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Awareness, Attitude and Barriers of Colorectal Cancer Screening Among High-risk Populations in China: a cross-sectional study

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Awareness, Attitude and Barriers of Colorectal Cancer Screening Among High-risk Populations in China

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Awareness, Attitude and Barriers of Colorectal Cancer Screening Among High-risk Populations in China: a cross-sectional study

Abstract

Objective: To assess the awareness, attitude and barriers of colorectal cancer screening among high-risk populations in China.

Design: A cross-sectional study was employed.

Setting: This study was conducted in ten hospitals in Hunan province, China.

Participants: Individuals with high-risk for colorectal cancer were interviewed using a pretested structured questionnaire.

Primary and secondary outcome measures: Knowledge, attitude of colorectal cancer screening, sociodemographic factors associated with colorectal cancer screening knowledge and behaviour, barriers of colorectal cancer screening.

Results: This study included 648 participants. The mean knowledge score was 11.86/24 (SD 4.84). But over 70% of them held a positive attitude towards screening. Only 13.3% had undergone colorectal cancer screening. Independent factors related to knowledge were education level of college or above, working as a white collar, higher income, having health insurance, having seen a doctor in the past year and with high perceived risk ($p<0.05$). Factors independently associated with screening behaviour included personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, high perceived risk and better knowledge ($p<0.05$). Main reasons for not undergoing screening were no symptoms or discomfort (71.1%), never thought of the disease or screening (67.4%), and doctor did not advise me (29.8%).

Conclusion: In China, the majority of high-risk people had deficient knowledge and never undergone colorectal cancer screening. But most of them held a positive attitude towards the benefits of colorectal cancer screening. This has promising implications to design targeted educational

campaigns and establish CRC screening programmes to improve colorectal cancer awareness and screening participation. Health care professionals should advise high-risk individuals to participate in CRC screening and inform them about cancer risk.

Keywords: colorectal cancer screening, awareness, barriers, prevention

Strengths and limitations of this study

- This study assessed the awareness, attitude and behaviour about colorectal cancer screening and explored the reasons underlying low screening rate among high-risk populations in China.
- These findings may be used as a reference for other countries with no screening programmes.
- The study achieved a high response rate and through face-to-face interviews by trained data collectors.
- The participants' screening history was self-reported, therefore, recall bias may have occurred.
- We might not cover of all of the barriers regarding screening uptake as only a quantitative method was used.

Introduction

Colorectal cancer (CRC) is the third most common cancer and the second leading cause of cancer death worldwide[1]. The World Health Organization (WHO) showed nearly half of new CRC cases were found in Asia, mostly in China[2]. CRC is the fifth most common malignancy in China, with 376,300 new cases and 191,000 deaths occurring in 2015[3]. The incidence rates and mortality rates of CRC in China continue to rise due to aging and growing population[4].

Early colorectal cancer has better prognosis than advanced and metastatic colorectal cancer[5]. However, most patients are diagnosed during the advanced stage of the disease with a poor prognosis[6,7]. In China, the 5-year survival rate of colorectal cancer is lower than in many developed countries such as Korea with a rising cancer burden[8-10], suggesting delays in diagnosis and treatment[11]. These studies indicate that there are problems regarding screening and prevention of this disease. High-risk populations are the key target populations of cancer screening[12]. To strengthen efforts to promote colorectal cancer prevention and control, it is particularly important to improve screening for prevention and early detection of colorectal cancer for high-risk populations in China. High-risk populations for developing colorectal cancer are individuals with colorectal diseases such as colorectal adenomas, inflammatory bowel disease and hereditary syndromes and those with a family history of colorectal cancer[13,14].

Colorectal cancer screening via colonoscopy is known as an effective method to prevent and detect early-stage CRC and improve survival and prognosis[15]. Despite the heavy burden of colorectal cancer in China, however, unlike in other East Asian countries such as Korea, there are no nationwide CRC screening guidelines or programmes[16]. As a result of the large populations but with an uneven distribution of health, medical and financial resources, opportunistic screening with colonoscopy in asymptomatic people is widely used in China[17]. Opportunistic screening is performed on a

voluntary basis and dependent on request from a physician or individual[18].

Unfortunately, screening rate of colorectal cancer in China is far away from satisfactory level. The majority (about 85%) of high-risk populations still never have done colorectal cancer screening according to the report by Chen H et al[19] in 2018. Key factors contributing to non-participation in colorectal cancer screening could be poor awareness of colorectal cancer screening, negative attitude towards screening and multiple barriers related to screening[20]. Previous studies suggested that the general population had deficient knowledge of colorectal cancer and screening[21,22]. Moreover, few studies also indicated that screening knowledge and practice were suboptimal among high risk population[23,24]. In China, fewer studies reported inadequate public knowledge and screening of colorectal cancer[25,26].

Currently, there are little studies exploring awareness, attitude and identify barriers for colorectal cancer screening among high-risk populations in China. Therefore, it is crucial to assess awareness, attitude and possible barriers that hinder CRC screening so that more effective approaches can be implemented to promote screening uptake. The objectives of this study were to (1) assess awareness, attitude and behaviour of colorectal cancer screening among high-risk populations in China, (2) examine sociodemographic factors associated with colorectal cancer screening knowledge and behaviour, (3) identify the barriers to colorectal cancer screening.

Methods

Setting and sample

This was a cross-sectional study conducted between April and August 2019. The sample size was calculated based on 15% of prevalence rate of colorectal cancer screening using a formula $N=[\mu^2\alpha/2\times\pi\times(1-\pi)]/\delta^2$[27], with 0.03 allowable error at 95% confidence interval. Considering the 40% non-response rate, the final sample size was 760.

Ten hospitals were selected from a total of 42 in Hunan province using a

cluster random sampling method. The source population were individuals from gastrointestinal department of hospitals with a high risk of developing colorectal cancer according to medical records. With the support of hospitals, each trained interviewer was accompanied by a medical staff to introduce the study aim. The inclusion criteria[13,14] included: (1) age 18 to 75 years, (2) a family history of colorectal cancer or adenomas, (3) a personal history of colorectal cancer or adenomas, (4) a personal history of inflammatory bowel disease, (5) a personal history of hereditary syndromes. The exclusion criteria[13,14] included: (1) age less than 18 years, (2) being diagnosed with colorectal cancer, (3) unable to communicate with the investigator, (4) severe cognitive impairment. Individuals who consented to participate in the study completed a standardized face-to-face questionnaire, which lasted for approximately 15 to 20 minutes. Each participants received ¥30 (about $4.2) for completing the survey. This study was approved by the Ethic Committee of the University of XX (No. 4304081009636) and informed consent was obtained from all participants prior to participation.

Instrument

The questionnaire included items about awareness, attitudes and screening for colorectal cancer. Survey items were identified from research literature[28,29], the American Cancer Society and China Anti-Cancer Association[30]. The questionnaire consisted of 4 sections. The first section comprised socio-demographic characteristics: gender, age, education level, occupation, marital status, residence, income, health insurance, and perceived health status, etc. The second part included 24 questions about knowledge of colorectal cancer: risk factors, warning signs and screening tests. Two items had multiple answers, so the scoring was 1 point for each correct answer and 0 point for the wrong answer or ‘don’t know’ with a total score of 24 points. The third section was related to attitudes toward the colorectal cancer screening: colorectal cancer is preventable, early colorectal cancer is curable, colonoscopy can help to find colorectal cancer early, colonoscopy can help to

prevent colorectal cancer, colonoscopy is beneficial, colonoscopy is important etc. The possible responses were 'yes', or 'no'. In the fourth section, participants were questioned whether they had ever undergone colorectal cancer screening with 'yes' or 'no' answer. Participants who answered 'no' would be asked to choose the reasons for not undergoing screening, and more than 1 choice was allowed. Mean knowledge scores were calculated based on the number of correct responses and total scores ranged from 0 to 24 points.

The reliability of the questionnaire was evaluated by pretesting in 80 people. The test-retest reliability of the second, third and fourth sections were 0.81, 0.83 and 0.79, respectively, while the Cronbach's a coefficients were 0.83 and 0.76 and 0.67, respectively.

Statistical analysis

Data were analysed using SPSS V.23. Descriptive statistics were used to describe the participants' socio-demographics and responses to each question. The $\chi 2$ or Fisher's exact test were used to find association between demographic factors and knowledge and behaviour of colorectal cancer screening. Variables with a p value ≤0.15 in the univariate analysis were included in multiple linear regression analysis to investigate the independent factors for screening knowledge, while variables with a p value ≤0.15 in the univariate analysis were included in the multivariate logistic regression analysis to identify the independent factors for screening behaviour. Only the results of the multivariate analysis were presented using odds ratios (OR) and 95% confidence intervals (CI), a p value of <0.05 was regarded as statistically significant.

Patient and public involvement

No participants were involved in our work. The study results will be made available to participants interested in this subject.

Results

Sample characteristics

Of the 760 high-risk individuals, 712 consented to involve in the study, of whom 28 completed less than 50% of the questionnaire. Thus, the final response rate was 90.0% (n=684). The mean age of participants was 47.01±7.39 years (range=27-74 years). Of the total sample, more than half (54.5%) of participants were men, 75.6% had high school education or below and 58.0% lived in urban areas. Almost all (94.4%) were married and 86.7% were insured. About 37.9% had low income. The majority (88.7%) had no personal history of colorectal disease and 93.1% had a family history of colorectal cancer or adenomas. Only 14.2% reported previous discussion of screening with the doctor and 13.7% perceived their risk of developing colorectal cancer was high. Other variables are listed in (Table 1).

Table 1 Participant characteristics(n=684)

Characteristics	N (%)
Gender	
Male	373 (54.5)
Female	311 (45.5)
Age (years)	
<40	79 (11.5)
40-49	399 (58.3)
50-59	163 (23.8)
>60	43 (6.3)
Mean±SD	47.01±7.39
Education level	
High school or below	517 (75.6)
College or above	167 (24.4)
Occupation	
Farmer	63 (9.2)
Worker	304 (44.4)

Unemployed	105 (15.4)
White collar	212 (31.0)
Marital status	
Single	38 (5.6)
Married	646 (94.4)
Residence	
Urban	397 (58.0)
Rural	287 (42.0)
Income(¥)	
<3000	259 (37.9)
3000-5000	207 (30.3)
>5000	218 (31.9)
Health insurance	
Yes	593 (86.7)
No	91 (13.3)
Self-reported health status	
Good	274 (40.1)
Fair	363 (53.1)
Poor	47 (6.9)
Personal history of colorectal disease	
Yes	77 (11.3)
No	607 (88.7)
Seen a doctor in the past year	
None	356 (52.0)
1-2 times	230 (33.6)
≥3 times	98 (14.3)
Previous discussion of colorectal cancer screening	
Yes	97 (14.2)

No	587 (85.8)
Family history of colorectal cancer or adenomas	
Yes	637 (93.1)
No	47 (6.9)
Perceived risk	
Low	248 (36.3)
Medium	342 (50.0)
High	94 (13.7)

Knowledge of colorectal cancer and screening

Table 2 presents knowledge of colorectal cancer and screening including risk factors, warning signs and screening tests. The mean total knowledge score was 11.86 (SD 4.84, range 0-24). The mean knowledge for risk factors, warning signs and screening tests were 5.38 (SD 2.70, range from 0-11), 4.60 (SD 2.03, range 0-8) and 1.88 (SD 1.19, range 0-5), respectively. The most well recognised risk factors were inflammatory bowel disease (63.2%), followed by colon polyps (62.1%) and excess alcohol consumption (60.4%). Less well-recognised risk factors included family history of colorectal cancer (49.6%), smoking (48.1%), older age (45.3%), being overweight or obese (44.0%), having an inherited syndrome (40.8%) and diabetes (11.5%). The most highly recognised warning signs were blood in the stool (76.0%), rectal bleeding (74.0%) and change in bowel habits (66.4%). The least recognised symptoms included unexplained weight loss (57.3%), bowel does not empty (55.3%) and tiredness/anaemia (29.5%). Importantly, only 40.9% were aware that colorectal cancer could be asymptomatic. The most commonly heard of screening test is colonoscopy but only 46.6% knew colonoscopy was the gold standard method of colorectal cancer screening. Less than a third were aware of stool DNA test (21.5%) and IFOBT and high-risk factor questionnaire (8.6%).

Table 3 presents the results of multiple linear regression for factors associated with colorectal cancer screening knowledge. In the univariate analysis, education level, occupation, residence, income, health insurance, having seen a doctor in the past year, previous discussion of colorectal cancer screening and perceived risk were significantly associated with colorectal cancer knowledge ($p<0.05$). These factors plus variables with p value <0.15 in the univariate analysis were included in the multiple linear regression model. Factors were independently associated with knowledge were education level, occupation, income, health insurance, having seen a doctor in the past year and perceived risk ($p<0.05$).

Participants who were found to be more knowledgeable about colorectal cancer and screening included with a college education or above (95%CI 1.54 to 3.28), working as a white collar (95%CI 0.42, 3.36), with higher income (95%CI 0.70, 2.59; 95%CI 0.43 to 2.51), having health insurance (95%CI 0.43, 2.36), having seen a doctor in the past year (95%CI 0.93 to 2.92) and perceiving greater risk (95%CI 0.76 to 2.88).

Table 2 Knowledge of colorectal cancer and screening (n= 684)

Category	N	%
Risk factors		
Older age	310	45.3
Low physical activity	384	56.1
High intake of red and processed meat	388	56.7
Smoking	329	48.1
Excess alcohol consumption	413	60.4
Being overweight or obese	301	44.0
Colon polyps	425	62.1
Inflammatory bowel disease	432	63.2
Family history of colorectal cancer	339	49.6

Having an inherited syndrome	279	40.8
Diabetes	79	11.5
Warning symptoms		
Blood in the stool	520	76.0
Rectal bleeding	506	74.0
Change in bowel habits	454	66.4
Tiredness/Anaemia	202	29.5
Unexplained weight loss	392	57.3
Abdominal pain	417	61.0
Bowel does not empty	378	55.3
Colorectal cancer can be present without any symptoms	280	40.9
Screening tests		
FOBT	294	43.0
Colonoscopy/sigmoidoscopy	465	68.0
Stool DNA test	147	21.5
IFOBT and High-risk factor questionnaire	59	8.6
Which of the four choices is the gold standard method of colorectal cancer screening? (Colonoscopy)	319	46.6
Score on knowledge of risk factors (11 points)	5.38 (SD 2.70)	
Score on knowledge of warning symptoms (8 points)	4.60 (SD 2.03)	
Score on knowledge of screening tests (5 points)	1.88 (SD 1.19)	
Mean knowledge score (24 points)	11.86 (SD 1.19)	

Table 3 Multiple Linear Regression of factors associated with colorectal cancer knowledge (n=684)

	Knowledge Score			
	β	**SE**	**95%CI**	**P**

Education level				
High school or below	1 (ref)			
College or above	2.410	0.442	1.542, 3.279	<0.001*
Occupation				
Farmer	1 (ref)			
Worker	1.002	0.645	-0.264, 2.268	0.121
Unemployed	0.786	0.693	-0.573, 2.146	0.257
White collar	1.891	0.750	0.420, 3.363	0.012*
Income(¥)				
<3000	1 (ref)			
3000-5000	1.646	0.480	0.703, 2.589	0.001*
>5000	1.470	0.530	0.429, 2.512	0.006*
Health insurance				
No	1 (ref)			
Yes	1.386	0.493	0.429, 2.364	0.005*
Seen a doctor in the past year				
None	1 (ref)			
1-2 times	0.586	0.368	-0.137, 1.309	0.112
≥3 times	1.925	0.506	0.932, 2.918	<0.001*
Perceived risk				
Low	1 (ref)			
Medium	-0.292	0.364	-1.007, 0.423	0.423
High	1.820	0.540	0.760, 2.879	0.001*

*Statistically significant at P<0.05.

CI, confidence interval; SE, standard error; ref, reference.

Attitudes towards colorectal cancer screening

Table 4 shows the attitudes towards colorectal cancer screening. A majority of participants held a positive attitude towards screening with more than 70% of

them thinking colorectal cancer was preventable, early colorectal cancer was curable, colonoscopy could help to find colorectal cancer early, colonoscopy could help to prevent early colorectal cancer, colonoscopy was beneficial and colonoscopy was important. But only 58.7% thought they needed colonoscopy even if felt well. Of all the participants, only 91 (13.3%) had undergone colorectal cancer screening. There was a significant portion of participants (86.7%) who had not participated in colorectal cancer screening.

Table 5 shows the results of multivariate analysis for factors associated with colorectal cancer screening behaviour. In the univariate analysis, factors significantly associated with colorectal cancer screening behaviour were personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening and perceived risk ($p<0.05$). These factors plus variables with p value <0.15 in the univariate analysis were included in the multivariate logistic regression model. The independent variables associated with colorectal cancer screening behaviour included personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, perceived risk and knowledge ($p<0.05$). Participants with a personal history of colorectal disease were more likely to have attended colorectal cancer screening compared with those without colorectal disease (OR 2.33; 95%CI 1.12 to 4.87). Participants who had seen a doctor in the past year were more likely to have undergone colorectal cancer screening than those who had never seen a doctor in the past year (OR 3.20, 95%CI 1.80 to 5.68; OR 2.41, 95%CI 1.17 to 4.96). Moreover, participants had previous discussion of colorectal cancer screening were more likely to have been screened for colorectal cancer (OR 2.42; 95%CI 1.25 to 4.66). Further, those with a higher perceived risk of developing colorectal cancer tend to have undergone screening than the other groups (OR 4.03; 95%CI 1.95 to 8.32). Additionally, those who had more knowledge were more likely to have done colorectal cancer screening (OR 1.06; 95%CI 1.00 to 1.12).

Table 4 Colorectal cancer screening perceptions (n=684)

Question	N	%
Colorectal cancer is preventable	524	76.6
Early colorectal cancer is curable	595	87.0
Colonoscopy can help to find colorectal cancer early	615	89.9
Colonoscopy can help to prevent colorectal cancer	521	76.2
Colonoscopy is beneficial	567	82.9
Colonoscopy is important	496	72.5
You need colonoscopy even if you feel healthy	402	58.8
Have you ever participated in colorectal cancer screening?	91	13.3

Table 5 Multivariate analysis of factors associated with colorectal cancer screening behaviour (n=684)

Variable	Screened N(%)	Unscreened N(%)	OR	95%CI	P
Personal history of colorectal disease					
No	60 (9.9)	547 (90.1)	1 (ref)		
Yes	31 (40.3)	46 (59.7)	2.337	1.121, 4.874	0.024*
Seen a doctor in the past year					
None	23 (6.5)	333 (93.5)	1 (ref)		
1-2 times	43 (18.7)	187 (81.3)	3.195	1.799, 5.676	<0.001*

≥3 times	25 (25.5)	73 (74.5)	2.409	1.170, 4.958	0.017*
Previous discussion of colorectal cancer screening					
No	57 (9.7)	530 (90.3)	1 (ref)		
Yes	34 (35.1)	63 (64.9)	2.416	1.254, 4.655	0.008*
Perceived risk					
Low	17 (6.9)	231 (93.1)	1 (ref)		
Medium	38 (11.1)	304 (88.9)	1.246	0.666, 2.333	0.491
High	36 (38.3)	58 (61.7)	4.029	1.951, 8.320	<0.001*
Knowledge score, mean(SD)	13.9 (4.6)	11.6 (4.8)	1.060	1.001, 1.121	0.044*

*Statistically significant at P<0.05.

CI, confidence interval; OR, odds ratio; ref, reference.

Barriers to participate in colorectal cancer screening

Table 6 reported reasons why participants did not undergone colorectal cancer screening. There were 71.1% of the participants pointed out that screening was not needful due to no symptoms or discomfort, 67.4% said that they never thought of the disease or screening, and 29.8% mentioned that lack of recommended by physicians. There was a significant number of participants who thought screening was too painful, unpleasant or embarrassing (20.0%) and some answered that they were not at risk for colorectal cancer (19.0%). Other reasons were lack of time (15.3%), difficult to assess medical facilities (12.4%), fear of bowel preparation (12.3%), unawareness of the benefits of screening (11.2%) and financial problem (9.6%).

Table 6 Reasons for not undergoing colonoscopy (n=684)

Reasons	N	%
Never thought of	400	67.4
Doctor did not advise me	177	29.8
No symptoms or discomfort	422	71.1
Afraid of detecting CRC	39	6.5
Lack of time	91	15.3
Fear regarding bowel preparation	73	12.3
Too painful, unpleasant or embarrassing	119	20.0
Financial problem	57	9.6
Unawareness of the benefits of screening	67	11.2
Difficult to access medical facilities	74	12.4
Believed risks outweight benefits	17	2.8
Lack of support from others	4	0.6
I am not at risk for colorectal cancer	113	19.0

Discussion

Understanding and recognizing awareness and attitude regarding colorectal cancer screening and reasons towards low screening uptake among high-risk populations could help in developing appropriate policies for prevention and control of colorectal cancer. The study found that majority of the participants had deficient knowledge and never done colorectal cancer screening, but held a positive attitude towards screening and its benefits. Main reasons for not seeking screening included no symptoms and never thought of the disease or screening.

Colorectal cancer and screening awareness

Participants' knowledge of colorectal cancer and screening was insufficient, which was similar to a study conducted in Hong Kong[31] but lower than that found in the Australian studies[32]. Moreover, while participants had relatively

good awareness of warning symptoms, they had a poorer awareness of risk factors and screening tests. Less than half of participants identified risk factors such as smoking, older age, being overweight or obese, having an inherited syndrome and diabetes. This result indicates that people are unfamiliar with cancer related risk factors.

Two of thirds of participants identified the main warning signs, whist nonspecific symptoms such as tiredness/anaemia, bowel does not empty and unexplained weight loss were less likely to identified. This would delay in seeking medical help[33]. Importantly, less than half of participants knew colorectal cancer can be asymptomatic, which was below the rate among Australians (56.5%)[32], implying a gap in educational interventions. Furthermore, approximately a quarter of the participants indicated that they had never heard of even one screening test. This result shows that poor awareness of screening test is a factor contributing to low participation rate of colorectal cancer screening, and indicates that screening test could be a good target for cancer awareness-raising initiatives[34].

Our finding found that respondents with lower education level and income, and who worked as farmers had worse awareness. Further, those who had no health insurance, had never seen a physician within the past year and with lower perceived risk of colorectal cancer showed lower knowledge. There is possibility that they have insufficient access to social resources and are less aware of information about colorectal cancer screening[35]. Studies have reported similar findings that socially disadvantaged groups were less knowledgeable[31][36]. Evidence also suggests that the socially disadvantaged groups were less likely to have undergone screening[22][35]. Thus, educational interventions should target to these underserved and socially disadvantaged individuals.

Colorectal cancer screening attitude

Participants held positive attitudes towards screening and early diagnosis of colorectal cancer, implying that they were aware of the value of early diagnosis

and the benefits of screening, while only less than 60% of the participants agreed that they needed colonoscopy even if they felt healthy. Therefore, it is necessary to educate the public about the importance and necessity of screening. Only a small percentage of participants (13.3%) had undergone colorectal cancer screening at least once, which was similar to that reported in the Hong Kong studies (14%)[26] but lower than that in the Korean and Iranian studies (>45%)[23][37]. This difference might be because in China colonoscopy is conducted via opportunistic screening, and thus it relies on individuals voluntarily requesting it and shouldering the expenses[16,17]. It is noteworthy that the majority of participants had never done colonoscopy screening possibly due to low-risk perception, poor awareness towards screening or other reasons which may limit access to screening[23]. Therefore, it is crucial to explore the important barriers of colonoscopy screening among Chinese high-risk populations[19].

Multivariate analysis showed that personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, perceived risk and knowledge were significantly associated with better screening behaviour. We found that only a minority (14%) of participants reported previous discussion about screening with physicians and thought that they had a high risk of developing colorectal cancer, which was below the estimates (28%–55%) from studies in Iran and USA[23,24]. This finding indicated that the participants were underestimate their risk of colorectal cancer and not aware of the importance of screening. It is therefore urgent to plan health education intervention to correct public perception of their self-risk of developing colorectal cancer and emphasize the significance of screening.

Similar to our findings, a study found that individuals with gastrointestinal tract diseases were more likely to undergo gastrointestinal cancer screening than individuals without diseases, which may because the onset of uncomfortable symptoms motivate them to seek medical help and participate in screening[38]. A study that assessed beliefs, knowledge and screening

among Asian Americans in California, found that participants had seen their physician within the past year were more likely to attend colorectal cancer screening[22]. Furthermore, participants who received a physician's advice for screening were associated with higher adherence to cancer screening[39]. Choi et al found that those who with a greater perceived risk of colorectal cancer were also significantly more likely to be screened than those who with lower perceived risk[40]. Wong et al found that participants with better knowledge concerning colorectal cancer screening were associated with performing screening[26]. Therefore, physicians should emphasize screening and risk education for high-risk individuals.

Colorectal cancer screening barriers

'No symptoms or discomfort' was the most common reason for not undergoing screening, consistent with previous studies[38][41], implying that participants mistakenly convinced that screening is only required upon symptoms or feel ill and they go to health facilities to seek medical help, which can be worrying because the disease only becomes symptomatic at an advanced stage[42]. Therefore, there is a strong need to address such misconception and educate people about the indications of cancer screening.

Moreover, 'never thought about the disease or screening' was another major barrier for participation in screening, which further reflects the lack of knowledge about CRC and its screening. This may be partly because colonoscopy for colorectal cancer screening is not covered by Chinese routine medical check-up[16]. In addition, it may also be because in Chinese culture and traditional beliefs, cancer is a taboo topic and Chinese people are reluctant to think or speak about it. The notion of detecting hidden or asymptomatic disease by screening does not exist in traditional Chinese beliefs[12]. This result emphasizes the need to increases awareness of the importance of CRC screening for this preventable disease and design culturally tailored education to reduce adverse beliefs or attitudes towards cancer.

'Lack of recommendation from physician' was found to be a key reason for not participating in screening. This suggests that clinicians need to pay more attention to screening education of patients as well as improve patient-physician communication. Physicians should also play an active role in delivering early screening information to high-risk populations. Other barriers observed included 'too painful, unpleasant or embarrassing' and 'I am not at risk for colorectal cancer'. As reported, the majority of barriers are related to a lack of understanding and awareness of CRC screening, some were health system and health professional related. Therefore, it is imperative to conduct awareness campaigns to bring out public attention, correct these misconceptions and overcome psychological barriers. Better communication with participants regarding the screening procedure could potentially remove the perception of embarrassment and fear. Health care professionals should encourage high-risk individuals to participate in CRC screening and inform them about cancer risk.

Implications

In Korea, a country with high incidence rates of colorectal cancer, has implemented a nationwide screening program and set up institutions responsible for providing comprehensive cancer information to promote public awareness and screening uptake[10]. In China, the government has started to pay attention to awareness and screening about cancer. Health China Action: Cancer Prevention and Control Implementation Plan and Healthy China 2030 Strategy set a series of goals of attaining more than 70% awareness rate of cancer prevention knowledge, making public aware of their cancer risk and promoting cancer screening for high-risk groups[43,44]. However, data to evaluate the effectiveness of such initiatives are lacking, therefore, this study could be used as a basis to measure the effectiveness of further health promoting campaigns.

Our results has indicated that Chinese high-risk people have deficient awareness, some misconceptions and barriers regarding colorectal cancer

screening. Moreover, they are still not aware of their cancer risk and the need for undergoing screening. Our findings suggest that strategies to improve awareness and screening uptake in high-risk populations should include three components. First, the government should learn from initiatives in different countries, appropriate and effective educational campaigns should be conducted, using web-based education tools to broadcast scientific colorectal cancer prevention information[45,46]. Moreover, the government should establish an organised colorectal cancer screening programme and incorporate screening into healthcare system in the future[23]. Second, health care professionals should be trained to play an active role in improving high-risk people's awareness, perceptions and behaviour about colorectal cancer screening. Less-known risk factors, screening tests and major barriers discovered in this study need to be emphasized during education interventions. Further, health promotion campaigns should focus on those who do not see their physician regularly, without colorectal disease, with low perceived risk and poor knowledge.

Strengths and limitations

To our knowledge, this is the first study in mainland China aiming to assess awareness, attitude and behaviour about colorectal cancer screening and explore the reasons underlying low screening rate among high-risk populations. The study achieved a high response rate and through face-to-face interviews by trained interviewers strengthened the validity of the study results. Our study had some limitations. First, as the participants' screening history was self-reported, recall bias may have occurred. However, respondents were given a brief description of screening tests before asking if they had ever undergone screening. Second, we might not cover of all of the barriers regarding screening uptake as only a quantitative method was used. Further study is warranted to use qualitative or mixed-method to comprehensively explore the related factors. Moreover, We assume that respondents who visit hospitals tend to have better health awareness.

Conclusion

This study indicates that the majority of high-risk people had deficient knowledge and never undergone colorectal cancer screening. But most of them held a positive attitude towards the benefits of screening. Being asymptomatic and never thought of the disease or screening were the main reasons for not undergoing screening. Our study gives insight into the development of strategies to improve screening of colorectal cancer in China.

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Conflict of interest The authors declare that they have no competing interests.

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Contributors Ying Zeng, Xi Zeng, Ruo-lin Huang and Qi Liu conceived and designed the study. Ruo-lin Huang, Qi Liu, Ying-xin Wang, Jin-yu Zou, Li-feng Hu, Wen Wang, Ying-hui Huang, Yi-zhuo Wang and Bo Zeng carried out the data collection. Ying-xin Wang and Wen Wang analysed the data. Ying Zeng, Ruo-lin Huang and Qi Liu drafted the manuscript. Ying Zeng and Xi Zeng reviewed and edited the manuscript.

Data availability statement Data are available by contacting Ying Zeng by E-mail: zengying2003@126.com

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Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	4
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	6

Objectives	#3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	#4	Present key elements of study design early in the paper	7
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7,8
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	8
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	8,9
Bias	#9	Describe any efforts to address potential sources of bias	
Study size	#10	Explain how the study size was arrived at	7,8
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	9
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	9

Statistical methods	#12c	Explain how missing data were addressed	
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	
Statistical methods	#12e	Describe any sensitivity analyses	
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	10
Participants	#13b	Give reasons for non-participation at each stage	
Participants	#13c	Consider use of a flow diagram	
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	10,11
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12,13,14,15, 16,17,18

Main results	#16b	Report category boundaries when continuous variables were categorized	12,13,14,15, 16,17,18
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	#18	Summarise key results with reference to study objectives	19
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	24
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	19,20
Generalisability	#21	Discuss the generalisability (external validity) of the study results	21,22,23
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	25

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Awareness, Attitude and Barriers of Colorectal Cancer Screening Among High-risk Populations in China: A Cross-sectional Study

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Awareness, Attitude and Barriers of Colorectal Cancer Screening Among High-risk Populations in China: A Cross-sectional Study

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Awareness, Attitude and Barriers of Colorectal Cancer Screening Among High-risk Populations in China: A Cross-sectional Study

Abstract

Objective: To assess the awareness, attitude and barriers of colorectal cancer screening among high-risk populations in China.

Design: A cross-sectional study was employed.

Setting: This study was conducted in nine hospitals in Hunan province, China.

Participants: Individuals with high-risk for colorectal cancer were interviewed using a pretested structured questionnaire.

Primary and secondary outcome measures: Knowledge, attitude of colorectal cancer screening, sociodemographic factors associated with colorectal cancer screening knowledge and behaviour, barriers of colorectal cancer screening.

Results: This study included 684 participants. The mean knowledge score was 11.86/24 (SD 4.84). But over 70% of them held a positive attitude towards screening. Only 13.3% had undergone colorectal cancer screening. Independent factors related to knowledge were education level of college or above, working as a white collar, higher income, having health insurance, having seen a doctor in the past year and with high perceived risk ($p<0.05$). Factors independently associated with screening behaviour included personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, high perceived risk and better knowledge ($p<0.05$). Main reasons for not undergoing screening were no symptoms or discomfort (71.1%), never thought of the disease or screening (67.4%), and doctor did not advise me (29.8%).

Conclusion: In China, the majority of high-risk people had deficient knowledge and never undergone colorectal cancer screening. But most of them held a positive attitude towards the benefits of colorectal cancer screening. This has promising implications to design targeted educational

campaigns and establish CRC screening programmes to improve colorectal cancer awareness and screening participation. Health care professionals should advise high-risk individuals to participate in CRC screening and inform them about cancer risk.

Keywords: colorectal cancer screening, awareness, barriers, prevention

Strengths and limitations of this study

- These findings may be used as a reference for other countries with no screening programmes.
- The study achieved a high response rate and through face-to-face interviews by trained data collectors.
- The participants' screening history was self-reported, therefore, recall bias may have occurred.
- We might not cover of all of the barriers regarding screening uptake as only a quantitative method was used.

Introduction

Colorectal cancer (CRC) is the third most common cancer and the second leading cause of cancer death worldwide[1]. The World Health Organization (WHO) showed nearly half of new CRC cases were found in Asia, mostly in China[2]. CRC is the fifth most common malignancy in China, with 376,300 new cases and 191,000 deaths occurring in 2015[3]. The incidence rates and mortality rates of CRC in China continue to rise due to aging and growing population[4].

Early colorectal cancer has better prognosis than advanced and metastatic colorectal cancer[5]. However, most patients are diagnosed during the advanced stage of the disease with a poor prognosis[6,7]. In China, the 5-year survival rate of colorectal cancer is lower than in many developed countries such as Korea with a rising cancer burden[8-10], suggesting delays in diagnosis and treatment[11]. These studies indicate that there are problems regarding screening and prevention of this disease. High-risk populations are the key target populations of cancer screening[12]. To strengthen efforts to promote colorectal cancer prevention and control, it is particularly important to improve screening for prevention and early detection of colorectal cancer for high-risk populations in China. High-risk populations for developing colorectal cancer are individuals with colorectal diseases such as colorectal adenomas, inflammatory bowel disease and hereditary syndromes and those with a family history of colorectal cancer[13,14].

Colorectal cancer screening via colonoscopy is known as an effective method to prevent and detect early-stage CRC and improve survival and prognosis[15]. Despite the heavy burden of colorectal cancer in China, however, unlike in other East Asian countries such as Korea, there are no nationwide CRC screening guidelines or programmes[16]. As a result of the large populations but with an uneven distribution of health, medical and financial resources, opportunistic screening with colonoscopy in asymptomatic people is widely used in China[17]. Opportunistic screening is performed on a voluntary

basis and dependent on request from a physician or individual[18].

Unfortunately, screening rate of colorectal cancer in China is far away from satisfactory level. The majority (about 85%) of high-risk populations still never have done colorectal cancer screening according to the report by Chen H et al[19] in 2018. Key factors contributing to non-participation in colorectal cancer screening could be poor awareness of colorectal cancer screening, negative attitude towards screening and multiple barriers related to screening[20]. Previous studies suggested that the general population had deficient knowledge of colorectal cancer and screening[21,22]. Moreover, few studies also indicated that screening knowledge and practice were suboptimal among high risk population[23,24]. In China, fewer studies reported inadequate public knowledge and screening of colorectal cancer[25,26].

Currently, there are little studies exploring awareness, attitude and identify barriers for colorectal cancer screening among high-risk populations in China. Therefore, it is crucial to assess awareness, attitude and possible barriers that hinder CRC screening so that more effective approaches can be implemented to promote screening uptake. The objectives of this study were to (1) assess awareness, attitude and behaviour of colorectal cancer screening among high-risk populations in China, (2) examine sociodemographic factors associated with colorectal cancer screening knowledge and behaviour, (3) identify the barriers to colorectal cancer screening.

Methods

Setting and sample

This was a cross-sectional study conducted between April and August 2019. The sample size was calculated based on 15% (π) of prevalence rate of colorectal cancer screening using a formula $N=[\mu^2_{\alpha/2}\times\pi\times(1-\pi)]/\delta^2$[27], with 0.03 allowable error (δ) and $u_{\alpha/2}=1.96$ at 95% confidence interval. Considering the 40% non-response rate, the final sample size was 760.

Nine hospitals were selected from a total of 42 in Hunan province using a

cluster random sampling method. The source population were individuals from gastrointestinal department of hospitals with a high risk of developing colorectal cancer according to medical records by convenience sampling. With the support of hospitals, each trained interviewer was accompanied by a medical staff to introduce the study aim. The inclusion criteria[13,14] included: (1) age 18 to 75 years, (2) a family history of colorectal cancer or adenomas, (3) a personal history of colorectal cancer or adenomas, (4) a personal history of inflammatory bowel disease, (5) a personal history of hereditary syndromes. The exclusion criteria[13,14] included: (1) age less than 18 years, (2) being diagnosed with colorectal cancer, (3) unable to communicate with the investigator, (4) severe cognitive impairment. Individuals who consented to participate in the study completed a standardized face-to-face questionnaire, which lasted for approximately 15 to 20 minutes. Each participants received ¥30 (about $4.2) for completing the survey. This study was approved by the Ethic Committee of the University of South China (No. 4304081009636) and informed consent was obtained from all participants prior to participation.

Instrument

The questionnaire included items about awareness, attitudes and screening for colorectal cancer. Survey items were identified from research literature[28,29], the American Cancer Society and China Anti-Cancer Association[30]. The questionnaire consisted of 4 sections. The first section comprised socio-demographic characteristics: gender, age, education level, occupation, marital status, residence, income, health insurance, and perceived health status, etc. The second part included 24 questions about knowledge of colorectal cancer: risk factors, warning signs and screening tests. Two items had multiple answers, so the scoring was 1 point for each correct answer and 0 point for the wrong answer or ‘don’t know’ with a total score of 24 points. The third section was related to attitudes toward the colorectal cancer screening: colorectal cancer is preventable, early colorectal cancer is curable, colonoscopy can help to find colorectal cancer early, colonoscopy can help to

prevent colorectal cancer, colonoscopy is beneficial, colonoscopy is important etc. The possible responses were 'yes', or 'no'. In the fourth section, participants were questioned whether they had ever undergone colorectal cancer screening with 'yes' or 'no' answer. Participants who answered 'no' would be asked to choose the reasons for not undergoing screening, and more than 1 choice was allowed. Mean knowledge scores were calculated based on the number of correct responses and total scores ranged from 0 to 24 points.

The reliability was evaluated by pretesting in 80 people. The internal consistency of the questionnaires was accomplished by estimating the Cronbach's alpha based on the recommendation of >0.70. The Cronbach's alpha calculated was 0.88. Face validity was performed to assess the comprehension towards understanding of the questionnaire and to assess how important it was to target study participants. Finally, the questionnaire was modified and re-evaluated to fit the study population based on the feedbacks of the pilot study.

Statistical analysis

Data were analysed using IBM SPSS V.23.0. Descriptive statistics were used to describe the participants' socio-demographics and responses to each question. The t test and analysis of variance test were used to investigate the association of demographic factors with knowledge. The $\chi 2$ or Fisher's exact test were used to find association between demographic factors and behaviour of colorectal cancer screening. Variables with a p value ≤0.15 in the univariate analysis were included in multiple linear regression analysis to investigate the independent factors for screening knowledge, while variables with a p value ≤0.15 in the univariate analysis were included in the binary logistic regression analysis to identify the independent factors for screening behaviour. Only the results of the bivariate and multivariate analysis were presented using odds ratios (OR) and 95% confidence intervals (CI), a p value of <0.05 was regarded as statistically significant.

Patient and public involvement

No participants were involved in our work. The study results will be made available to participants interested in this subject.

Results

Sample characteristics

Of the 760 high-risk individuals, 712 consented to involve in the study, of whom 28 completed less than 50% of the questionnaire. Thus, the final response rate was 90.0% (n=684). The mean age of participants was 47.01±7.39 years (range=27-74 years). Of the total sample, more than half (54.5%) of participants were men, 75.6% had high school education or below and 58.0% lived in urban areas. Almost all (94.4%) were married and 86.7% were insured. About 37.9% had low income. The majority (88.7%) had no personal history of colorectal disease and 93.1% had a family history of colorectal cancer or adenomas. Only 14.2% reported previous discussion of screening with the doctor and 13.7% perceived their risk of developing colorectal cancer was high. Other variables are listed in (Table 1).

Table 1 Participant characteristics(n=684)

Characteristics	N (%)
Gender	
Male	373 (54.5)
Female	311 (45.5)
Age (years)	
<40	79 (11.5)
40-49	399 (58.3)
50-59	163 (23.8)
>60	43 (6.3)
Mean±SD	47.01±7.39
Education level	

High school or below	517 (75.6)
College or above	167 (24.4)
Occupation	
Farmer	63 (9.2)
Worker	304 (44.4)
Unemployed	105 (15.4)
White collar	212 (31.0)
Marital status	
Single	38 (5.6)
Married	646 (94.4)
Residence	
Urban	397 (58.0)
Rural	287 (42.0)
Income(¥)	
<3000	259 (37.9)
3000-5000	207 (30.3)
>5000	218 (31.9)
Health insurance	
Yes	593 (86.7)
No	91 (13.3)
Self-reported health status	
Good	274 (40.1)
Fair	363 (53.1)
Poor	47 (6.9)
Personal history of colorectal disease	
Yes	77 (11.3)
No	607 (88.7)
Seen a doctor in the past year	
None	356 (52.0)

1-2 times	230 (33.6)
≥3 times	98 (14.3)
Previous discussion of colorectal cancer screening	
Yes	97 (14.2)
No	587 (85.8)
Family history of colorectal cancer or adenomas	
Yes	637 (93.1)
No	47 (6.9)
Perceived risk	
Low	248 (36.3)
Medium	342 (50.0)
High	94 (13.7)

Knowledge of colorectal cancer and screening

Table 2 presents knowledge of colorectal cancer and screening including risk factors, warning signs and screening tests. The mean total knowledge score was 11.86 (SD 4.84, range 0-24). The mean knowledge for risk factors, warning signs and screening tests were 5.38 (SD 2.70, range from 0-11), 4.60 (SD 2.03, range 0-8) and 1.88 (SD 1.19, range 0-5), respectively. The most well recognised risk factors were inflammatory bowel disease (63.2%), followed by colon polyps (62.1%) and excess alcohol consumption (60.4%). Less well-recognised risk factors included family history of colorectal cancer (49.6%), smoking (48.1%), older age (45.3%), being overweight or obese (44.0%), having an inherited syndrome (40.8%) and diabetes (11.5%). The most highly recognised warning signs were blood in the stool (76.0%), rectal bleeding (74.0%) and change in bowel habits (66.4%). The least recognised symptoms included unexplained weight loss (57.3%), bowel does not empty (55.3%) and tiredness/anaemia (29.5%). Importantly, only 40.9% were aware

that colorectal cancer could be asymptomatic. The most commonly heard of screening test is colonoscopy but only 46.6% knew colonoscopy was the gold standard method of colorectal cancer screening. Less than a third were aware of stool DNA test (21.5%) and IFOBT and high-risk factor questionnaire (8.6%).

Table 3 presents the results of multiple linear regression for factors associated with colorectal cancer screening knowledge. In the univariate analysis, education level, occupation, residence, income, health insurance, having seen a doctor in the past year, previous discussion of colorectal cancer screening and perceived risk were significantly associated with colorectal cancer knowledge ($p<0.05$). These factors plus variables with p value <0.15 (personal history of colorectal disease) in the univariate analysis were included in the multiple linear regression model. Factors were independently associated with knowledge were education level, occupation, income, health insurance, having seen a doctor in the past year and perceived risk ($p<0.05$).

Participants who were found to be more knowledgeable about colorectal cancer and screening included with a college education or above (β=2.41, 95%CI 1.54 to 3.28, p<0.001), working as a white collar (β=1.89, 95%CI 0.42 to 3.36, p=0.012), with higher income (β=1.65, 95%CI 0.70 to 2.59, p=0.001; β=1.47, 95%CI 0.43 to 2.51, p=0.006), having health insurance (β=1.39, 95%CI 0.43 to 2.36, p=0.005), having seen a doctor in the past year (β=1.93, 95%CI 0.93 to 2.92, p<0.001) and perceiving greater risk (β=1.82, 95%CI 0.76 to 2.88, p=0.001).

Table 2 Knowledge of colorectal cancer and screening (n= 684)

Category	N	%
Risk factors		
Older age	310	45.3
Low physical activity	384	56.1

High intake of red and processed meat	388	56.7
Smoking	329	48.1
Excess alcohol consumption	413	60.4
Being overweight or obese	301	44.0
Colon polyps	425	62.1
Inflammatory bowel disease	432	63.2
Family history of colorectal cancer	339	49.6
Having an inherited syndrome	279	40.8
Diabetes	79	11.5
Warning symptoms		
Blood in the stool	520	76.0
Rectal bleeding	506	74.0
Change in bowel habits	454	66.4
Tiredness/Anaemia	202	29.5
Unexplained weight loss	392	57.3
Abdominal pain	417	61.0
Bowel does not empty	378	55.3
Colorectal cancer can be present without any symptoms	280	40.9
Screening tests		
FOBT	294	43.0
Colonoscopy/sigmoidoscopy	465	68.0
Stool DNA test	147	21.5
IFOBT and High-risk factor questionnaire	59	8.6
Which of the four choices is the gold standard method of colorectal cancer screening? (Colonoscopy)	319	46.6

Table 3 Multiple Linear Regression of factors associated with colorectal cancer knowledge (n=684)

	Knowledge Score			
	β	SE	95%CI	P
Education level				
High school or below	1 (ref)			
College or above	2.410	0.442	1.542, 3.279	<0.001*
Occupation				
Farmer	1 (ref)			
Worker	1.002	0.645	-0.264, 2.268	0.121
Unemployed	0.786	0.693	-0.573, 2.146	0.257
White collar	1.891	0.750	0.420, 3.363	0.012*
Income(¥)				
<3000	1 (ref)			
3000-5000	1.646	0.480	0.703, 2.589	0.001*
>5000	1.470	0.530	0.429, 2.512	0.006*
Health insurance				
No	1 (ref)			
Yes	1.386	0.493	0.429, 2.364	0.005*
Seen a doctor in the past year				
None	1 (ref)			
1-2 times	0.586	0.368	-0.137, 1.309	0.112
≥3 times	1.925	0.506	0.932, 2.918	<0.001*
Perceived risk				
Low	1 (ref)			
Medium	-0.292	0.364	-1.007, 0.423	0.423
High	1.820	0.540	0.760, 2.879	0.001*
Constant	7.365	0.704	5.983, 8.747	0.000*

R^2 = 0.210, F= 17.510, P=0.000.

*Statistically significant at P<0.05.

CI, confidence interval; SE, standard error; ref, reference.

Attitudes towards colorectal cancer screening

Table 4 shows the attitudes towards colorectal cancer screening. A majority of participants held a positive attitude towards screening with more than 70% of them thinking colorectal cancer was preventable, early colorectal cancer was curable, colonoscopy could help to find colorectal cancer early, colonoscopy could help to prevent early colorectal cancer, colonoscopy was beneficial and colonoscopy was important. But only 58.7% thought they needed colonoscopy even if felt well. Of all the participants, only 91 (13.3%) had undergone colorectal cancer screening. There was a significant portion of participants (86.7%) who had not participated in colorectal cancer screening.

Table 5 shows the results of bivariate analysis for factors associated with colorectal cancer screening behaviour. In the univariate analysis, factors significantly associated with colorectal cancer screening behaviour were personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening and perceived risk ($p<0.05$). These factors plus variables with p value <0.15 (education level) in the univariate analysis were included in the binary logistic regression model. The independent variables associated with colorectal cancer screening behaviour included personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, perceived risk and knowledge ($p<0.05$). Participants with a personal history of colorectal disease were more likely to have attended colorectal cancer screening compared with those without colorectal disease (OR 2.33, 95%CI 1.12 to 4.87, $p=0.024$). Participants who had seen a doctor in the past year were more likely to have undergone colorectal cancer screening than those who had never seen a doctor in the past year (OR 3.20, 95%CI 1.80 to 5.68, $p<0.001$; OR 2.41, 95%CI 1.17 to 4.96, $p=0.017$). Moreover, participants had previous discussion of colorectal cancer screening were more likely to have been screened for colorectal cancer (OR 2.42, 95%CI 1.25 to 4.66, $p=0.008$).

Further, those with a higher perceived risk of developing colorectal cancer tend to have undergone screening than the other groups (OR 4.03, 95%CI 1.95 to 8.32, p<0.001). Additionally, those who had more knowledge were more likely to have done colorectal cancer screening (OR 1.06, 95%CI 1.00 to 1.12, p=0.044).

Table 4 Colorectal cancer screening perceptions (n=684)

Question	N	%
Colorectal cancer is preventable	524	76.6
Early colorectal cancer is curable	595	87.0
Colonoscopy can help to find colorectal cancer early	615	89.9
Colonoscopy can help to prevent colorectal cancer	521	76.2
Colonoscopy is beneficial	567	82.9
Colonoscopy is important	496	72.5
You need colonoscopy even if you feel healthy	402	58.8

Table 5 Bivaraite analysis of factors associated with colorectal cancer screening behaviour (n=684)

Variable	Screened N(%)	Unscreened N(%)	OR	95%CI	P
Personal history of colorectal disease					
No	60 (9.9)	547 (90.1)	1 (ref)		
Yes	31 (40.3)	46 (59.7)	2.337	1.121, 4.874	0.024*
Seen a doctor in the past year					

None	23 (6.5)	333 (93.5)	1 (ref)		
1-2 times	43 (18.7)	187 (81.3)	3.195	1.799, 5.676	<0.001*
≥3 times	25 (25.5)	73 (74.5)	2.409	1.170, 4.958	0.017*
Previous discussion of colorectal cancer screening					
No	57 (9.7)	530 (90.3)	1 (ref)		
Yes	34 (35.1)	63 (64.9)	2.416	1.254, 4.655	0.008*
Perceived risk					
Low	17 (6.9)	231 (93.1)	1 (ref)		
Medium	38 (11.1)	304 (88.9)	1.246	0.666, 2.333	0.491
High	36 (38.3)	58 (61.7)	4.029	1.951, 8.320	<0.001*
Knowledge score, mean(SD)	13.9 (4.6)	11.6 (4.8)	1.060	1.001, 1.121	0.044*

*Statistically significant at P<0.05.

CI, confidence interval; OR, odds ratio; ref, reference.

Barriers to participate in colorectal cancer screening

Table 6 reported reasons why participants did not undergone colorectal cancer screening. There were 71.1% of the participants pointed out that screening was not needful due to no symptoms or discomfort, 67.4% said that they never thought of the disease or screening, and 29.8% mentioned that lack of recommended by physicians. There was a significant number of participants who thought screening was too painful, unpleasant or embarrassing (20.0%) and some answered that they were not at risk for colorectal cancer (19.0%). Other reasons were lack of time (15.3%), difficult to assess medical facilities

(12.4%), fear of bowel preparation (12.3%), unawareness of the benefits of screening (11.2%) and financial problem (9.6%).

Table 6 Reasons for not undergoing colonoscopy (n=593)

Reasons	N	%
Never thought of	400	67.4
Doctor did not advise me	177	29.8
No symptoms or discomfort	422	71.1
Afraid of detecting CRC	39	6.5
Lack of time	91	15.3
Fear regarding bowel preparation	73	12.3
Too painful, unpleasant or embarrassing	119	20.0
Financial problem	57	9.6
Unawareness of the benefits of screening	67	11.2
Difficult to access medical facilities	74	12.4
Believed risks outweight benefits	17	2.8
Lack of support from others	4	0.6
I am not at risk for colorectal cancer	113	19.0

Discussion

Understanding and recognizing awareness and attitude regarding colorectal cancer screening and reasons towards low screening uptake among high-risk populations could help in developing appropriate policies for prevention and control of colorectal cancer. The study found that majority of the participants had deficient knowledge and never done colorectal cancer screening, but held a positive attitude towards screening and its benefits. Main reasons for not seeking screening included no symptoms and never thought of the disease or screening.

Colorectal cancer and screening awareness

Participants' knowledge of colorectal cancer and screening was insufficient, which was similar to studies conducted in Hong Kong and Saudi Arabia[31,32] but lower than that found in the Australian and Iranian studies[33.34]. Moreover, while participants had relatively good awareness of warning symptoms, they had a poorer awareness of risk factors and screening tests. Less than half of participants identified risk factors such as smoking, older age, being overweight or obese, having an inherited syndrome and diabetes. This result indicates that people are unfamiliar with cancer related risk factors.

Two of thirds of participants identified the main warning signs, whist nonspecific symptoms such as tiredness/anaemia, bowel does not empty and unexplained weight loss were less likely to identified. This would delay in seeking medical help[35]. Importantly, less than half of participants knew colorectal cancer can be asymptomatic, implying a gap in educational interventions. Furthermore, approximately a quarter of the participants indicated that they had never heard of even one screening test. This result shows that poor awareness of screening test is a factor contributing to low participation rate of colorectal cancer screening, and indicates that screening test could be a good target for cancer awareness-raising initiatives[36].

Our finding found that respondents with lower education level and income, and who worked as farmers had worse awareness. Further, those who had no health insurance, had never seen a physician within the past year and with lower perceived risk of colorectal cancer showed lower knowledge. There is possibility that they have insufficient access to social resources and are less aware of information about colorectal cancer screening[37]. Studies have reported similar findings that socially disadvantaged groups were less knowledgeable[31][38]. Evidence also suggests that the socially disadvantaged groups were less likely to have undergone screening[22][37]. Thus, educational interventions should target to these underserved and socially disadvantaged individuals.

Colorectal cancer screening attitude

Participants held positive attitudes towards screening and early diagnosis of colorectal cancer, implying that they were aware of the value of early diagnosis and the benefits of screening, while only less than 60% of the participants agreed that they needed colonoscopy even if they felt healthy. Therefore, it is necessary to educate the public about the importance and necessity of screening. Only a small percentage of participants (13.3%) had undergone colorectal cancer screening at least once, which was similar to that reported in the Hong Kong studies (14%)[26] but lower than that in the Korean and Iranian studies (>45%)[23][39]. This difference might be because in China colonoscopy is conducted via opportunistic screening, and thus it relies on individuals voluntarily requesting it and shouldering the expenses[16,17]. It is noteworthy that the majority of participants had never done colonoscopy screening possibly due to low-risk perception, poor awareness towards screening or other reasons which may limit access to screening[23]. Therefore, it is crucial to explore the important barriers of colonoscopy screening among Chinese high-risk populations[19].

Bivariate analysis showed that personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, perceived risk and knowledge were significantly associated with better screening behaviour. We found that only a minority (14%) of participants reported previous discussion about screening with physicians and thought that they had a high risk of developing colorectal cancer, which was below the estimates (28%–55%) from studies in Iran and USA[23,24]. This finding indicated that the participants were underestimate their risk of colorectal cancer and not aware of the importance of screening. It is therefore urgent to plan health education intervention to correct public perception of their self-risk of developing colorectal cancer and emphasize the significance of screening.

Similar to our findings, a study found that individuals with gastrointestinal tract diseases were more likely to undergo gastrointestinal cancer screening than individuals without diseases, which may because the onset of

uncomfortable symptoms motivate them to seek medical help and participate in screening[40]. A study that assessed beliefs, knowledge and screening among Asian Americans in California, found that participants had seen their physician within the past year were more likely to attend colorectal cancer screening[22]. Furthermore, participants who received a physician's advice for screening were associated with higher adherence to cancer screening[41]. Choi et al found that those who with a greater perceived risk of colorectal cancer were also significantly more likely to be screened than those who with lower perceived risk[42]. Wong et al found that participants with better knowledge concerning colorectal cancer screening were associated with performing screening[26]. Therefore, physicians should emphasize screening and risk education for high-risk individuals.

Colorectal cancer screening barriers

'No symptoms or discomfort' was the most common reason for not undergoing screening, consistent with previous studies[40][43], implying that participants mistakenly convinced that screening is only required upon symptoms or feel ill and they go to health facilities to seek medical help, which can be worrying because the disease only becomes symptomatic at an advanced stage[44]. Therefore, there is a strong need to address such misconception and educate people about the indications of cancer screening.

Moreover, 'never thought about the disease or screening' was another major barrier for participation in screening, which further reflects the lack of knowledge about CRC and its screening. This may be partly because colonoscopy for colorectal cancer screening is not covered by Chinese routine medical check-up[16]. In addition, it may also be because in Chinese culture and traditional beliefs, cancer is a taboo topic and Chinese people are reluctant to think or speak about it. The notion of detecting hidden or asymptomatic disease by screening does not exist in traditional Chinese beliefs[12]. This result emphasizes the need to increases awareness of the importance of CRC screening for this preventable disease and design

culturally tailored education to reduce adverse beliefs or attitudes towards cancer.

'Lack of recommendation from physician' was found to be a key reason for not participating in screening. This suggests that clinicians need to pay more attention to screening education of patients as well as improve patient-physician communication. Physicians should also play an active role in delivering early screening information to high-risk populations. Other barriers observed included 'too painful, unpleasant or embarrassing' and 'I am not at risk for colorectal cancer'. As reported, the majority of barriers are related to a lack of understanding and awareness of CRC screening, some were health system and health professional related. Therefore, it is imperative to conduct awareness campaigns to bring out public attention, correct these misconceptions and overcome psychological barriers. Better communication with participants regarding the screening procedure could potentially remove the perception of embarrassment and fear. Health care professionals should encourage high-risk individuals to participate in CRC screening and inform them about cancer risk.

Implications

In Korea, a country with high incidence rates of colorectal cancer, has implemented a nationwide screening program and set up institutions responsible for providing comprehensive cancer information to promote public awareness and screening uptake[10]. In China, the government has started to pay attention to awareness and screening about cancer. Health China Action: Cancer Prevention and Control Implementation Plan and Healthy China 2030 Strategy set a series of goals of attaining more than 70% awareness rate of cancer prevention knowledge, making public aware of their cancer risk and promoting cancer screening for high-risk groups[45,46]. However, data to evaluate the effectiveness of such initiatives are lacking, therefore, this study could be used as a basis to measure the effectiveness of further health promoting campaigns.

Our results has indicated that Chinese high-risk people have deficient awareness, some misconceptions and barriers regarding colorectal cancer screening. Moreover, they are still not aware of their cancer risk and the need for undergoing screening. Our findings suggest that strategies to improve awareness and screening uptake in high-risk populations should include three components. First, the government should learn from initiatives in different countries, appropriate and effective educational campaigns should be conducted, using web-based education tools to broadcast scientific colorectal cancer prevention information[47,48]. Moreover, the government should establish an organised colorectal cancer screening programme and incorporate screening into healthcare system in the future[23]. Second, health care professionals should be trained to play an active role in improving high-risk people's awareness, perceptions and behaviour about colorectal cancer screening. Less-known risk factors, screening tests and major barriers discovered in this study need to be emphasized during education interventions. Further, health promotion campaigns should focus on those who do not see their physician regularly, without colorectal disease, with low perceived risk and poor knowledge.

Strengths and limitations

To our knowledge, this is the first study in mainland China aiming to assess awareness, attitude and behaviour about colorectal cancer screening and explore the reasons underlying low screening rate among high-risk populations. The study achieved a high response rate and through face-to-face interviews by trained interviewers strengthened the validity of the study results. Our study had some limitations. First, as the participants' screening history was self-reported, recall bias may have occurred. However, respondents were given a brief description of screening tests before asking if they had ever undergone screening. Second, we might not cover of all of the barriers regarding screening uptake as only a quantitative method was used. Further study is warranted to use qualitative or mixed-method to comprehensively

explore the related factors. Moreover, We assume that respondents who visit hospitals tend to have better health awareness. Third, validity of the instrument, which is an important evaluation factor of the quality of the instrument, was not explored well.

Conclusion

This study indicates that the majority of high-risk people had deficient knowledge and never undergone colorectal cancer screening. But most of them held a positive attitude towards the benefits of screening. Being asymptomatic and never thought of the disease or screening were the main reasons for not undergoing screening. Our study gives insight into the development of strategies to improve screening of colorectal cancer in China.

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Conflict of interest The authors declare that they have no competing interests.

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Contributors Ying Zeng, Xi Zeng, Ruo-lin Huang and Qi Liu conceived and designed the study. Ruo-lin Huang, Qi Liu, Ying-xin Wang, Jin-yu Zou, Li-feng Hu, Wen Wang, Ying-hui Huang, Yi-zhuo Wang and Bo Zeng carried out the data collection. Ying-xin Wang and Wen Wang analysed the data. Ying Zeng, Ruo-lin Huang and Qi Liu drafted the manuscript. Ying Zeng and Xi Zeng reviewed and edited the manuscript.

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	4
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	6

Objectives	#3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	#4	Present key elements of study design early in the paper	7
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7,8
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	8
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	8,9
Bias	#9	Describe any efforts to address potential sources of bias	
Study size	#10	Explain how the study size was arrived at	7,8
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	9
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	9

Statistical methods	#12c	Explain how missing data were addressed	
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	
Statistical methods	#12e	Describe any sensitivity analyses	
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	10
Participants	#13b	Give reasons for non-participation at each stage	
Participants	#13c	Consider use of a flow diagram	
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	10,11
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12,13,14,15, 16,17,18

Main results	#16b	Report category boundaries when continuous variables were categorized	12,13,14,15, 16,17,18
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	#18	Summarise key results with reference to study objectives	19
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	24
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	19,20
Generalisability	#21	Discuss the generalisability (external validity) of the study results	21,22,23
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	25

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Awareness, Attitude and Barriers of Colorectal Cancer Screening among High-risk Populations in China: A Cross-sectional Study

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Awareness, Attitude and Barriers of Colorectal Cancer Screening among High-risk Populations in China: A Cross-sectional Study

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Awareness, Attitude and Barriers of Colorectal Cancer Screening among High-risk Populations in China: A Cross-sectional Study

Abstract

Objective: To assess the awareness, attitude and barriers of colorectal cancer screening among high-risk populations in China.

Design: A cross-sectional study was employed.

Setting: This study was conducted in nine hospitals in Hunan province, China.

Participants: Individuals with a high-risk for colorectal cancer were interviewed using a pretested structured questionnaire.

Primary and secondary outcome measures: Knowledge, attitude of colorectal cancer screening, sociodemographic factors associated with colorectal cancer screening knowledge and behaviour, and barriers of colorectal cancer screening.

Results: This study included 684 participants. The mean knowledge score was 11.86/24 (SD 4.84). But over 70% of them held a positive attitude towards screening. Only 13.3% had undergone colorectal cancer screening. Independent factors related to knowledge were education level of college or above, working as a white collar, higher income, having health insurance, having seen a doctor in the past year and with a high perceived risk ($p<0.05$). Factors independently associated with screening behaviour included personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, high perceived risk and better knowledge ($p<0.05$). Main reasons for not undergoing screening were no symptoms or discomfort (71.1%), never having thought of the disease or screening (67.4%) and no doctor advised me (29.8%).

Conclusion: In China, the majority of high-risk people had deficient knowledge and had never undergone colorectal cancer screening. But most of them held a positive attitude towards the benefits of colorectal cancer screening. This has promising implications to design targeted educational

campaigns and establish screening programmes to improve colorectal cancer awareness and screening participation. Health care professionals should advise high-risk individuals to participate in screening and inform them about cancer risk.

Keywords: colorectal cancer screening, awareness, barriers, prevention

Strengths and limitations of this study

- These findings may be used as a reference for other countries with no screening programmes.
- The study achieved a high response rate through face-to-face interviews by trained data collectors.
- The participants' screening history was self-reported, therefore, recall bias may have occurred.
- We may not have covered all of the barriers regarding screening uptake as only a quantitative method was used.

Introduction

Colorectal cancer is the third most common cancer and the second leading cause of cancer death worldwide.[1] The World Health Organization (WHO) showed that nearly half of the new cases were found in Asia and mostly in China.[2] Colorectal cancer is the second most common malignancy in China, with 521,400 new cases and 248,000 deaths occurring in 2018.[2] The incidence rates and mortality rates of colorectal cancer in China continue to rise due to an aging and growing population.[3]

Early colorectal cancer has a better prognosis than advanced and metastatic colorectal cancer.[4] However, most patients are diagnosed during the advanced stage of the disease with a poor prognosis.[5,6] In China, the 5-year survival rate of colorectal cancer is lower than that of many developed countries such as Korea with a rising cancer burden.[7-10] A study showed that the incidence of prehospital delay among Chinese patients with colorectal cancer was 47%, suggesting delays in diagnosis and treatment.[11] These studies indicate that there are problems regarding screening and prevention of this disease. High-risk populations are the key target populations of cancer screening.[12] To strengthen efforts to promote colorectal cancer prevention and control, it is particularly important to improve screening for prevention and early detection of colorectal cancer for high-risk populations in China. High-risk populations for developing colorectal cancer are individuals with colorectal diseases such as colorectal adenomas, inflammatory bowel disease and hereditary syndromes and those with a family history of colorectal cancer.[13,14]

Colorectal cancer screening via colonoscopy is known as an effective method to prevent and detect early-stage colorectal cancer and improve survival and prognosis.[15] Despite the heavy burden of colorectal cancer in China, unlike in other East Asian countries such as Korea, there are no nationwide screening guidelines or programmes.[16] As a result of the large populations but with an uneven distribution of health, medical and financial resources, opportunistic screening with colonoscopy in asymptomatic people

is widely used in China.[17] Opportunistic screening is performed on a voluntary basis and is dependent on a request from a physician or individual.[18]

Unfortunately, the screening rate of colorectal cancer in China is far away from satisfactory level. The majority (about 85%) of high-risk populations still never have done colorectal cancer screening according to the report by Chen et al[19] in 2018. Key factors contributing to non-participation in colorectal cancer screening could be a poor awareness of colorectal cancer screening, a negative attitude towards screening and multiple barriers related to screening.[20] Previous studies suggested that the general population had deficient knowledge of colorectal cancer and screening.[21,22] Moreover, few studies also indicated that screening knowledge and practice were suboptimal among high-risk populations.[23,24] In China, fewer studies reported inadequate public knowledge and screening of colorectal cancer.[25,26]

Currently, there are few studies exploring awareness, attitude and identify barriers for colorectal cancer screening among high-risk populations in China. Therefore, it is crucial to assess awareness, attitude and possible barriers that hinder screening so that more effective approaches can be implemented to promote screening uptake. The objectives of this study were to (1) assess awareness, attitude and behaviour of colorectal cancer screening among high-risk populations in China, (2) examine sociodemographic factors associated with colorectal cancer screening knowledge and behaviour, and (3) identify the barriers to colorectal cancer screening.

Methods

Setting and sample

This was a cross-sectional study conducted between April and August 2019. The sample size was calculated based on 15% (π) of the prevalence rate of colorectal cancer screening using a formula $N=[Z^2_{\alpha/2}\times\pi\times(1-\pi)]/\delta^2$,[27] with 0.03 allowable error (δ) and $Z_{\alpha/2}=1.96$ at 95% confidence interval. Considering the 40% non-response rate, the final sample size was 760.

Nine hospitals were selected from a total of 42 in Hunan province using a cluster random sampling method. The source population were individuals from gastrointestinal department of hospitals with a high risk of developing colorectal cancer according to medical records by convenience sampling. With the support of hospitals, each trained interviewer was accompanied by a medical staff to introduce the study aim. The inclusion criteria[13,14] included: (1) age 18 to 75 years, (2) a family history of colorectal cancer or adenomas, (3) a personal history of colorectal cancer or adenomas, (4) a personal history of inflammatory bowel disease and (5) a personal history of hereditary syndromes. The exclusion criteria[13,14] included: (1) age less than 18 years, (2) being diagnosed with colorectal cancer, (3) unable to communicate with the investigator and (4) severe cognitive impairment. Individuals who consented to participate in the study completed a standardised face-to-face questionnaire, which lasted for approximately 15 to 20 minutes. Each participant received ¥30 (about $4.2) for completing the survey. This study was approved by the Ethic Committee of the University of South China (No. 4304081009636) and informed consent was obtained from all participants prior to participation.

Instrument

The questionnaire included items about awareness, attitudes and screening for colorectal cancer. Survey items were identified from the research literature,[28,29] the American Cancer Society and China Anti-Cancer Association.[30] The questionnaire consisted of 4 sections. The first section comprised socio-demographic characteristics, such as gender, age, education level, occupation, marital status, residence, income, health insurance, and perceived health status. The second part included 24 questions about knowledge of colorectal cancer: risk factors, warning signs and screening tests. Two items had multiple answers, so the scoring was 1 point for each correct answer and 0 points for the wrong answer or 'don't know' with a total score of 24 points. The third section was related to attitudes toward the colorectal cancer screening, such as colorectal cancer is preventable, early colorectal

cancer is curable, colonoscopy can help to find colorectal cancer early, colonoscopy can help to prevent colorectal cancer, colonoscopy is beneficial, colonoscopy is important. The possible responses were 'yes', or 'no'. In the fourth section, participants were questioned whether they had ever undergone colorectal cancer screening with 'yes' or 'no' answer. Participants who answered 'no' were asked to choose the reasons for not undergoing screening, and more than 1 choice was allowed. Mean knowledge scores were calculated based on the number of correct responses and total scores ranged from 0 to 24 points.

The reliability was evaluated by pretesting 80 people. The internal consistency of the questionnaires was accomplished by estimating the Cronbach's alpha based on the recommendation of >0.70. The Cronbach's alpha calculated was 0.88. Face validity was performed to assess the comprehension towards understanding of the questionnaire and to assess how important it was to target study participants. Finally, the questionnaire was modified and re-evaluated to fit the study population based on the feedback from the pilot study.

Statistical analysis

Data were analysed using IBM SPSS V.23.0. Descriptive statistics were used to describe the participants' socio-demographics and responses to each question. The t test and analysis of variance test were used to investigate the association of demographic factors with knowledge. The $\chi 2$ or Fisher's exact test were used to find the association between demographic factors and behaviour of colorectal cancer screening. Variables with a p value ≤0.15 in the univariate analysis were included in the multiple linear regression analysis to investigate the independent factors for screening knowledge, while variables with a p value ≤0.15 in the univariate analysis were included in the binary logistic regression analysis to identify the independent factors for screening behaviour. Only the results of the bivariate and multivariate analyses were presented using odds ratios (OR) and 95% confidence intervals (CI). A p value

of <0.05 was regarded as statistically significant.

Patient and public involvement

No participants were involved in our work. The study results will be made available to participants interested in this subject.

Results

Sample characteristics

Of the 760 high-risk individuals, 712 consented to involve in the study, of whom 28 completed less than 50% of the questionnaire. Thus, the final response rate was 90.0% (n=684). The mean age of the participants was 47.01±7.39 years (range=27-74 years). Of the total sample, more than half (54.5%) were men, 75.6% had high school education or below and 58.0% lived in urban areas. Almost all (94.4%) were married and 86.7% were insured. About 37.9% had low income. The majority (88.7%) had no personal history of colorectal disease and 93.1% had a family history of colorectal cancer or adenomas. Only 14.2% reported previous discussion of screening with the doctor, and 13.7% perceived their risk of developing colorectal cancer was high. Other variables are listed in Table 1.

Table 1 Participant characteristics (n=684)

Characteristics	N (%)
Gender	
Male	373 (54.5)
Female	311 (45.5)
Age (years)	
<40	79 (11.5)
40-49	399 (58.3)
50-59	163 (23.8)
>60	43 (6.3)

Mean±SD	47.01±7.39
Education level	
High school or below	517 (75.6)
College or above	167 (24.4)
Occupation	
Farmer	63 (9.2)
Worker	304 (44.4)
Unemployed	105 (15.4)
White collar	212 (31.0)
Marital status	
Single	38 (5.6)
Married	646 (94.4)
Residence	
Urban	397 (58.0)
Rural	287 (42.0)
Income (¥)	
<3000	259 (37.9)
3000-5000	207 (30.3)
>5000	218 (31.9)
Health insurance	
Yes	593 (86.7)
No	91 (13.3)
Self-reported health status	
Good	274 (40.1)
Fair	363 (53.1)
Poor	47 (6.9)
Personal history of colorectal disease	
Yes	77 (11.3)
No	607 (88.7)

Seen a doctor in the past year	
None	356 (52.0)
1-2 times	230 (33.6)
≥3 times	98 (14.3)
Previous discussion of colorectal cancer screening	
Yes	97 (14.2)
No	587 (85.8)
Family history of colorectal cancer or adenomas	
Yes	637 (93.1)
No	47 (6.9)
Perceived risk	
Low	248 (36.3)
Medium	342 (50.0)
High	94 (13.7)

Knowledge of colorectal cancer and screening

Table 2 presents the participants' knowledge about colorectal cancer and screening including risk factors, warning signs and screening tests. The mean total knowledge score was 11.86 (SD 4.84, range 0-24). The mean knowledge scores for risk factors, warning signs and screening tests were 5.38 (SD 2.70, range from 0-11), 4.60 (SD 2.03, range 0-8) and 1.88 (SD 1.19, range 0-5), respectively. The most well recognised risk factors were inflammatory bowel disease (63.2%), followed by colon polyps (62.1%) and excess alcohol consumption (60.4%). Less well-recognised risk factors included family history of colorectal cancer (49.6%), smoking (48.1%), older age (45.3%), being overweight or obese (44.0%), having an inherited syndrome (40.8%) and diabetes (11.5%). The most highly recognised warning signs were blood in the stool (76.0%), rectal bleeding (74.0%) and change in bowel habits (66.4%).

The least recognised symptoms included unexplained weight loss (57.3%), bowel does not empty (55.3%) and tiredness/anaemia (29.5%). Importantly, only 40.9% were aware that colorectal cancer could be asymptomatic. The most commonly heard of screening test was colonoscopy but only 46.6% knew that colonoscopy was the gold standard method of colorectal cancer screening. Less than a third were aware of stool DNA test (21.5%) and IFOBT and high-risk factor questionnaire (8.6%).

Table 3 presents the results of the multiple linear regression for factors associated with colorectal cancer screening knowledge. In the univariate analysis, education level, occupation, residence, income, health insurance, having seen a doctor in the past year, previous discussion of colorectal cancer screening and perceived risk were significantly associated with colorectal cancer knowledge ($p<0.05$). These factors plus variables with p value <0.15 (personal history of colorectal disease) in the univariate analysis were included in the multiple linear regression model. Factors independently associated with knowledge were education level, occupation, income, health insurance, having seen a doctor in the past year and perceived risk ($p<0.05$).

Participants who were found to be more knowledgeable about colorectal cancer and screening included with a college education or above (β=2.41, 95%CI 1.54 to 3.28, $p<0.001$), working as a white collar (β=1.89, 95%CI 0.42 to 3.36, p=0.012), with higher income (β=1.65, 95%CI 0.70 to 2.59, p=0.001; β=1.47, 95%CI 0.43 to 2.51, p=0.006), having health insurance (β=1.39, 95%CI 0.43 to 2.36, p=0.005), having seen a doctor in the past year (β=1.93, 95%CI 0.93 to 2.92, $p<0.001$) and perceiving greater risk (β=1.82, 95%CI 0.76 to 2.88, p=0.001).

Table 2 Knowledge of colorectal cancer and screening (n=684)

Category	N	%
Risk factors		

Older age	310	45.3
Low physical activity	384	56.1
High intake of red and processed meat	388	56.7
Smoking	329	48.1
Excess alcohol consumption	413	60.4
Being overweight or obese	301	44.0
Colon polyps	425	62.1
Inflammatory bowel disease	432	63.2
Family history of colorectal cancer	339	49.6
Having an inherited syndrome	279	40.8
Diabetes	79	11.5
Warning symptoms		
Blood in the stool	520	76.0
Rectal bleeding	506	74.0
Change in bowel habits	454	66.4
Tiredness/anaemia	202	29.5
Unexplained weight loss	392	57.3
Abdominal pain	417	61.0
Bowel does not empty	378	55.3
Colorectal cancer can be present without any symptoms	280	40.9
Screening tests		
FOBT	294	43.0
Colonoscopy/sigmoidoscopy	465	68.0
Stool DNA test	147	21.5
IFOBT and high-risk factor questionnaire	59	8.6
Which of the four choices is the gold standard method of colorectal cancer screening? (Colonoscopy)	319	46.6

Table 3 Multiple linear regression of factors associated with colorectal cancer knowledge (n=684)

	Knowledge Score			
	β	SE	95%CI	P
Education level				
High school or below	1 (ref)			
College or above	2.410	0.442	1.542, 3.279	<0.001*
Occupation				
Farmer	1 (ref)			
Worker	1.002	0.645	-0.264, 2.268	0.121
Unemployed	0.786	0.693	-0.573, 2.146	0.257
White collar	1.891	0.750	0.420, 3.363	0.012*
Income (¥)				
<3000	1 (ref)			
3000-5000	1.646	0.480	0.703, 2.589	0.001*
>5000	1.470	0.530	0.429, 2.512	0.006*
Health insurance				
No	1 (ref)			
Yes	1.386	0.493	0.429, 2.364	0.005*
Seen a doctor in the past year				
None	1 (ref)			
1-2 times	0.586	0.368	-0.137, 1.309	0.112
≥3 times	1.925	0.506	0.932, 2.918	<0.001*
Perceived risk				
Low	1 (ref)			
Medium	-0.292	0.364	-1.007, 0.423	0.423
High	1.820	0.540	0.760, 2.879	0.001*
Constant	7.365	0.704	5.983, 8.747	0.000*

R^2=0.210, F=17.510, P=0.000.

*Statistically significant at P<0.05.

CI, confidence interval; SE, standard error; ref, reference.

Attitudes towards colorectal cancer screening

Table 4 shows the attitudes towards colorectal cancer screening. A majority of participants held a positive attitude towards screening. More than 70% of them thought that colorectal cancer was preventable, early colorectal cancer was curable, colonoscopy could help to find colorectal cancer early, colonoscopy could help to prevent early colorectal cancer, colonoscopy was beneficial and colonoscopy was important. But only 58.7% thought they needed colonoscopy if they felt well. Of all the participants, only 91 (13.3%) had undergone colorectal cancer screening. There was a significant portion of participants (86.7%) who had not participated in colorectal cancer screening.

Table 5 shows the results of the bivariate analysis for factors associated with colorectal cancer screening behaviour. In the univariate analysis, factors significantly associated with colorectal cancer screening behaviour were personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening and perceived risk ($p<0.05$). These factors plus variables with p value <0.15 (education level) in the univariate analysis were included in the binary logistic regression model. The independent variables associated with colorectal cancer screening behaviour included personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, perceived risk and knowledge ($p<0.05$). Participants with a personal history of colorectal disease were more likely to have attended colorectal cancer screening compared with those without colorectal disease (OR 2.33, 95%CI 1.12 to 4.87, $p=0.024$). Participants who had seen a doctor in the past year were more likely to have undergone colorectal cancer screening than those who had never seen a doctor in the past year (OR 3.20, 95%CI 1.80 to 5.68, $p<0.001$; OR 2.41, 95%CI 1.17 to 4.96, $p=0.017$). Moreover, participants who had previous

discussion of colorectal cancer screening were more likely to have been screened for colorectal cancer (OR 2.42, 95%CI 1.25 to 4.66, p=0.008). Further, those with a higher perceived risk of developing colorectal cancer tended to have undergone screening than the other groups (OR 4.03, 95%CI 1.95 to 8.32, p<0.001). Additionally, those who had more knowledge were more likely to have done colorectal cancer screening (OR 1.06, 95%CI 1.00 to 1.12, p=0.044).

Table 4 Colorectal cancer screening perceptions (n=684)

Question	N	%
Colorectal cancer is preventable	524	76.6
Early colorectal cancer is curable	595	87.0
Colonoscopy can help to find colorectal cancer early	615	89.9
Colonoscopy can help to prevent colorectal cancer	521	76.2
Colonoscopy is beneficial	567	82.9
Colonoscopy is important	496	72.5
You need colonoscopy even if you feel healthy	402	58.8

Table 5 Bivariate analysis of factors associated with colorectal cancer screening behaviour (n=684)

Variable	Screened N (%)	Unscreened N (%)	OR	95%CI	P
Personal history of colorectal disease					
No	60 (9.9)	547 (90.1)	1 (ref)		
Yes	31 (40.3)	46 (59.7)	2.337	1.121,	0.024*

				4.874	
Seen a doctor in the past year					
None	23 (6.5)	333 (93.5)	1 (ref)		
1-2 times	43 (18.7)	187 (81.3)	3.195	1.799, 5.676	<0.001*
≥3 times	25 (25.5)	73 (74.5)	2.409	1.170, 4.958	0.017*
Previous discussion of colorectal cancer screening					
No	57 (9.7)	530 (90.3)	1 (ref)		
Yes	34 (35.1)	63 (64.9)	2.416	1.254, 4.655	0.008*
Perceived risk					
Low	17 (6.9)	231 (93.1)	1 (ref)		
Medium	38 (11.1)	304 (88.9)	1.246	0.666, 2.333	0.491
High	36 (38.3)	58 (61.7)	4.029	1.951, 8.320	<0.001*
Knowledge score, mean (SD)	13.9 (4.6)	11.6 (4.8)	1.060	1.001, 1.121	0.044*

*Statistically significant at P<0.05.

CI, confidence interval; OR, odds ratio; ref, reference.

Barriers to participate in colorectal cancer screening

Table 6 reports the reasons why participants have not undergone colorectal cancer screening. There were 71.1% of the participants pointed out that screening was not needful due to no symptoms or discomfort, 67.4% said that they had never thought of the disease or screening, and 29.8% mentioned that lack of recommendation by physicians. There was a significant number of participants who thought screening was too painful, unpleasant or

embarrassing (20.0%) and some answered that they were not at risk for colorectal cancer (19.0%). Other reasons were lack of time (15.3%), difficult to assess medical facilities (12.4%), fear of bowel preparation (12.3%), unawareness of the benefits of screening (11.2%) and financial problem (9.6%).

Table 6 Reasons for not undergoing colonoscopy (n=593)

Reasons	N	%
Never thought of it	400	67.4
Doctor did not advise me	177	29.8
No symptoms or discomfort	422	71.1
Afraid of detecting colorectal cancer	39	6.5
Lack of time	91	15.3
Fear regarding bowel preparation	73	12.3
Too painful, unpleasant or embarrassing	119	20.0
Financial problem	57	9.6
Unawareness of the benefits of screening	67	11.2
Difficult to access medical facilities	74	12.4
Believe risks outweigh benefits	17	2.8
Lack of support from others	4	0.6
Not at risk for colorectal cancer	113	19.0

Discussion

Understanding and recognising awareness and attitude regarding colorectal cancer screening and reasons towards low screening uptake among high-risk populations could help in developing appropriate policies for prevention and control of colorectal cancer. The study found that most of the participants had deficient knowledge and had never done colorectal cancer screening, but held a positive attitude towards screening and its benefits. Main reasons for not

seeking screening included no symptoms and never having thought of the disease or screening.

Colorectal cancer and screening awareness

Participants' knowledge of colorectal cancer and screening was insufficient, which was similar to studies conducted in Hong Kong and Saudi Arabia[31,32] but lower than that found in the Australian and Iranian studies.[33.34] Moreover, while participants had a relatively good awareness of warning symptoms, they had a poorer awareness of risk factors and screening tests. Less than half of participants identified risk factors such as smoking, older age, being overweight or obese, having an inherited syndrome and diabetes. This result indicates that people are unfamiliar with cancer-related risk factors.

Two of thirds of participants identified the main warning signs, whilst nonspecific symptoms such as tiredness/anaemia, bowel does not empty and unexplained weight loss were less likely to be identified. This would delay in seeking medical help.[35] Importantly, less than half of participants knew colorectal cancer can be asymptomatic, implying a gap in educational interventions. Furthermore, approximately a quarter of the participants indicated that they had never heard of even one screening test. This result shows that poor awareness of screening tests is a factor contributing to low participation rate of colorectal cancer screening, and indicates that screening tests could be a good target for cancer awareness-raising initiatives.[36]

Our finding found that respondents with lower education level and income, and who worked as farmers had worse awareness. Further, those who had no health insurance, had never seen a physician within the past year and with a lower perceived risk of colorectal cancer showed lower knowledge. There is a possibility that they had insufficient access to social resources and were less aware of information about colorectal cancer screening.[37] Studies have reported similar findings that socially disadvantaged groups were less knowledgeable.[38,39] Evidence also suggests that socially disadvantaged groups were less likely to have undergone screening.[22][37] Thus, educational

interventions should target these underserved and socially disadvantaged individuals.

Colorectal cancer screening attitude

Participants held positive attitudes towards screening and early diagnosis of colorectal cancer, implying that they were aware of the value of early diagnosis and the benefits of screening, while only less than 60% of the participants agreed that they needed colonoscopy even if they felt healthy. Therefore, it is necessary to educate the public about the importance and necessity of screening. Only a small percentage of participants (13.3%) had undergone colorectal cancer screening at least once, which was similar to that reported in the Hong Kong studies (14%)[26] but lower than that of the Korean and Iranian studies (>45%).[23][40] This difference may be because, in China, colonoscopy is conducted via opportunistic screening, and thus it relies on individuals voluntarily requesting it and shouldering the expenses.[16,17] It is noteworthy that the majority of participants had never done colonoscopy screening possibly due to low-risk perception, poor awareness towards screening or other reasons that may have limited their access to screening.[23] Therefore, it is crucial to explore the important barriers of colonoscopy screening among Chinese high-risk populations.[19]

Bivariate analysis showed that personal history of colorectal disease, having seen a doctor in the past year, previous discussion of colorectal cancer screening, perceived risk and knowledge were significantly associated with better screening behaviour. We found that only a minority (14%) of participants reported previous discussion about screening with physicians and thought that they had a high risk of developing colorectal cancer, which was below the estimates (28%–55%) from studies in Iran and USA.[23,24] This finding indicated that the participants were underestimating their risk of colorectal cancer and were not aware of the importance of screening. It is therefore urgent to plan health education interventions to correct public misperceptions of self-risk of developing colorectal cancer, and to emphasise the significance of screening.

Similar to our findings, a study found that individuals with gastrointestinal tract diseases were more likely to undergo gastrointestinal cancer screening than individuals without diseases, which may because the onset of uncomfortable symptoms motivates them to seek medical help and participate in screening.[41] A study that assessed beliefs, knowledge and screening among Asian Americans in California, found that participants who had seen their physician within the past year were more likely to attend colorectal cancer screening.[22] Furthermore, participants who received a physician's advice for screening were associated with higher adherence to cancer screening.[42] Choi et al found that those with a greater perceived risk of colorectal cancer were also significantly more likely to be screened than those with a lower perceived risk.[43] Wong et al found that participants with better knowledge concerning colorectal cancer screening were associated with performing screening.[26] Therefore, physicians should emphasise screening and risk education for high-risk individuals.

Colorectal cancer screening barriers

'No symptoms or discomfort' was the most common reason for not undergoing screening. This was consistent with previous studies.[41][44] This implies that participants mistakenly become convinced that screening is only required upon symptoms or feeling ill. They then go to health facilities to seek medical help, which can be worrying because the disease only becomes symptomatic at an advanced stage.[45] Therefore, there is a strong need to address such misconceptions and to educate people about the indications of cancer screening.

Moreover, 'never thought about the disease or screening' was another major barrier for participation in screening, which further reflects the lack of knowledge about colorectal cancer and its screening. This may be partly because colonoscopy for colorectal cancer screening is not covered by Chinese routine medical check-up.[16] In addition, it may also be because cancer is a taboo topic in Chinese culture and traditional beliefs, and Chinese

people are reluctant to think or speak about it. The notion of detecting a hidden or asymptomatic disease by screening does not exist in traditional Chinese beliefs.[12] This result emphasises the need to increase awareness of the importance of colorectal cancer screening for this preventable disease. It is also necessary to design culturally tailored education to reduce adverse beliefs or attitudes towards cancer.

'Lack of recommendation from physician' was found to be a key reason for not participating in screening. This suggests that clinicians need to pay more attention to educating patients about screening and to improving patient-physician communication. Physicians should also play an active role in delivering early screening information to high-risk populations. Other barriers observed included 'too painful, unpleasant or embarrassing' and 'I am not at risk for colorectal cancer'. As reported, the majority of the barriers are related to a lack of understanding and awareness of colorectal cancer screening. Some were health system and health professional related. Therefore, it is imperative to conduct awareness campaigns to attract public attention, correct these misconceptions and overcome psychological barriers. Better communication with participants regarding the screening procedure could potentially remove the perception of embarrassment and fear. Health care professionals should encourage high-risk individuals to participate in screening and inform them about cancer risk.

Implications

Korea, a country with high incidence rates of colorectal cancer, has implemented a nationwide screening programme and set up institutions responsible for providing comprehensive cancer information to promote public awareness and screening uptake.[9] In China, the government has begun to pay attention to awareness and screening about cancer. Health China Action: Cancer Prevention and Control Implementation Plan and Healthy China 2030 Strategy set a series of goals of attaining more than a 70% awareness rate of cancer prevention knowledge, making public aware of their cancer risk and

promoting cancer screening for high-risk groups.[46,47] However, data to evaluate the effectiveness of such initiatives are lacking, therefore, this study could be used as a basis to measure the effectiveness of further health promoting campaigns.

Our results have indicated that Chinese high-risk people have deficient awareness, some misconceptions and barriers regarding colorectal cancer screening. Moreover, they are still not aware of their cancer risk and the need for undergoing screening. Our findings suggest that strategies to improve awareness and screening uptake in high-risk populations should include three components. First, the government should learn from initiatives in different countries. Appropriate and effective educational campaigns should be conducted, using web-based education tools to broadcast scientific colorectal cancer prevention information.[48,49] Moreover, the government should establish an organised colorectal cancer screening programme and incorporate screening into healthcare system in the future.[23] Second, health care professionals should be trained to play an active role in improving high-risk people's awareness, perceptions and behaviour about colorectal cancer screening. Less-known risk factors, screening tests and major barriers discovered in this study need to be emphasised during education interventions. Further, health promotion campaigns should focus on those who do not see their physician regularly, those without colorectal disease, those with a low perceived risk, and those with poor knowledge.

Strengths and limitations

To our knowledge, this is the first study in mainland China aiming to assess awareness, attitude and behaviour about colorectal cancer screening and to explore the reasons underlying low screening rate among high-risk populations. The study achieved a high response rate through face-to-face interviews by trained interviewers, which strengthened the validity of the study results. Our study had some limitations. First, as the participants' screening history was self-reported, recall bias may have occurred. However, respondents were

given a brief description of screening tests before asking if they had ever undergone screening. Second, we may not have covered all of the barriers regarding screening uptake as only a quantitative method was used. Further study is warranted to use qualitative or mixed-method to comprehensively explore the related factors. Moreover, we assume that respondents who visit hospitals tend to have better health awareness. Third, validity of the instrument, which is an important factor in evaluating the quality of the instrument, was not explored well.

Conclusion

This study indicates that the majority of high-risk people had deficient knowledge and had never undergone colorectal cancer screening. But most of them held a positive attitude towards the benefits of screening. Being asymptomatic and never having thought of the disease or screening were the main reasons for not undergoing screening. Our study gives insight into the development of strategies to improve screening of colorectal cancer in China.

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	4
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	6

Objectives	#3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	#4	Present key elements of study design early in the paper	7
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7,8
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	8
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	8,9
Bias	#9	Describe any efforts to address potential sources of bias	
Study size	#10	Explain how the study size was arrived at	7,8
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	9
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	9

Statistical methods	#12c	Explain how missing data were addressed	
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	
Statistical methods	#12e	Describe any sensitivity analyses	
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	10
Participants	#13b	Give reasons for non-participation at each stage	
Participants	#13c	Consider use of a flow diagram	
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	10,11
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12,13,14,15, 16,17,18

Main results	#16b	Report category boundaries when continuous variables were categorized	12,13,14,15, 16,17,18
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	#18	Summarise key results with reference to study objectives	19
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	24
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	19,20
Generalisability	#21	Discuss the generalisability (external validity) of the study results	21,22,23
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	25