RESEARCH ARTICLE

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Exploring Gender Disparities in Factors Influencing Colorectal Cancer Screening Compliance in Singapore

Qing Huang*, Li Ying Tan

Abstract

Objective: The uptake of colorectal cancer (CRC) screening remains suboptimal in Singapore. Existing research highlights gender-related disparities in screening behaviors. This study aims to evaluate the gender differences in factors associated with CRC screening compliance in Singapore, with a specific focus on cancer screening beliefs and knowledge on CRC screening guidelines. **Methods:** Data were collected from an online survey on cancer screening belief, knowledge, and practices in Singapore. Multivariate logistic regression analysis was conducted to identify independent factors associated with compliance in CRC screening. **Results:** The study included 633 participants aged 50-69 years, eligible for CRC screening. Only 132 participants (20.9%) complied with CRC screening guidelines with no significant gender differences observed in compliance rates. Most participants held positive beliefs on routine screening (86.9%) and perceived screening benefits in improving treatment outcomes (89.6%) and reducing mortality rates (77.6%). However, both genders exhibited limited knowledge regarding CRC screening guidelines. Only 28.3% were aware that CRC screening should commence at age 50 years. While nearly half of participants knew FIT (44.7%) and colonoscopy (52.0%) as CRC screening modalities, only 27.5% and 15.2% recognized the recommended intervals for FIT and colonoscopy screening respectively. Multivariate analysis revealed a positive association between knowledge on CRC screening guidelines and CRC screening compliance for both genders. Gender-specific variations were observed in the factors associated with CRC screening compliance. Specifically, women with a family history of cancer, believing in routine cancer screening, and prior adherence to breast cancer screening and men within the older cohort (55-69 years) were more likely to comply with CRC screening. **Conclusion:** Low compliance with CRC screening was observed in Singapore. Targeted interventions should address gender-specific factors and highlight CRC screening guidelines as a crucial component of cancer education for entire screening eligible population in order to improve CRC screening compliance.

Keywords: Colorectal cancer- screening guidelines- screening compliance- gender differences

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Introduction

Colorectal cancer (CRC) is a major health concern globally and has been one of the top cancers in Singapore over the past few decades [1]. CRC screening is recommended by global health authorities as an evidence-based and effective approach to reduce the burden of CRC by mitigating its incidence and mortality [2, 3]. In Singapore, the Ministry of Health has issued Clinical Practice Guidelines on Cancer Screening, which advise individuals with average risk to start CRC screening at the age of 50, either having a fecal immunochemical test (FIT) annually or a colonoscopy once every 10 years [4]. Singapore has implemented a nationwide CRC screening programme Screen for Life, which encourages individuals aged 50 and above to go for regular CRC screening using FIT. Those with positive FIT results will be referred for follow-up colonoscopy at public hospitals. Additionally, the Singapore Cancer Society has been actively promoting CRC screening through the distribution of complimentary FIT kits to eligible individuals since 2002. However, despite these multifaceted efforts, the uptake of CRC screening in Singapore remains suboptimal, with less than 40% of the eligible population complying with the recommended guidelines [4, 5]. This underscores the urgent need to understand factors associated with screening behavior and improve CRC screening compliance among the eligible population in Singapore.

Prior studies have highlighted gender-related disparities in screening practices, emphasizing the necessity of adopting a gender-specific approach to enhance CRC screening uptake [6, 7]. However, the role of gender in shaping the interplay between cancer screening beliefs, knowledge on CRC screening guidelines, and screening compliance remains an area with limited exploration. While numerous studies have extensively

*Department of Research and Data Analytics, Singapore Cancer Society, Singapore. *For Correspondence: huang_qing@singaporecancersociety.org.sg*

explored into CRC screening practices using established frameworks such as the Health Belief Model [8], this study aimed to focus specifically on cancer screening beliefs and knowledge on screening guidelines, which have emerged as potential determinants influencing individual screening intentions and actions [9, 10] and can be effectively addressed through educational campaigns and interventions.

This study aims to evaluate the gender differences in factors influencing CRC screening compliance in Singapore, with a specific focus on cancer screening beliefs and knowledge on CRC screening guidelines. We hypothesized gender-specific associations between cancer screening beliefs, knowledge on CRC screening guidelines, and CRC screening compliance. The results of this study will offer valuable insights to inform targeted interventions and address any existing gender-based barriers to CRC screening compliance.

Materials and Methods

Study Population and Recruitment

Data used in this study was derived from a cross-sectional online survey conducted by the Singapore Cancer Society in Singapore in June 2021. The survey aimed to examine cancer awareness, knowledge, and screening practices among adult Singaporeans. A total of 2,000 Singapore citizens and permanent residents aged 21 to 69 years were recruited via Toluna online Panel (www.toluna.com), which comprises panelists who agreed to participate in online survey research administered by Toluna. Toluna, a market research company, employed advanced technologies such as Duplicate Respondent Detection™ cookie-based technology, digital fingerprinting, and proprietary algorithms to minimize the likelihood of duplicate responses. Furthermore, Toluna implemented rigorous measures and processes as a form of quality checks to ensure data quality throughout the survey administration [11].

To recruit participants, Toluna employed a multi-channel approach, reaching out to potential participants in their databases through email, mobile text, and the Toluna App, with a direct link to the online survey hosted on Toluna's platform. Potential participants were subsequently guided to the online informed consent form. Those who provided consent underwent a screening procedure to ensure their eligibility to the survey (Singapore citizen or permanent resident, aged 21-69 years). Quotas on gender, age, and ethnicity reflective of the Singapore population were also managed. Eligible participants who met these criteria under each quota were then granted access to the survey. Upon completion of the entire questionnaire, participants received incentives in the form of "Toluna points," which could be redeemed for vouchers or cash at the Toluna site.

To assess the relationship between the beliefs, knowledge, and practices regarding CRC screening among eligible individuals in Singapore, this study focused on individuals aged 50 years and above and excluded those who were diagnosed with cancer, considering their potential regular screening during treatment follow-up. Participants who responded with "No" to the question "Have you heard about cancer screening?" were classified as unaware of cancer screening and subsequently excluded. In summary, of the initial 2,000 survey participants, those below 50 years of age (n=1,198), unaware of cancer screening (n=455), or had a history of cancer (n=44) were excluded from the analysis. Data from a total of 633 participants was included for further analysis.

Results

Questionnaire and Data Collection

The anonymous, self-administered online questionnaire explored sociodemographic variables, health-related factors, beliefs on cancer screening, knowledge on CRC screening guidelines, and compliance of CRC screening. The outcome variable of this study, compliance of CRC screening, was defined as having had a FIT in the past year and/or a colonoscopy within the last decade, following the national cancer screening guidelines in Singapore [4]. Screening compliance status was determined based on self-reported answers to the questions on the timing of their last FIT or colonoscopy. Sociodemographic variables included age, gender, ethnicity, marital status, education level, and employment status. Health-related factors included family history of cancer and compliance to breast and cervical cancer screening (for women only) (Table 1).

The beliefs on cancer screening were evaluated using 5 items on the necessity of screening before symptom onset, routine screening, and the perceived benefits of cancer screening on treatment costs, outcomes and mortality rates (as shown in Table 2). Participants rated their level of agreement with each statement on a 5-point Likert scale. The responses were dichotomized into two categories for analysis: (i) strongly agree/agree and (ii) neutral/disagree/strongly disagree.

The knowledge CRC screening guideline knowledge and screening compliance for both genders (Men: OR=1.99, 95%CI 1.62-2.46; Women: OR=2.69, 95%CI 2.01-3.61). For men only, older age was correlated with higher screening compliance. Specifically, men aged 55-59 (OR=3.12, 95%CI 1.25-7.80), 60-64 (OR=2.99, 95%CI 1.12-7.99), and 65-69 (OR=3.53, 95%CI 1.21-10.28) demonstrated higher likelihoods of CRC screening compliance compared to those aged 50-54 (Table 3,4). Among women, significant predictors included believing in routine cancer screening for early cancer detection (OR=12.07, 95%CI 1.39-105.00), having a family history of cancer (OR=2.52, 95%CI 1.20-5.31), and compliance with breast cancer screening (OR=3.12, 95% CI 1.35-7.24). These factors were associated with an increased likelihood of complying with CRC screening (Table 4).

Statistical Analysis

All analyses were stratified by gender. Descriptive statistics were used to report the sociodemographic and health-related characteristics, beliefs on cancer screening, knowledge on CRC screening guidelines, and compliance to screening among survey participants. Numerical variables were summarized as mean ± standard deviation (SD). Bivariate analysis was performed for each

Table 1. Sociodemographic and Health-Related Characteristics of the Study Population (n=633)

Characteristic	Total (n=633)		Male (n=350)		Female (n=283)		p-value
	n	%	n	%	n	%	
Age							
Mean (SD)	58.2 (4.83)		58.3 (4.96)		58.2 (4.67)		
50-54	131	20.7	75	21.4	56	19.8	0.800
55-59	262	41.4	142	40.6	120	42.4	
60-64	157	24.8	84	24.0	73	25.8	
65-69	83	13.1	49	14.0	34	12.0	
Ethnicity							
Chinese	525	82.9	291	83.1	234	82.7	0.488
Malay	42	6.6	25	7.1	17	6.0	
Indian	40	6.3	18	5.1	22	7.8	
Others	26	4.1	16	4.6	10	3.5	
Marital status							
Married	482	76.1	292	83.4	190	67.1	<0.001
Single/divorced/widowed	151	23.9	58	16.6	93	32.9	
Education							
Primary	25	3.9	10	2.9	15	5.3	<0.001
Secondary	137	21.6	58	16.6	79	27.9	
Post-secondary	471	74.4	282	80.6	189	66.8	
Employment status							
Employed	512	80.9	293	83.7	219	77.4	0.044
Unemployed/studying/retired	121	19.1	57	16.3	64	22.6	
Family history of cancer							
Yes	218	34.4	116	33.1	102	36.0	0.445
No/don't know	415	65.6	234	66.9	181	64.0	
Compliance of cancer screening*							
Colorectal cancer screening	132	20.9	73	20.9	59	20.8	0.998
Breast cancer screening	-	-	-	-	69	24.4	
Cervical cancer screening	-	-	-	-	33	11.7	

* Colorectal cancer screening compliance refers to having had either FIT within last 1 year or colonoscopy within last 10 years. Breast cancer screening compliance refers to having had mammogram screening within last 2 years. Cervical cancer screening compliance refers to having had Pap smear within last 3 years or Human papillomavirus (HPV) test within last 5 years.

Table 2. Prevalence of Beliefs on Cancer Screening and Knowledge on CRC Screening Guidelines among Men and Women

Statement	Total (n=633)		Men (n=350)		Women (n=283)		p-value
	% Agree/aware		% Agree/aware		% Agree/aware		
	n	%	n	%	n	%	
Beliefs on cancer and cancer screening							
Cancer screening should be done before a person has any symptom.	505	79.8	279	79.7	226	79.9	0.964
Routine cancer screening is necessary to detect cancer early.	550	86.9	300	85.7	250	88.3	0.331
Finding cancer early means less treatment costs.	457	72.2	263	75.1	194	68.6	0.066
Finding cancer early means better treatment outcomes.	567	89.6	316	90.3	251	88.7	0.514
Cancer screening is effective in reducing people's risk of dying from cancer.	491	77.6	268	76.6	223	78.8	0.504
Knowledge on CRC screening guidelines							
Screening for colorectal cancer should begin at age 50 years.	179	28.3	112	32.0	67	23.7	0.021
I am aware of FIT for the test for colorectal cancer screening.	283	44.7	156	44.6	127	44.9	0.939
FIT should be done annually.	174	27.5	86	24.6	88	31.1	0.068
I am aware of colonoscopy for the test for colorectal cancer screening.	329	52.0	185	52.9	144	50.9	0.621
Colonoscopy should be done once every 10 years.	96	15.2	54	15.4	42	14.8	0.838
CRC screening guideline knowledge score (mean ± SD)	1.68 ± 1.55		1.69 ± 1.51		1.65 ± 1.60		0.651

Table 3. Association between Sociodemographic and Health-Related Characteristics, Beliefs on Cancer Screening, CRC Screening Guideline Knowledge and CRC Screening Compliance among Men and Women

	Men (n=350)				p-value	Women (n=283)				p-value
	Non-compliance to CRC screening		Compliance to CRC screening			Non-compliance to CRC screening		Compliance to CRC screening		
	n	%	n	%		n	%	n	%	
Sociodemographic And Health-Related Characteristics										
Age										
50-54	67	24.2	8	11.0	0.097	45	20.1	11	18.6	0.647
55-59	109	39.4	33	45.2		97	43.3	23	39.0	
60-64	65	23.5	19	26.0		54	24.1	19	32.2	
65-69	36	13.0	13	17.8		28	12.5	6	10.2	
Ethnicity										
Chinese	228	82.3	63	86.3	0.418	181	80.8	53	89.8	0.103
Non-Chinese	49	17.7	10	13.7		43	19.2	6	10.2	
Marital status										
Married	225	81.2	67	91.8	0.031	151	67.4	39	66.1	0.849
Single/divorced/widowed	52	18.8	6	8.2		73	32.6	20	33.9	
Education										
Secondary & below	59	21.3	9	12.3	0.085	82	36.6	12	20.3	0.018
Post-secondary	218	78.7	64	87.7		142	63.4	47	79.7	
Employment status										
Employed	234	84.5	59	80.8	0.452	172	76.8	47	79.7	0.639
Unemployed/studying/retired	43	15.5	14	19.2		52	23.2	12	20.3	
Family history of cancer										
Yes	86	31.0	30	41.1	0.105	73	32.6	29	49.2	0.018
No/don't know	191	69.0	43	58.9		151	67.4	30	50.8	
Breast cancer screening compliance										
No	-	-	-	-	-	182	81.3	32	54.2	<0.001
Yes	-	-	-	-		42	18.8	27	45.8	
Cervical cancer screening compliance										
No	-	-	-	-	-	206	92.0	44	74.6	<0.001
Yes	-	-	-	-		18	8.0	15	25.4	
Beliefs On Cancer Screening										
Cancer screening should be done before a person has any symptom.										
Disagree/neutral	63	22.7	8	11.0	0.026	49	21.9	8	13.6	0.157
Agree	214	77.3	65	89.0		175	78.1	51	86.4	
Routine cancer screening is necessary to detect cancer early.										
Disagree/neutral	48	17.3	2	2.7	0.002	32	14.3	1	1.7	0.007
Agree	229	82.7	71	97.3		192	85.7	58	98.3	
Finding cancer early means less treatment costs.										
Disagree/neutral	71	25.6	16	21.9	0.514	76	33.9	13	22.0	0.080
Agree	206	74.4	57	78.1		148	66.1	46	78.0	
Finding cancer early means better treatment outcomes.										
Disagree/neutral	30	10.8	4	5.5	0.170	27	12.1	5	8.5	0.440
Agree	247	89.2	69	94.5		197	87.9	54	91.5	
Cancer screening is effective in reducing people's risk of dying from cancer.										
Disagree/neutral	70	25.3	12	16.4	0.113	52	23.2	8	13.6	0.106
Agree	207	74.7	61	83.6		172	76.8	51	86.4	
CRC Screening Guideline Knowledge Score										
Mean ± SD	1.38 ± 1.42		2.88 ± 1.22		<0.001	1.25 ± 1.48		3.19 ± 1.01		<0.001

Table 4. Multivariate Logistic Regression Model Indicating Adjusted Odds Ratios for CRC Screening Compliance among Men and Women

	Men (n=350)		Women (n=283)	
	Compliance to CRC screening		Compliance to CRC screening	
	Adjusted OR*	95% CI	Adjusted OR*	95% CI
Age group				
50-54	Reference		NE~	
55-59	3.12	1.25-7.80		
60-64	2.99	1.12-7.99		
65-69	3.53	1.21-10.28		
Family history of cancer				
No	NE~		Reference	
Yes			2.52	1.20-5.31
Breast cancer screening compliance				
Never screened	NA^		Reference	
Ever screened			3.12	1.35-7.24
Cervical cancer screening compliance				
Never screened	NA^		Reference	
Ever screened			2.42	0.86-6.83
Routine cancer screening is necessary to detect cancer early.				
Disagree/neutral	Reference		Reference	
Agree	4.37	0.98-19.45	12.07	1.39-105.00
CRC screening guideline knowledge score	1.99	1.62-2.46	2.69	2.01-3.61

* OR adjusted for other significant factors obtained from backward multivariate logistic regression analysis using variables with p-value <0.1 in bivariate analysis as candidate variables; ^ NA, not applicable for multivariate analysis; ~ NE, not entered multivariate analysis.

potential influencing factor associated with CRC screening compliance. Variables with $p < 0.1$ from bivariate analysis were chosen as candidate variables for multivariate logistic regression analysis (with backward elimination). Adjusted odds ratios (OR) and 95% confidence intervals (CI) in the final logistic model were presented. Descriptive and bivariate analysis was performed using IBM SPSS Statistics Version 28.0, employing a two-sided test with a significance level of 5%. Multivariate logistic regression analysis was conducted using R version 4.2.2.

Discussion

Despite majority of the participants held the favorable beliefs on cancer screening, the compliance rate on CRC screening in our surveyed population was merely 20.9%. This rate falls below the levels reported in previous studies in Singapore [5, 6]. Even with the consideration of the potential impact of the COVID-19 pandemic, during which some participants might have postponed their CRC screenings, the observed compliance rate remains unacceptably low. This highlights the pressing need to further understand the underlying factors that influence compliance with CRC screening in Singapore.

In this study, we identified the following gender disparities in the factors influencing CRC screening compliance. Firstly, older age was positively correlated with CRC screening compliance among men, but not women. Specifically, men in the younger cohort (50-54 years), newly eligible for screening, were less likely to comply with CRC screening, mirroring similar findings in the study by Sinicrope et al. [12] where individuals delayed starting CRC screening by up to 5 years. This suggests the existence of potential barriers to screening within this specific age cohort. In our study, most non-compliant male participants in the 50-54 age group cited "feeling healthy" or "no need to undergo screening" as the primary justifications for their non-participation (data not shown). Interventions should be tailored for younger men aged 50-54 years to help address their unique barriers and improve their compliance rates. Moreover, CRC screening messages may be disseminated earlier to individuals under the age of 50. This approach could increase awareness and pave the way for better participation in CRC screening when these individuals reach the recommended screening age.

Secondly, the belief in the necessity of routine cancer screening was strongly associated with CRC screening compliance among women, but not men. Taking into account the myriad factors involved, it is crucial to consider the potential influence of cultural and societal factors on healthcare-seeking behavior and compliance with cancer screening guidelines. Previous research has indicated that women tend to prioritize healthcare seeking and preventive measures more than men [13, 14]. This could explain the higher likelihood of compliance with CRC screening among women who believe in the necessity of routine cancer screening. On the other hand, men may face unique challenges or barriers that affect their willingness to comply with CRC screening, such

as higher levels of cancer stigma compared to women [15]. Tailoring educational campaigns for women to emphasize the necessity of routine screening may be more impactful. These campaigns can highlight the benefits of early detection and prevention of CRC through routine screening. In contrast, interventions for men should address a diverse array of factors that potentially affect their CRC screening compliance.

Thirdly, having a family history of cancer was shown to be a predictor of CRC screening compliance among women; however, this correlation was not observed among men. This aligned with the study by Wong et al. [6] and may be attributed to women's inclination to take on caregiving roles within families and perceive more personal risk linked to family cancer history. This perception may act as a motivating factor for their screening compliance. Conversely, men might not share the same caregiving responsibilities, leading less focus on family medical history and a potentially lower perception on cancer risks.

Meanwhile, prior compliance with breast cancer screening emerged as an independent factor associated with CRC screening compliance among women. CRC screening rates have been reported to lag behind breast cancer screening rates [16]. Simultaneous offering of CRC and breast cancer screening was reported to enhance CRC screening rates [17]. Women who adhere to breast cancer screening might potentially exhibit a predisposition towards accepting screening for various cancer types. The integration of CRC and breast cancer screening could also reduce logistic challenges and achieve better engagement among women who may be susceptible to preventive healthcare yet encounter barriers to compliance. Implementing such integrated approach would be beneficial for healthcare systems to increase overall cancer screening rates and potentially improve outcomes for multiple cancers.

While there were gender differences in predictors of CRC screening compliance, the positive association between knowing CRC screening guidelines and screening compliance was consistent for both genders. Numerous studies have explored the influence of individuals' knowledge on cancer screening as a potentially modifiable factor affecting the screening behavior. However, the findings in this area were mixed. While some research highlighted the importance of knowledge related to cancer and screening guidelines as crucial factors influencing individual screening intent or practice [9, 10, 18, 19]; contrasting studies have reported a lack of significant association between CRC knowledge gained and the intention to undergo CRC screening [20, 21]. The results in this study not only align with prior studies showing a positive correlation between screening knowledge and screening practice, but also emphasize the need to highlight CRC screening guidelines in cancer education efforts among both genders. This should be part of a multifaceted strategy that includes synergistic collaboration between healthcare providers and community stakeholders through diverse communication platforms.

There are a number of limitations to this study. Firstly, we recruited our sample through Toluna online panel, which may introduce bias as the sample is made up of technology literate individuals who signed up as online panellists. This could have resulted in the over-representation of individuals with higher education levels and the exclusion of specific demographics, particularly among the elderly, who may lack reliable internet access or familiarity with digital technologies. Secondly, this study used self-reported measures of CRC screening practices that could have been over-reported or under-reported. The absence of an integrated screening monitoring system in Singapore made it challenging to validate participants' screening practices, highlighting the need for a national approach for electronic data collection and dissemination for cancer screening. Finally, our evaluation of beliefs on cancer screening was generalised, and there is a chance that beliefs and actions vary across different types of cancer. Consequently, attitudes towards cancer screening in general may have an unequal impact on specific screening practices.

In conclusion, our study highlights inadequate knowledge of CRC screening guidelines and low compliance of CRC screening among eligible individuals in Singapore. Older age, belief in the necessity of routine cancer screening, and having a family history of cancer were linked to CRC screening compliance with gender-specific differences. Women who complied with breast cancer screening were more likely to comply with CRC screening. Notably, knowledge on CRC screening guidelines was positively associated with CRC screening compliance across both genders. To improve CRC screening compliance, targeted interventions should address gender-specific factors and highlight CRC screening guidelines as a crucial component of cancer education for entire screening eligible population.

Author Contribution Statement

Conception and design, methodology development, data acquisition: All authors; Manuscript writing, data analysis and interpretation: Q.H.; Manuscript review and revision: All authors

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General

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Approval

This study was approved by the Singapore Cancer Society.

Ethical Declaration

This study was granted an exemption by Agency for Integrated Care Institutional Review Board, Singapore because there was minimal risk posed to participants who

can withdraw from the study at any moment.

Data Availability

The data generated and/or analyzed during this study are available from the corresponding author on reasonable request.

Conflict of Interest

The authors declare no conflicts of interest.

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