boland CR. 2022. The rising tide of early-onset colorectal cancer: a comprehensive review of epidemiology, clinical features, biology, risk factors, prevention, and early detection. *The Lancet Gastroenterology & Hepatology* 7(3):262–274

[9] Abualkhair WH, Zhou M, Ahnen D, Yu Q, Wu XC, et al. 2020. Trends in incidence of early-onset colorectal cancer in the United States among those approaching screening age. *JAMA Network Open* 3(1):e1920407

[10] Rex DK, Boland RC, Dominitz JA, Giardiello FM, Johnson DA, et al. 2017. Colorectal cancer screening: recommendations for physicians and patients from the U.S. multi-society task force on colorectal cancer. *American Journal of Gastroenterology* 112(7):1016–1030

[11] Sung JY, Ng SC, Chan FL, Chiu HM, Kim HS, et al. 2015. An updated Asia Pacific Consensus Recommendations on colorectal cancer screening. *Gut* 64(1):121–132

[12] Wolf AMD, Fontham ETH, Church TR, Flowers CR, Guerra CE, et al. 2018. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American Cancer Society. *CA: A Cancer Journal for Clinicians* 68(4):250–281

[13] Chiu HM, Chen SL, Su CW, Yen AM, Hsu WF, et al. 2025. Long-term effectiveness associated with fecal immunochemical testing for early-age screening. *JAMA Oncology* 11(8):846–854

[14] Hong Kong Hospital Authority. 2023. *Overview of Hong Kong Cancer Statistics of 2021*. https://www3.ha.org.hk/cancereg

[15] Li C, Chen T, Chen H, Zhang B, Sun B, et al. 2025. Temporal trends in colorectal cancer incidence and case numbers among individuals aged 45-49 in the US during 2001-2019. *Cancer Control* 32:1–11

[16] Siddique S, Wang R, Yasin F, Gaddy JJ, Zhang L, et al. 2024. USPSTF colorectal cancer screening recommendation and uptake for individuals aged 45 to 49 years. *JAMA Network Open* 7(10):e2436358

[17] Liu-Galvin R, Xie Z, Hong YR. 2025. Colorectal cancer screening in adults aged 45–49: provider availability, CT colonography access, and screening rates. *Journal of the National Cancer Center* 5(4):414–425

[18] Liu W, Liu M, Li P, Hou Y, Zhao Q, et al. 2025. Colonoscopy uptake in first-degree relatives of CRC patients: challenges and intervention strategies. *Patient Preference and Adherence* 19:855–868

[19] Sonkin D, Thomas A, Teicher BA. 2024. Cancer treatments: Past, present, and future. *Cancer Genetics* 286:18–24

[20] Huang J, Choi P, Pang TWY, Chen X, Wang J, et al. 2021. Factors associated with participation in colorectal cancer screening: a population-based study of 7200 individuals. *European Journal of Cancer Care* 30(2):e13369

[21] Janz NK, Becker MH. 1984. The health belief model: a decade later. *Health Education & Behavior* 11(1):1–47

[22] Skinner CS, Tiro J, Champion VL. 2015. Background on the health belief model. In *Health behavior: Theory, research, and practice*. 5th Edition. pp. 1–34

[23] Berg-Beckhoff G, Leppin A, Nielsen JB. 2022. Reasons for participation and non-participation in colorectal cancer screening. *Public Health* 205:83–89

[24] Chen L, Wang J, Zheng F, Jiang H, Dou J, et al. 2025. Study on the influencing factors of community residents' willingness to participate in colorectal cancer screening: a cross-sectional survey based on the Shanghai's major public health project. *The Lancet Regional Health - Western Pacific* 55:101429

[25] Le Bonniec A, Meade O, Fredrix M, Morrissey E, O'Carroll RE, et al. 2023. Exploring non-participation in colorectal cancer screening: a systematic review of qualitative studies. *Social Science & Medicine* 329:116022

[26] Almadi M, Mosli M, Bohlega M, Al Essa M, AlDohan M, et al. 2015. Effect of public knowledge, attitudes, and behavior on willingness to undergo colorectal cancer screening using the health belief model. *Saudi Journal of Gastroenterology* 21(2):71–77

[27] Ghai NR, Jensen CD, Merchant SA, Schottinger JE, Lee JK, et al. 2020. Primary care provider beliefs and recommendations about colorectal cancer screening in four healthcare systems. *Cancer Prevention Research* 13(11):947–958

[28] Huang RL, Liu Q, Wang YX, Zou JY, Hu LF, et al. 2021. Awareness, attitude and barriers of colorectal cancer screening among high-risk populations in China: a cross-sectional study. *BMJ Open* 11(7):e045168

[29] Yen T, Schroy PC, Hampel H, Aubertine M, Sylvester K, et al. 2025. Knowledge, attitudes, and perceptions around colorectal cancer screening and risk among 20–49Year olds. *Digestive Diseases and Sciences* 70(12):4090–4098

[30] Harsono AAH, Ruiz R, Katta M, Sheffer HF, McLeod MC, et al. 2025. The association between health literacy and colorectal cancer screening: findings using a three-question health literacy measure. *Journal of Gastrointestinal Cancer* 56(1):111

[31] Dolan NC, Ferreira MR, Davis TC, Fitzgibbon ML, Rademaker A, et al. 2004. Colorectal cancer screening knowledge, attitudes, and beliefs among veterans: does literacy make a difference? *Journal of Clinical Oncology* 22(13):2617–2622

[32] Gram MA, Therkildsen C, Clarke RB, Andersen KK, Mørch LS, et al. 2021. The influence of marital status and partner concordance on participation in colorectal cancer screening. *European Journal of Public Health* 31(2):340–346

[33] Liu L, Peshin S, Zevallos Barboza A, Vijayvergia N. 2025. Effects of marital status on survival in patients with colorectal cancer. *Journal of Clinical Oncology* 43(16_suppl):3628

[34] Fedewa SA, Yabroff KR, Bandi P, Smith RA, Nargis N, et al. 2022. Unemployment and cancer screening: Baseline estimates to inform health care delivery in the context of COVID-19 economic distress. *Cancer* 128(4):737–745

[35] Owusu D, Quinn M, Wang KS. 2015. Alcohol consumption, depression, insomnia and colorectal cancer screening: racial differences. *International Journal of High Risk Behaviors and Addiction* 4(2):e23424

[36] Guiriguet C, Pera G, Castells A, Toran P, Grau J, et al. 2017. Impact of comorbid conditions on participation in an organised colorectal cancer screening programme: a cross-sectional study. *BMC Cancer* 17(1):524

[37] Chan DNS, Choi KC, Au DWH, So WKW. 2022. Identifying the factors promoting colorectal cancer screening uptake in Hong Kong using Andersen's behavioural model of health services use. *BMC Public Health* 22(1):1228

[38] Rahimi F, Rezayatmand R, Dalvand Z, Ravankhah Z, Adibi P. 2025. Factors influencing participation in colorectal cancer screening among average-risk populations: a descriptive-analytical study in a developing country. *PLoS One* 20(5):e0323291

[39] Onyenemezu KR, Ezike TC, Nwebonyi SO, Ikwuka OV, Aroh EV. 2024. Assessing the relationship between self-rated general health and colorectal cancer screening uptake. *Cureus* 16(11):e74014

[40] Wong BC, Chan AO, Wong WM, Hui WM, Kung HF, et al. 2006. Attitudes and knowledge of colorectal cancer and screening in Hong Kong: a population-based study. *Journal of Gastroenterology and Hepatology* 21(1):41–46

[41] Hoeck S, Tran TN. 2024. Insights into personal perceptions and experiences of colonoscopy after positive FIT in the Flemish colorectal cancer screening program. *Gastrointestinal Disorders* 6(1):49–63

[42] Qian H, Yuan C. 2012. Factors associated with self-care self-efficacy among gastric and colorectal cancer patients. *Cancer Nursing* 35(3):E22–E31

[43] Rakhshani T, Razeghi E, Kashfi SM, Kamyab A, Khani Jeihooni A. 2024. The effect of educational intervention based on health belief model on colorectal cancer screening behaviors. *BMC Public Health* 24(1):1640

[44] Fields C. 2020. *Perceptions of Early Detection Screening for Colorectal Cancer in African American Men and Women Aged 30–44, Using the Health Belief Model*. PhD Thesis. Texas Woman's University, United States. 244 pp

[45] Kan T, Zhang J. 2018. Factors influencing seasonal influenza vaccination behaviour among elderly people: a systematic review. *Public Health* 156:67–78

[46] Hughes AG, Watanabe-Galloway S, Schnell P, Soliman AS. 2015. Rural–urban differences in colorectal cancer screening barriers in Nebraska. *Journal of Community Health* 40(6):1065–1074

[47] Lau J, Lim TZ, Jianlin Wong G, Tan KK. 2020. The health belief model and colorectal cancer screening in the general population: a systematic review. *Preventive Medicine Reports* 20:101223

[48] Lin TY, Chuang ST, Huang SF, Hsu HP, Lu LT, et al. 2019. Likelihood of a fecal occult blood test uptake among older adults: comparisons between health professionals and healthcare volunteers based on the health belief model. *BMC Geriatrics* 19(1):51

[49] Katz ML, Loomans-Kropp HA, Reiter PL. 2025. Colorectal cancer screening blood test: awareness and willingness among a national sample of adults post-Federal and Drug Administration approval. *BMC Public Health* 25(1):1853

[50] Wong GCY, Lee KY, Lam KF, Fan SYS. 2017. Community-based survey of knowledge of, attitudes to and practice of colorectal cancer screening in Hong Kong. *Journal of Digestive Diseases* 18(10):582–590

[51] Centre for Health Protection. 2024. Colorectal Cancer Screening Programme – Progress report of the screening outcome for participants enrolled between 28 Sep 2016 and 31 Dec 2024 Hong Kong: Hong Kong Department of Health. www.colonscreen.gov.hk/sites/default/files/pdf/CRCSP_progress_report.pdf

[52] Kirkøen B, Berstad P, Botteri E, Dalén E, Nilsen J, et al. 2017. Acceptability of two colorectal cancer screening tests: pain as a key determinant in sigmoidoscopy. *Endoscopy* 49(11):1075–1086

[53] McCabe MA, Mauro AJ, Schoen RE. 2025. Novel colorectal cancer screening methods—opportunities and challenges. *Nature Reviews Clinical Oncology* 22(8):581–591

[54] Kortlever T, van der Vlugt M, Dekker E. 2022. Future of colorectal cancer screening: from one-size-FITs-all to tailor-made. *Frontiers in Gastroenterology* 1:906052

[55] Grigore B, Lewis R, Peters J, Robinson S, Hyde CJ. 2020. Development, validation and effectiveness of diagnostic prediction tools for colorectal cancer in primary care: a systematic review. *BMC Cancer* 20(1):1084

[56] Obaro AE, Burling DN, Plumb AA. 2018. Colon cancer screening with CT colonography: logistics, cost-effectiveness, efficiency and progress. *The British Journal of Radiology* 91(1090):20180307

[57] Xu HL, Gong TT, Song XJ, Chen Q, Bao Q, et al. 2025. Artificial intelligence performance in image-based cancer identification: umbrella review of systematic reviews. *Journal of Medical Internet Research* 27:e53567

[58] Lau LHS, Ho JCL, Lai JCT, Ho AHY, Wu CWK, et al. 2024. Effect of real-time computer-aided polyp detection system (ENDO-AID) on adenoma detection in endoscopists-in-training: a randomized trial. *Clinical Gastroenterology and Hepatology* 22(3):630–641.e4