RESEARCH ARTICLE

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Factors Associated with Attending to the Colorectal Cancer Screening Services among at-Risk Individuals in a Community Care Hospital: A Cross-Sectional Analytical Study

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Abstract

Background: Colorectal cancer (CRC) is a major global public health concern, yet screening participation remains low among at-risk populations. This study investigated factors influencing attendance at CRC screening services among at-risk individuals aged 50–70 years. **Methods:** A cross-sectional analytical study was conducted from November 2023 to February 2024, involving 360 participants aged 50–70 years. The sample included 180 cases (participants who attended CRC screening) and 180 controls (those who did not), selected through simple random sampling from a registry of at-risk individuals. Data were collected using validated questionnaires assessing demographic characteristics, health literacy, social, and family support. The content validity indices ranging from 0.66 to 1.00 with Cronbach's alpha coefficients of 0.91, 0.88, and 0.77, respectively. Descriptive statistics and multiple logistic regression were used for analysis. **Results:** Annual physical check-ups and body mass index (BMI) were significantly associated with screening attendance with CRC screening attendance. Individuals without annual check-ups were 55% less likely to attend CRC screening (Adjusted Odds Ratio [AOR] = 0.45, 95% Confidence Interval [CI]: 0.29–0.70). Those with a normal BMI were 3.91 times more likely to attend screening compared to those with underweight BMI (AOR = 3.91, 95% CI: 1.20–12.77), after adjusting for gastrointestinal disease history. **Conclusions:** Regular health check-ups and BMI play crucial roles in CRC screening participation. Targeted health interventions are essential to improve awareness and encourage screening participation, particularly among individuals lacking routine check-ups. Strengthening preventive healthcare efforts can help reduce CRC prevalence and enhance public health outcomes.

Keywords: Preventive healthcare- risk factors analysis- health literacy evaluation- screening participation

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Introduction

Colorectal cancer (CRC) is characterized by the abnormal proliferation of epithelial cells in the large intestine, forming tumors that may become malignant [1]. The rectum and sigmoid colon are the most commonly affected areas [2]. CRC often leads to complications such as bowel obstruction, perforation, and local tissue invasion [3]. Additionally, cancer cells may metastasize through lymphatic or circulatory pathways, spreading to vital organs like the liver, lungs, and bones [4]. While the exact causes of CRC remain unclear, several risk factors are well-documented. Genetic predispositions, including a family history of colorectal or related cancers, contribute to increased susceptibility. Lifestyle factors also play a critical role, particularly diets high in red and processed meats and low in dietary fiber. Other modifiable risks include excessive alcohol consumption, smoking, and physical inactivity, which collectively exacerbate CRC risk. Early identification of risk factors is crucial for prevention and timely intervention [5, 6].

CRC imposes significant physical, psychological, and economic burdens on individuals, families, and healthcare systems [7]. Patients often experience symptoms such as abdominal and bone pain, fatigue, and severe weight loss, which can contribute to mental health issues like anxiety and depression, compounded by high treatment costs [8]. Globally, CRC was the second leading cause of cancer deaths in 2020, with over 1.9 million new cases and 930,000 deaths projected by 2040 [9]. High incidence rates are observed in regions like Europe, Australia, and New Zealand, particularly in Eastern Europe with elevated mortality rates. In Thailand, CRC ranks as the third most common cancer among males (8.8 cases per 100,000) and fifth among females (7.6 cases per 100,000) [10]. Nakhon Si Thammarat Province has notably high incidence rates.

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Despite the benefits of early detection, Thailand's CRC screening rates have declined over five years, from 56.93% to 37.84% [11], underscoring the need for improved screening strategies.

From 2018 to 2022, CRC screening in Chaloem Phra Kiat District, Nakhon Si Thammarat Province, showed fluctuating positive cases (9, 11, 14, 3, and 5 annually) [11], reflecting an inconsistent trend. This decline in screening outcomes complicates efforts to reduce CRC-related morbidity and mortality. With over 60% of CRC cases asymptomatic in early stages, late detection leads to higher treatment costs and poorer survival rates. Early detection, however, can offer a five-year survival rate of approximately 90% [12]. The district's geography, characterized by low-lying floodplains, limits healthcare accessibility, including CRC screening services. Most residents are agricultural workers in a semi-urban community, where dietary habits may be shaped by convenience food outlets, increasing the risk of unhealthy diets [13]. These geographic and lifestyle challenges, coupled with inconsistent screening trends, underscore the urgent need for targeted interventions to raise CRC awareness and enhance participation in screening programs.

Several factors influence CRC screening attendance, including demographics, smoking, alcohol consumption, physical inactivity, and inadequate intake of fruits and vegetables [14]. Key determinants also include bowel health history [15], health literacy [16], psychological factors, and awareness of CRC risks and the benefits of screening [17]. Additional barriers, such as rural living conditions [18], family history of cancer [19], and limited accessibility for individuals with mobility issues [20], further affect participation rates. In Chaloem Phra Kiat District, Nakhon Si Thammarat Province, CRC screening programs have yet to achieve target rates among at-risk individuals aged 50–70 years. Despite these efforts, new CRC cases are diagnosed annually, highlighting gaps in the effectiveness of existing initiatives. This study seeks to explore the factors influencing CRC screening attendance among at-risk individuals, aiming to provide actionable insights that can strengthen screening programs and ultimately reduce the burden of CRC within the community.

Materials and Methods

Study Design

This cross-sectional analytical study was conducted between November 2023 and February 2024 in Chaloem Phra Kiat District, Nakhon Si Thammarat Province, Thailand.

Study Subjects

The study population consisted of individuals aged 50–70 years at risk for CRC residing in six villages within the service area of Chaloem Phra Kiat District Hospital, Nakhon Si Thammarat Province. Based on the Health Data Center (HDC) database, 1,046 individuals were identified as the target population for CRC screening in 2023 [11]. A case-control design was employed, with the sample stratified into two groups at a 1:1 ratio. The case group comprised 180 individuals who underwent CRC screening during the 2023 fiscal year, while the control group included 180 individuals who did not participate in screening during the same period. Inclusion criteria required participants to reside in the hospital's service area, provide informed consent, and complete the study questionnaire. Exclusion criteria included an inability to communicate or effectively respond to the questionnaire.

Research Instruments and Quality Assessment

Data were collected using a structured, self-administered questionnaire comprising five sections. Demographic Characteristics (6 items) gathered information on gender, age, education, occupation, income, and body mass index (BMI). Health Information (5 items) included underlying diseases, annual physical health check-ups, history of gastrointestinal illnesses, CRC screening history, and rectal bleeding history. Health Literacy Related to CRC (24 items) covered six dimensions: accessibility to health information (4 items), knowledge and understanding (4 items), communication skills (4 items), self-management skills (4 items), media literacy (4 items), and decision-making skills (4 items). Social Support (10 items) divided into four dimensions: emotional support (3 items), esteem support (2 items), informational support (3 items), and resource support (2 items); Family Support (21 items) covered five dimensions: well-being (5 items), physical condition (5 items), interpersonal and neighborhood relationships (5 items), emotional state (4 items), and information and communication (2 items). Sections 1 and 2 used a checklist format, while Sections 3 to 5 employed a 5-point Likert scale ranging from "Very much" to "Very little."

To ensure validity and reliability, the questionnaire was reviewed by three experts: a medical doctor specializing in family medicine, a nurse practitioner, and a research methodology expert. Content validity was assessed using the Index of Item-Objective Congruence (IOC), with scores ranging from 0.66 to 1.00. Based on expert feedback, revisions were made to enhance clarity and ensure alignment with the study's objectives. A pilot test was then conducted with participants from a similar context to the study's setting to evaluate the questionnaire's reliability. The Cronbach's alpha coefficients for the health literacy, social support, and family support sections were 0.91, 0.88, and 0.77, respectively.

Health literacy related to CRC screening was interpreted using criteria from the Health Education Division, Ministry of Public Health, Thailand [21], categorized into four levels: 1) Needs improvement (<32 points), 2) Fair (32–49 points), 3) Good (50–67 points), and 4) Very good (≥68 points). Social support and family support levels were classified into three categories high, moderate, and low by dividing the range of possible scores into three equal intervals based on the minimum and maximum scores.

Data Collection

After obtaining ethical approval, the researcher collaborated with staff at Chalerm Phrakiat Hospital

to collect data from individuals who had undergone colorectal cancer screening. For participants with positive Fecal Immunochemical Test (FIT) results, indicating potential risk for colorectal cancer, interviews were conducted after an appropriate waiting period to minimize psychological distress. Participants were fully informed of their right to withdraw from the interview at any time without any consequences or impact on their participation in the study.

Statistical Analysis

Descriptive statistics were used to summarize the demographic characteristics of the participants. As all 180 cases and 180 controls were successfully approached and provided complete responses, no missing data were present in this study, ensuring the robustness of the analysis. The outcome variable for the analysis was attendance at CRC screening services, categorized dichotomously: cases (attended CRC screening, coded as Yes = 1) and controls (did not attend CRC screening, coded as No = 0). Bivariate analyses were initially conducted using simple logistic regression to identify factors associated with CRC screening attendance for inclusion in the multivariate analysis. Variables with p-values less than 0.25 from Wald's test were initially included. We then applied the backward elimination method, systematically removing the least significant variables until only those with strong statistical association remained. The backward elimination method was subsequently applied to refine the model and identify the most significant factors in the multiple logistic regression model.

Results are reported as odds ratios (OR) and adjusted odds ratios (AOR) with 95% confidence intervals (95% CI). An OR greater than 1 indicates an increased likelihood of CRC screening attendance, while an OR less than 1 suggests a decreased likelihood. An OR of 1 signifies no association between the examined factors and CRC screening attendance.

Ethics Approval

This study was approved by the Human Research Ethics Committee of Thaksin University (COA No. TSU 2023_247, REC No. 0655, dated December 22, 2023). All participants were thoroughly informed about the study's objectives, and participation was entirely voluntary. Confidentiality was ensured by anonymizing data and presenting results in aggregate form to protect participant identities. Written informed consent was obtained from all participants prior to their involvement in the study.

Results

Demographic Characteristics

Among the cases, approximately two-thirds were female (65.00%). Half of the participants were aged between 50 and 59 years (50.56%), with a mean age of 59.79 years (SD = 5.86). Nearly two-thirds were overweight (59.44%), with an average BMI of 24.40 kg/m² (SD = 4.02). More than half had a waist circumference above the normal range (55.56%). About one-third were employed (31.67%), and the majority had a monthly income exceeding 3,000 baht (69.44%), with an average income of 6,457.78 baht (SD = 5,986.96). Most participants had completed junior high school education (71.67%).

Among the controls, approximately two-thirds were female (61.11%). More than half were aged between 50 and 59 years (55.00%), with a mean age of 58.86 years (SD = 6.21). Two-thirds were overweight (60.00%), with an average BMI of 24.13 kg/m² (SD = 4.27). Over half had a normal waist circumference (53.89%), with an average measurement of 1.46 cm (SD = 0.50). About one-third were employed (35.00%), and two-thirds had a monthly income exceeding 3,000 baht (66.67%), with an average income of 7,490.07 baht (SD = 10,280.28). The majority had completed junior high school (80.56%), as detailed in Table 1.

Health Information

Among the cases, more than half had underlying diseases (53.33%), with hypertension (28.89%), hyperlipidemia (20.56%), and diabetes (12.78%) being the most common. Over half underwent annual health check-ups (52.22%), and 3.89% had a history of gastrointestinal diseases. Half of the participants had undergone CRC screening (50.00%), while 8.89% reported blood in their stool, and 6.67% had a family history of cancer.

Among the controls, nearly half had underlying diseases (49.44%), including hypertension (49.02%), hyperlipidemia (48.61%), and diabetes (45.24%). The majority had never undergone an annual physical health check-up (70.00%), and 7.78% had a history of gastrointestinal diseases. Half had no history of CRC screening (50.00%), and 7.78% reported blood in stool. Additionally, 6.11% had a family history of cancer, as shown in Table 2.

Health Literacy, Social Support and Family Support

Among the cases, the majority demonstrated a very good level of health literacy related to colorectal cancer (70.00%; Mean ± SD: 75.67 ± 16.93). Over half had a moderate level of social support (57.78%; Mean ± SD: 34.59 ± 6.25), and two-thirds reported moderate family support (63.89%; Mean ± SD: 72.85 ± 9.15). Similarly, among the controls, most exhibited a very good level of health literacy related to colorectal cancer (71.67%; Mean ± SD: 75.14 ± 17.02). Two-thirds had a moderate level of social support (62.78%; Mean ± SD: 33.40 ± 6.22) and a comparable proportion reported moderate family support (66.67%; Mean ± SD: 70.96 ± 10.84), as detailed in Figure 1.

Bivariate Analysis of Factors Associated with Attending Colorectal Cancer Screening Services

Bivariate analysis using logistic regression identified education (p-value = 0.049) and annual physical check-ups (p-value < 0.001) as statistically significant factors associated with attending CRC screening services. Individuals with a senior high school education or higher were 1.64 times more likely to attend CRC screening services compared to those with only a junior high school education (OR = 1.64, 95% CI: 1.01–2.68). Additionally,

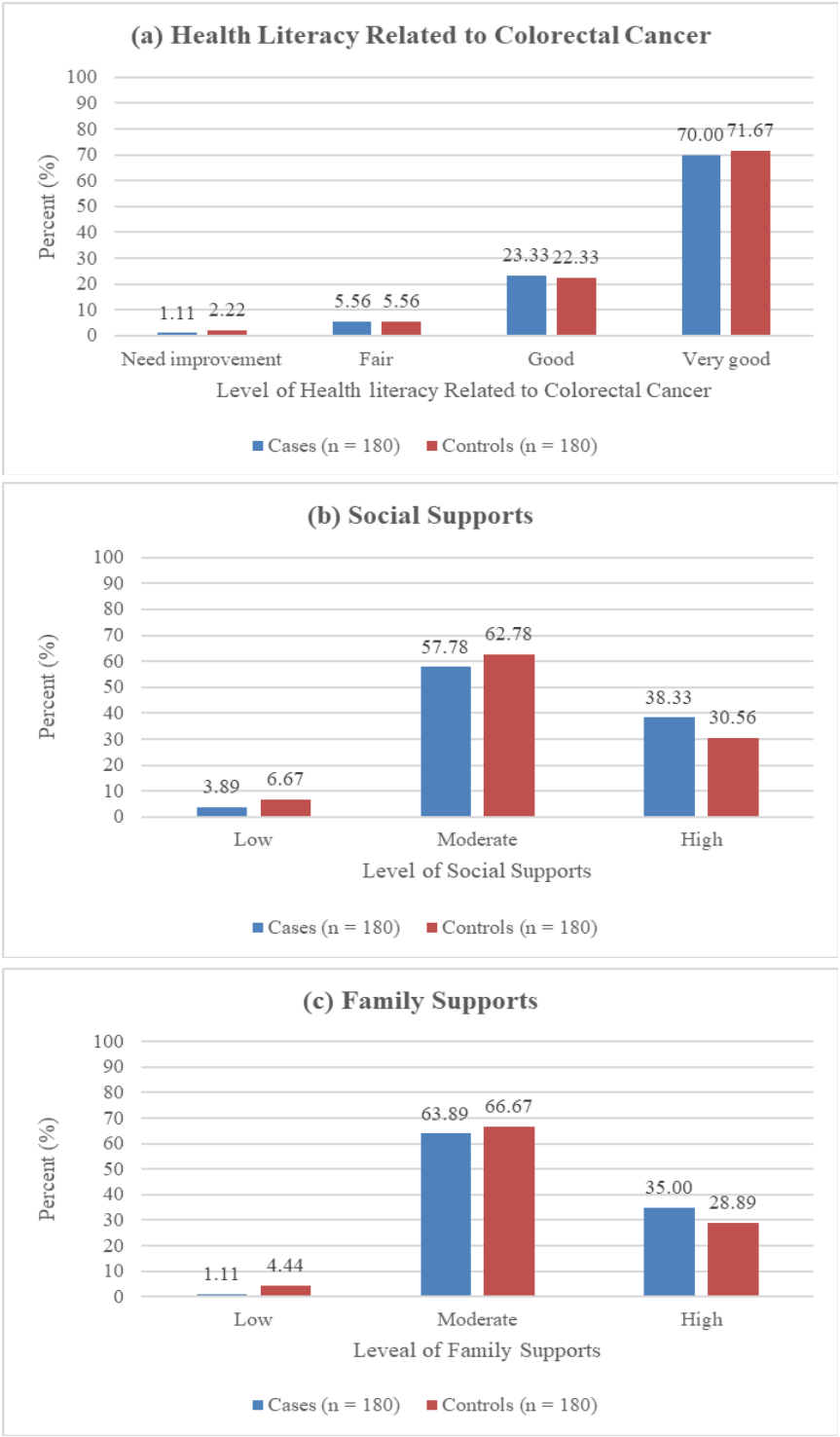

Figure 1. Level of (a) health literacy related to colorectal cancer, (b) social supports and (c) family supports among subjects

individuals who had never undergone an annual physical check-up were 53% less likely to attend CRC screening services compared to those who had participated in annual physical check-ups (OR = 0.47, 95% CI: 0.30–0.72).

However, other factors such as sex (p-value = 0.445), age (p-value = 0.399), BMI (p-value = 0.914), waist circumference (p-value = 0.074), occupation (p-value = 0.758), monthly income (p-value = 0.572), underlying diseases (p-value = 0.461), history of gastrointestinal diseases (p-value = 0.122), presence of blood in stool (p-value = 0.703), family history of cancer (p-value = 0.829), health literacy related to CRC (p-value = 0.777), social support (p-value = 0.199), and family support (p-value = 0.214) were not significantly associated with attending CRC screening services, as detailed in Table 3.

Multivariate Analysis of Factors Associated with Attending Colorectal Cancer Screening Services

The multivariate analysis using backward elimination

Table 1. Demographic Characteristics among Subjects with and without CRC Screening Attendance (n = 360)

Demographic characteristics	Cases (n = 180)		Controls (n = 180)	
	n	%	n	%
Sex				
Males	63	35.00	70	38.89
Females	117	65.00	110	61.11
Age (Year)				
50 - 59	91	50.56	99	55.00
60 - 70	89	49.44	81	45.00
Mean ± SD	59.79 ± 5.86		58.86 ± 6.21	
Min-Max	50 - 70		50 - 70	
Body mass index (BMI: kg/m^2)				
Normal weight (18.5 - 22.9)	73	40.56	72	40.00
Overweight (>22.9)	107	59.44	108	60.00
Mean ± SD	24.40 ± 4.02		24.13 ± 4.27	
Min-Max	18.5-41.00		18.5-37.78	
Waist circumstance				
Normal (Males <90; females <80)	80	44.44	97	53.89
Over waist circumstance	100	55.56	83	46.11
Mean ± SD	1.56 ± 0.498		1.46 ± 0.500	
Min-Max	38-114		60-111	
Occupation				
Unemployment	31	17.22	24	13.33
Sale	32	17.78	33	18.33
Employee	57	31.67	63	35.00
Official government	6	3.33	6	3.33
Agriculturists	54	30.00	54	30.00
Average income (Baht per month)				
≤3,000	55	30.56	60	33.33
>3,001	125	69.44	120	66.67
Mean ± SD	6,457.78 ± 5,986.96		7,490.07 ± 10,280.28	
Min-Max	0-38,600		0-100,000	
Education				
Junior high school or lower	129	71.67	145	80.56
Senior high school or higher	51	28.33	35	19.44

identified annual physical check-ups and BMI as significant factors associated with attending CRC screening services. Individuals who had never received an annual physical check-up were 55% less likely to attend CRC screening services compared to those who had (AOR = 0.45, 95% CI: 0.29–0.70). Furthermore, individuals with a normal BMI were 3.91 times more likely to attend CRC screening services compared to those classified as underweight (AOR = 3.91, 95% CI: 1.20–12.77), after adjusting for the history of gastrointestinal diseases, as shown in Table 4.

Discussion

In summary, annual physical check-ups and BMI were identified as statistically significant factors associated with attending CRC screening services, even after adjusting for a history of gastrointestinal diseases. These factors play a crucial role in influencing individuals' likelihood of participating in CRC screening services.

Our study revealed that individuals who had not undergone annual physical check-ups were less likely to attend CRC screening services. This may be attributed to a lack of perceived risk for CRC, as over half of the control group reported no underlying diseases (50.56%), potentially reducing their concern. Furthermore, limited decision-making skills, likely influenced by the lower educational attainment of many participants (80.56% had only completed junior high school or less), may have further hindered their ability to prioritize CRC screening. Additionally, a significant proportion of the control group demonstrated low levels of health service accessibility (37.22%), CRC knowledge and understanding (28.33%), communication skills (50.00%), and media literacy

Table 2. Health Information among Subjects with and without CRC Screening Attendance (n = 360)

Health information	Cases (n = 180)		Controls (n = 180)	
	n	%	n	%
Underlying diseases				
No	84	46.67	91	50.56
Yes	96	53.33	89	49.44
Hypertension	52	28.89	50	49.02
Diabetes	23	12.78	19	45.24
Hyperlipidemia	37	20.56	35	48.61
Others (Stroke / Depression / Psychological disorder / Heart diseases / Kidney diseases / Thyroid / Asthma / Lung diseases / Brain tumor / Gout)	17	9.44	29	63.04
History of annual physical check- ups				
Yes	86	47.78	54	30.00
No	94	52.22	126	70.00
History of gastrointestinal diseases				
Yes	7	3.89	14	7.78
No	173	96.11	166	92.22
History of CRC screening				
Yes	90	50.00	90	50.00
No	90	50.00	90	50.00
History of rectal breeding				
Yes	16	8.89	14	7.78
No	135	75	141	78.33
No noticed	29	16.11	25	13.89
History of family with cancer				
Yes	154	85.56	155	86.11
No	12	6.67	11	6.11
Father or mother	1	0.56	3	1.67
Grandfather / grandmother	5	2.78	8	4.44
Sibling	0	0.00	2	1.11
Spouse / Aunt / Uncle	8	4.44	1	0.56

(23.89%). These findings suggest that, despite some level of health literacy related to CRC, many lacked the awareness, skills, and resources necessary to seek and utilize screening services effectively.

These findings highlight that improved access to health services and higher health literacy are critical factors in increasing CRC screening attendance. Individuals who attended annual health check-ups were more likely to participate in CRC screenings, potentially due to receiving relevant health information. Those with chronic conditions such as hypertension (28.89%), hyperlipidemia (20.56%), and diabetes (12.78%) may have had more frequent interactions with healthcare providers, increasing their awareness of CRC and the importance of screening. Additionally, participants with an educational level of senior high school or higher (66.67%) demonstrated greater screening attendance compared to those with lower educational attainment. This underscores the pivotal role of education and health literacy in enabling individuals to understand and prioritize CRC screening, ultimately contributing to better health outcomes.

This study focuses the strong association between annual physical check-ups and CRC screening attendance. Among cases (screening attendees), 47.78% reported regular check-ups, compared to only 30.00% of controls. Routine health check-ups not only enhance access to healthcare but also create opportunities for providers to discuss and recommend CRC screening, significantly influencing patients' decisions [22, 23]. Those attending check-ups often exhibit greater trust in their providers and heightened awareness of CRC risks, particularly among individuals aged 50–70—a high-risk group, with mean ages of 59.79 years (cases) and 58.86 years (controls). Conversely, those skipping check-ups may encounter barriers such as time constraints, fear of diagnosis, or low perceived susceptibility, deterring them from screening. These findings highlight the critical role of routine health monitoring in fostering preventive health behaviors and addressing barriers to CRC screening, ultimately improving participation rates [24].

To enhance the practical application of our findings, we recommend that policymakers and healthcare providers implement targeted interventions to increase CRC screening participation. Strategies such as simplifying test procedures, securing general practitioner endorsements, and conducting telephone outreach have proven effective

Table 3 Bivariate analysis of factors associated with colorectal cancer screening attendance among individual at risk (n = 360)

Factors	n (%) CRC screening		OR	95%CI	p-value
	Yes	No			
Sex					0.445
Males	63 (47.37)	70 (52.63)	1		
Females	117 (51.54)	110 (48.46)	1.18	0.77-1.81	
Age (Year)					0.399
50 - 59	91 (47.89)	99 (52.11)	1		
60 - 70	89 (52.35)	81 (47.65)	1.2	0.79 - 1.81	
Body mass index (BMI: kg/m^2)					0.054
Underweight (<18.5)	4 (22.22)	14 (77.78)	1		
Normal weight (18.5 - 22.9)	69 (53.91)	59 (46.09)	4.16	1.30 - 13.35	
Overweight (>22.9)	107 (50.00)	107 (50.00)	3.47	1.11 - 10.87	
Waist circumstance					0.074
Normal (Male <90 cm; females <80 cm)	80 (45.20)	97 (54.80)	1		
Over waist circumstance	100 (54.64)	83 (45.36)	1.46	0.96 - 2.21	
Occupation					0.758
Unemployment	31 (56.36)	24 (43.64)	1		
Sales	32 (49.23)	33 (50.77)	0.75	0.36- 1.54	
Employees	63 (47.73)	69 (52.27)	0.71	0.38 - 1.33	
Agriculture	54 (50.00)	54 (50.00)	0.76	0.40 - 1.46	
Average income (Baht per month)					0.572
≤3,000	55 (47.83)	60 (52.17)	1		
>3,001	125 (51.02)	120 (48.98)	1.14	0.73 - 1.77	
Education					0.049
Junior high school or lower	129 (47.08)	145 (52.92)	1		
Senior high school or higher	51 (59.30)	35 (40.70)	1.64	1.01 - 2.68	
Underlying diseases					0.461
No	84 (48.00)	91 (52.00)	1		
Yes	96 (51.89)	89 (48.11)	1.17	0.77-1.77	
History of annual physical check ups					<0.001
Yes	86 (61.43)	54 (38.57)	1		
No	94 (42.73)	126 (57.27)	0.47	0.30 - 0.72	
History illness of gastrointestinal diseases					0.122
Yes	7 (33.33)	14 (66.67)	1		
No	173 (51.03)	166 (48.97)	2.08	0.82 - 5.29	
History of rectal breeding					0.703
Yes	16 (53.33)	14 (46.67)	1		
No	164 (49.70)	166 (50.30)	0.86	0.41 - 1.83	
History of family with cancer					0.829
No	154 (49.84)	155 (50.16)	1		
Yes	26 (50.98)	25 (49.02)	0.96	0.39 - 2.13	
Levels of health literacy related to CRC					0.777
Fair	12 (46.15)	14 (53.85)	1		
Good	42 (53.16)	37 (46.84)	1.32	0.54 - 3.22	
Very good	126 (49.41)	129 (50.59)	1.14	0.51 - 2.56	
Levels of social supports					0.199
Low	7 (36.84)	12 (63.16)	1		
Moderate	104 (47.93)	113 (52.07)	1.58	0.60 - 4.16	
High	69 (55.65)	55 (44.35)	2.15	0.79 - 5.83	
Levels of family supports					0.214
Low	117 (47.76)	128 (52.24)	1		
High	63 (54.78)	52 (45.22)	1.33	0.85 - 2.07	

OR, Odd Ratios; 95%CI, 95 Percent confidence interval

Table 4. Multivariate Analysis of Factors Associated with Colorectal Cancer Screening Attendance among Individual at Risk (n = 360)

Factors	OR (95%CI)	AOR (95%CI)	p-value
Having annual physical check-ups			<0.001
Yes	1	1	
No	0.47 (0.30 - 0.72)	0.45 (0.29 - 0.70)	
Body mass index (BMI: kg/m2)			0.049
Underweight (<18.5)	1	1	
Normal weight (18.5 - 22.9)	4.16 (1.30 - 13.35)	3.91 (1.20 - 12.77)	
Overweight (>22.9)	3.47 (1.11 - 10.87)	3.10 (0.97 - 9.91)	
History of gastrointestinal diseases			0.073
Yes	1	1	
No	2.08 (0.82 - 5.29)	2.42 (0.92 - 6.33)	

OR, Odd Ratios; AOR, Adjusted Odd Ratios; 95%CI, 95 Percent confidence interval; -2 Log Likelihood, 477.106; Cox & Snell R Square, 0.059; Nagelkerke R Square = 0.079

in boosting screening rates [25]. Additionally, providing and sustainably funding community-oriented outreach and support services can promote appropriate screening and follow-up care, thereby facilitating equitable access to cancer screening [26]. By adopting these approaches, healthcare systems can address barriers to CRC screening and improve early detection rates.

A history of annual physical check-ups may indicate better overall health literacy and engagement in preventive care, as evidenced by 70.00% of cases and 71.67% of controls demonstrating "very good" health literacy. However, the absence of annual check-ups among 52.22% of cases and 70.00% of controls points to potential barriers such as financial constraints, time limitations, or low perceived susceptibility to CRC. These challenges align with findings from [27], which highlight disparities in access to preventive care services. Additionally, physical activity and psychological factors play a significant role in CRC screening participation. A study from Northwestern Turkey reported that individuals not engaging in regular physical activity were significantly less likely to attend CRC screening (OR = 2.52, 95% CI: 1.25–5.06) [28]. This underscores the importance of health-promoting behaviors in adherence to screening [29]. Incorporating physical activity education into health promotion campaigns may enhance participation in preventive services.

Furthermore, implementing organized CRC screening programs has been associated with substantial decreases in CRC incidence and mortality within short time intervals [30]. Additionally, studies have demonstrated that screening colonoscopy is associated with a significant reduction in the risk of death from CRC [31]. The effectiveness of FIT in reducing CRC mortality has also been well documented, with a 62% reduction observed in screened populations [32]. These findings underscore the critical role of CRC screening programs in improving public health outcomes globally.

Psychological barriers and procedural concerns significantly influence CRC screening participation. A U.S. cross-sectional study of individuals aged 40–75 identified fear of invasive procedures (54.2%), concerns about completing colon preparation (41.3%), and doubts about screening test accuracy (41%) as key reasons for non-attendance [33]. These findings underscore the need for tailored educational interventions to alleviate test-related fears and improve understanding of the benefits and reliability of CRC screening methods. Similarly, Janz et al. [34] reported common barriers, including forgetting to complete tests (38.5% for fecal occult blood tests) and fear of pain (29.8% for colonoscopy). Notably, individuals with prior colonoscopy experience were more likely to prefer invasive tests (OR = 6.50, 95% CI: 2.90–14.50), whereas those concerned about discomfort favored less invasive options like fecal tests (OR = 0.39, 95% CI: 0.17–0.87). These findings highlight the importance of addressing individual preferences and psychological concerns to enhance CRC screening uptake.

This study highlights a significant link between BMI and CRC screening attendance. Participants with a normal BMI (18.5–22.9) were more likely to attend screening compared to those with an underweight BMI (<18.5), with 38.33% of cases having a normal BMI versus 32.22% of controls. Individuals with a normal BMI may perceive themselves as more health-conscious, encouraging participation in preventive behaviors like CRC screening. In contrast, underweight individuals (7.78% of controls vs. 2.22% of cases) might face challenges such as chronic illness or competing health priorities, aligning with findings from Lee KM et al. [35]. While most participants were overweight (BMI >22.9: 59.44% of cases, 60.00% of controls), many may not fully recognize the link between obesity and CRC risk. Studies show that those who understand this connection are twice as likely to engage in preventive behaviors like CRC screening (AOR = 2.0, 95%CI: 1.01-3.80) [36, 37]. These findings highlight the importance of raising awareness about the obesity-CRC connection to improve screening adherence.

Interestingly, although BMI categories were similar between cases and controls, a higher proportion of controls (53.89%) had a normal waist circumference compared to cases (44.44%). This finding suggests that abdominal obesity, as measured by waist circumference, may have a subtle yet significant impact on health behaviors and CRC screening attendance. Study by Langford AT et al. [37]

highlight the importance of social support in promoting preventive health behaviors; individuals with friends or family to discuss health matters were 2.3 times more likely to utilize preventive services. This highlights the potential for social networks to positively influence CRC screening participation. Addressing barriers faced by individuals with underweight BMI and abdominal obesity [22], while leveraging social support networks and increasing awareness of obesity-related CRC risks, could play a crucial role in improving CRC screening rates [38]. This comprehensive approach could enhance participation and reduce disparities in screening adherence.

Strength and Limitation of the Study

This study focuses on individuals aged 50 to 70, a high-risk group for CRC, providing valuable insights into factors influencing CRC screening participation. By examining socio-demographic characteristics, health behaviors, and social support, the study offers a comprehensive understanding of the determinants impacting screening rates. The use of statistical analysis enhances the reliability of findings, allowing meaningful conclusions to be drawn. Additionally, the study emphasizes the importance of CRC awareness within this age group, highlighting the need for targeted educational interventions to promote preventive health behaviors. These findings contribute to the growing body of knowledge on CRC screening and have the potential to inform future public health strategies and policies aimed at increasing screening rates. Moreover, our study demonstrated higher precision and included a sufficiently large sample size to detect an association. The power analysis was conducted using the prevalence of CRC screening attendance among cases (61.43%) and controls (38.57%). At a 95% two-sided confidence interval, the study achieved a statistical power of 99.27% based on normal approximation and 99.02% with continuity correction applied [39].

However, the study has notable limitations. Its cross-sectional design restricts the ability to establish causal relationships, necessitating longitudinal studies to clarify the directionality of associations. Reliance on self-reported data introduces the potential for reporting biases, including overreporting or underreporting of behaviors. Moreover, the findings may not be generalizable beyond the study's specific geographic and demographic context, as screening behavior can be influenced by cultural, economic, and healthcare system differences in other regions. Additionally, this study did not extensively examine psychological barriers, such as fear of diagnosis, concerns about screening procedures, or fatalistic beliefs, which have been identified as key factors affecting CRC screening participation in previous study [40]. Future studies should integrate qualitative methods or validated psychological measures to gain deeper insights into these factors. Healthcare access, including availability of screening facilities, transportation barriers, and financial constraints, was also not fully assessed, though these factors are known to impact screening uptake. [41] Addressing these barriers through further research could help develop targeted interventions to improve CRC screening participation. Selection bias may also have occurred if certain subgroups, particularly those with lower awareness, were underrepresented. Despite these limitations, the study provides significant insights into CRC awareness and screening participation among high-risk individuals, offering a foundation for future research and public health initiatives.

Implication

This study highlights the importance of improving CRC awareness and screening participation among individuals aged 50 to 70. Targeted public health interventions, particularly for those who have not participated in screening, are essential. Tailored education and outreach initiatives can enhance awareness and encourage proactive health behaviors [42]. The significant association between education level and screening participation suggests that accessible information about CRC and its screening could increase rates, especially among individuals with lower educational attainment. Moreover, the strong link between annual health check-ups and CRC screening underscores the effectiveness of promoting routine health assessments as a gateway to preventive behaviors [43].

To improve health literacy and accessibility, public health strategies should focus on integrating CRC screening education into routine primary healthcare services while leveraging digital tools such as mobile applications and SMS reminders to enhance awareness and participation. Expanding community-based programs, including mobile screening units and outreach campaigns, can bridge accessibility gaps, particularly in rural and underserved areas. Additionally, subsidized screening programs or financial assistance initiatives could help reduce economic barriers, ensuring equitable access to CRC screening. Strengthening health promotion campaigns that emphasize the benefits of early detection, flexible appointment scheduling, and decentralized screening services can further increase participation and reduce disparities among high-risk populations. These targeted interventions can play a crucial role in enhancing CRC screening rates, ultimately improving public health outcomes.

While social support and family history were not significant factors, addressing other barriers, such as limited awareness and motivational gaps, is vital for effective interventions. The study shows that general awareness does not always translate to action, underlining the need for programs that not only inform but also empower individuals to participate. These findings provide valuable insights for policymakers, guiding resource allocation toward campaigns that address barriers and enhance early detection efforts, ultimately reducing CRC incidence.

In conclusion, this study highlights critical insights into CRC awareness and screening participation among individuals aged 50 to 70. Key factors such as education level, annual health check-ups, and BMI significantly influenced screening rates, emphasizing the need for targeted interventions to promote regular check-ups and educational outreach. Despite good CRC awareness,

barriers like lack of motivation and access persist, underlining the importance of comprehensive health education programs to encourage action. Factors like social support and family history showed no significant impact, helping refine intervention strategies. Addressing access-related barriers through decentralized screening programs, financial incentives, and physician-led initiatives could further enhance participation and reduce disparities. Enhancing CRC screening participation remains essential for early detection and better health outcomes.

Author Contribution Statement

B.C. and S.W. conceptualized and designed the study. A.B., N.C., B.C., and S.W. contributed to drafting the research proposal and conducting the literature review. Data collection and verification were carried out by A.B., N.C., K.S., S.C., B.C., and S.W. Data analysis and interpretation were performed by A.B., N.C., B.C., and S.W. The initial manuscript was drafted by B.C. and S.W., under the supervision of A.B., N.C., K.S., S.C., B.C., and S.W. All authors reviewed and approved the final manuscript prior to submission.

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Availability of data and materials

Permission was obtained from the director of Chalerm Phrakiat Hospital to access and utilize the hospital's database containing the registry of individuals aged 50–70 years at risk for CRC.

Conflicts of interest

There are no conflicts of interest.

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