The Implementation and First-Round Results of a Community-Based Colorectal Cancer Screening Program in Shanghai, China

Yangming Gong,[a] Peng Peng,[a] Pingping Bao,[a] Weijian Zhong,[a] Yan Shi,[a] Kai Gu,[a] Ying Zheng,[a] Chunxiao Wu,[a] Sanjun Cai,[b] Ye Xu,[b] Jun Sheng,[b] Fan Wu[a]

[a]Shanghai Municipal Center for Disease Control and Prevention, Shanghai Institutes of Preventive Medicine, Shanghai, China; [b]Shanghai Tumor Hospital, Shanghai, China
Disclosures of potential conflicts of interest may be found at the end of this article.

ABSTRACT

Background. The incidence and mortality rate of colorectal cancer (CRC) have increased dramatically over the past 3 decades in China due to changes in lifestyle factors. Early detection and treatment guidelines for asymptomatic cases have shown to improve CRC control in developed countries. In response to these challenges, the Shanghai Municipal Government launched a community-based CRC screening program in 2012.

Materials and Methods. Free initial screening, inclusive of immunochemical fecal occult blood and risk assessment (questionnaire), was provided by community health centers in Shanghai. Participants with positive results were referred to a specialist for a colonoscopy.

Results. In 2013, 828,302 Shanghai residents were registered; 97.7% (809,528) of the registrants completed initial screening. Among 180,094 initial screening-positive participants, 71,733 underwent colonoscopy. The proportion of compliance to colonoscopy was 39.8%; the proportion decreased with age and educational level. A total of 6,668 adenomas were detected, and 1,630 CRC cases were diagnosed. The CRC detection rate of the program was 201.35/100,000; among the detected CRCs, 51.6% were in stage 0–I.

Conclusion. The screening program achieved great progress, especially on initial screening completion and CRC early stage rate, although particular intervention is still needed to improve the compliance of colonoscopy. *The Oncologist* 2018;23:928–935

Implications for Practice: Due to socioeconomic transitions and lifestyle changes, colorectal cancer is now becoming one of the most common cancers in developing countries, as it is in developed countries. While most developed countries have now initiated national colorectal cancer screening programs based on recommended country-specific colorectal cancer screening guidelines, colonoscopy has become the most commonly used screening method. This is a challenge in developing countries due to limited resources. Based on the analysis of the Shanghai colorectal cancer screening program, with immunological fecal occult blood test and risk assessment as initial screening, followed by a diagnostic testing of colonoscopy for individuals with positive results, this article provides the basis and suggestion for similar program in other regions of China and other developing countries.

INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer in the world [1]. The highest CRC incidence rates were mostly observed in high-income countries such as the U.S., New Zealand, Slovakia, Japan, and South Korea. Deaths from CRC accounted for 8% of all cancer mortality, which ranked as the fourth most common cause of death from cancer [2]. However, trends in incidence and mortality rates of CRC have differed between developed and developing countries. Whereas CRC incidence and mortality rates have decreased in the U.S. and most European countries [3–5], a dramatic increase in CRC incidence and mortality rates has been observed in middle- and low-income countries such as Brazil, China, Mexico, and Thailand [6–8]. Furthermore, the

5-year survival rate of CRC is only 28%–42% in developing countries, compared with that of more than 60% in developed countries [9–11]. The reduction in CRC incidence and mortality rates in developed countries can largely be attributed to the establishment of national-level colorectal cancer screening guidelines, as well as the utilization and improvement of CRC screening programs [12]. In China, CRC is the fourth most common cancer among men and the fifth most common cancer among women; its incidence and mortality rates have increased by 37% and 71% from 1991 to 2005 [13].

In Shanghai, one of the most developed cities in China, the incidence and mortality of CRC have increased dramatically

over the past 3 decades and are now among the highest in the nation [14]. According to the Shanghai Cancer Registry (SCR), the incidence of CRC has doubled in the past 20 years and has almost reached the incidence level in developed countries [15]. The incidence of CRC increased by 4.2% annually in Shanghai over the past 30 years; only 12% of the newly diagnosed cases per year were in the early stages [16]. In addition, overall 5-year survival rates of CRC in Shanghai were 10%–15% lower than those of developed countries [17]. According to the Shanghai Behavior Risk Factor Surveillance System, test rates for CRC screening tests, such as colonoscopy and fecal occult blood test, remained low in the past decade, at 4.01% and 11.01% [18]. Therefore, there was strong evidence of the necessity and urgency to set up a CRC screening program in Shanghai.

Although there is now good evidence of the benefits of early detection of cancer cases and removal of adenomas in asymptomatic individuals [19–27], the widespread implementation of colorectal screening programs is very resource-dependent [28, 29]. Although such programs have now been widely implemented in high-income regions and countries in North America, Europe, Japan, and South Korea [30–34], there are few examples of large-scale screening programs in low- and middle-income countries [35]. This paper describes the implementation of a comprehensive approach to CRC screening in Shanghai, China.

MATERIALS AND METHODS

Health System and Infrastructure

The Shanghai Municipal Commission of Health and Family Planning, Shanghai Municipal Finance Bureau, and Shanghai Municipal Human Resources and Social Security Bureau released a document in 2012 outlining an approach to CRC screening. This was the first municipal-level CRC screening approach in Shanghai. The whole screening service contained two steps—initial screening and colonoscopy. The initial screening service was facilitated by the community health centers (CHCs). Fifty officially designated hospitals were responsible for colonoscopy and further treatment of participants. The hospitals were selected by the District Health Bureau, with capacity of colonoscopy and multidisciplinary team of CRC. Of 50 designated hospitals, 35 (70%) were tier-2 hospitals, and the rest were tier-3 hospitals. The Shanghai Center for Disease Control and Prevention was responsible for program management, data management, training, quality control, and program evaluation. Immunological fecal occult blood test (FIT) package, provided by the Shanghai Government, was free to participants; it costs 1.5 Yuan RMB for each test, and each participant would take two tests in initial screening. The cost of colonoscopy was covered by each participant's personal health insurance account when the participant was referred to a designated hospital. About 95% of Shanghai residents were covered by different kinds of health insurance, including Basic Medical Insurance for Employees and Urban & Rural Residents Basic Medical Insurance; both official Shanghai residents and migrant populations could be covered.

Staff Training and Quality Control

Health workers from CHCs, including general practitioners and nurses, staff from district CDCs, and physicians from designated hospitals were recruited for training. The training contents contained CRC screening protocol, registration and system management instructions, standard CRC health education courses, CRC diagnosis and treatment guidelines, and colonoscopy criteria. A total of 733 staff members, from 223 CHCs, 50 officially designated hospitals, and 17 district CDCs, completed the training in 2013. Training would be provided to program staff annually to enhance the capacity of implementation.

The Shanghai Municipal Center for Disease Control and Prevention organized specialists from surgery, endoscopy, and pathology to check the quality of the diagnosis and treatment of CRCs and lesions.

Screening Protocol

The screening has two steps: (a) initial screening, including FIT and risk assessment, followed by (b) diagnostic testing of colonoscopy for individuals with positive results.

FIT

In the first step of initial screening, each participant was evaluated by FIT and a risk-assessment questionnaire during an in-person survey. For FIT, the minimal detective level was 100 ng/mL; each participant was given two sample containers to collect fecal samples at home, within an interval of 7 days, and was asked to return each sample to a CHC within 48 hours after collection. A 60-second video was made to explain how to collect the fecal samples at home and was played on repeat in CHCs. A participant was identified as FIT-positive if either one or both of the tests were positive. Participants who failed to return samples within 2 weeks would be reminded twice through telephone by CHCs and were recorded as nonresponders after the failure of the second attempt.

Risk Assessment

A face-to-face interview for risk assessment was conducted by questionnaire either before or after fecal sample collection. There were nine questions in this questionnaire, including anorectal symptoms, related diseases such as polyps and appendicitis, CRC family history, personal cancer history, etc. Questions had different weights [36], and the result would be given by computer after the data were entered into the system.

Colonoscopy

A participant who had either a positive FIT result or a positive risk assessment questionnaire result would be identified to be at a high risk for CRC and referred to officially designated hospitals for colonoscopy examination. In colonoscopy examination, the entire colon was examined [37]. If the condition of participants permitted, the scope should reach to ileocecus, and returning of scope should last for longer than 20 minutes.

Data Management

A 12-number barcode was assigned to each participant after registration to follow further screening results. The barcode would appear on the fecal collect tube, and when participants returned the tube, the FIT result could be entered into the system easily by scanning the barcode, the same as entering colonoscopy data in designated hospitals. The barcode was coded by year of screening, district of residence, community, and a random digit.
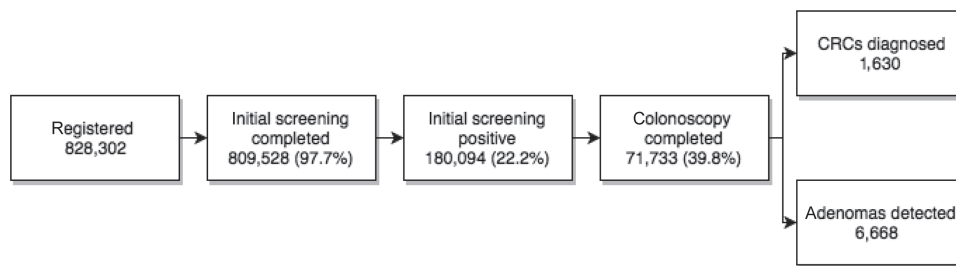
Figure 1. Number of screened population and outcomes in screening process.
Abbreviation: CRC, colorectal cancer.

Table 1. Characteristics of participants who completed initial screening

Characteristics	Participants, n (%)
Total screened	809,528 (100)
Sex	
Men	316,903 (39.1)
Women	492,625 (60.9)
Age at screening, years	
50–59	294,339 (36.4)
60–69	416,019 (51.4)
70–74	99,170 (12.3)
Marital status	
Married	735,858 (90.9)
Unmarried	21,531 (2.7)
Divorced	8,718 (1.1)
Widowed	34,740 (4.3)
Unknown	8,681 (1.1)
Education	
Illiteracy	63,634 (7.9)
Primary school	231,577 (28.6)
Middle school	439,662 (54.3)
High school	73,052 (9.0)
College/university	1,603 (.2)
Occupation	
Organizations/institutions	53,797 (6.6)
Industrial enterprises	327,096 (40.4)
Agriculture	245,046 (30.3)
Free occupation	19,551 (2.4)
Unemployment	33,476 (4.1)
Others	130,562 (16.1)
Area	
Urban	542,430 (67.0)
Rural	267,098 (33.0)

The Shanghai CRC screening registry and management system was an internet-based system that was created for the Shanghai CRC screening program. All screening data, including personal information, risk-assessment questionnaire, FIT result, colonoscopy result, diagnosis and treatment information, and initial screening result, would be provided by the system through comprehensive analysis of the questionnaire and FIT result. The system could also remind the staff to contact participants who did not return the FIT tube on time. The system would print initial screening result notification letters for participants, and positive-result letters could be used as referral letters when participants went for colonoscopies in designated hospitals. The system could remind the staff to contact participants who did not go for colonoscopies on time.

Target Population

Official Shanghai residents and migrant populations aged 50–74 years with no history of CRC were identified by CHCs and were invited to participate in the screening. CHCs mobilized target populations with the collaboration of neighborhood committees and village committees. A variety of mass media outlets were used to raise advocacy and awareness on CRC prevention and early detection and to increase enrollment. Promotion campaigns, aimed at increasing CRC screening, were launched on radio, television, and posters in public places. Health information brochures were distributed to individuals in target age groups. All participants were fully informed of the risks and benefits of CRC screening, and all participants provided written informed consent prior to participation. As a public health service, some residents older than 75 years took the initiative to participate in the program but were excluded in this analysis.

Data for Analysis

Based on the national census in 2010, the size of the target population between 50 and 74 years of age was 4 million; both official Shanghai residents and migrant populations were included. According to the official document released in 2012, each round of the Shanghai CRC screening program would last for 3 years. By comprehensive evaluation of the capacity of health resources, about 1 million participants from the target population could be covered in one round (3 years); therefore, it was estimated that most of the participants who were willing to join the screening could be enrolled within three rounds. Initially, the first round of screening should have started in 2011 and completed in 2013; however, because of the preparation of the program, the implementation of screening was carried out from January to December in 2013. Minhang District is one of the 17 districts in Shanghai; however, the screening data in Minhang was not submitted to Shanghai CDC because of the different information-management system used. Thus, the data of Minhang District was excluded in this analysis.

Because of the age range of the target population, occupation in this paper was the occupation before retired, and urban and rural areas were defined by Administrative Divisions Codes from the National Bureau of Statistics of China.

Table 2. Proportion of positive for initial screening

Characteristics	Screened individuals	Questionnaire positive only, n (%)	FIT positive only, n (%)	Both positive, n (%)	Initial screening positive, n (%)
Overall	809,528	75,141 (9.3)	88,222 (10.9)	16,731 (2.1)	180,094 (22.2)
Sex					
Men	316,903	25,950 (8.2)	38,521 (12.2)	6,578 (2.1)	71,049 (22.4)
Women	492,625	49,191 (10.0)	49,701 (10.1)	10,153 (2.1)	109,045 (22.1)
Age at screening, years					
50–59	294,339	25,620 (8.7)	29,475 (10.0)	5,100 (1.7)	60,195 (20.5)
60–69	416,019	39,393 (9.5)	46,932 (11.3)	9,104 (2.2)	95,429 (22.9)
70–74	99,170	10,128 (10.2)	11,815 (11.9)	2,527 (2.5)	24,470 (24.7)
Marital status					
Married	735,858	65,831 (8.9)	82,385 (11.2)	13,753 (1.9)	161,969 (22.0)
Unmarried	21,531	2,620 (12.2)	801 (3.7)	1,328 (6.2)	4,749 (22.1)
Divorced	8,718	1,251 (14.3)	748 (8.6)	233 (2.7)	2,232 (25.6)
Widowed	34,740	4,418 (12.7)	3,935 (11.3)	990 (2.8)	9,343 (26.9)
Unknown	8,681	1,021 (11.8)	353 (4.1)	427 (4.9)	1,801 (20.7)
Education					
Illiteracy	63,634	5,087 (8.0)	9,395 (14.8)	1,371 (2.2)	15,853 (24.9)
Primary school	231,577	15,294 (6.6)	31,476 (13.6)	4,024 (1.7)	50,794 (21.9)
Middle school	439,662	44,164 (10.0)	42,015 (9.6)	8,745 (2.0)	94,924 (21.6)
High school	73,052	10,384 (14.2)	5,195 (7.1)	2,549 (3.5)	18,128 (24.8)
College/university	1,603	212 (13.2)	141 (8.8)	42 (2.6)	395 (24.6)
Occupation					
Organizations/institutions	53,797	7,400 (13.8)	4,959 (9.2)	1,390 (2.6)	13,749 (25.6)
Industrial enterprises	327,096	35,577 (10.9)	29,652 (9.1)	6,412 (2.0)	71,641 (21.9)
Agriculture	245,046	14,820 (6.0)	34,511 (14.1)	4,099 (1.7)	53,430 (21.8)
Free occupation	19,551	1,563 (8.0)	2,300 (11.8)	373 (1.9)	4,236 (21.7)
Unemployment	33,476	3,265 (9.8)	4,567 (13.6)	792 (2.4)	8,624 (25.8)
Others	130,562	12,516 (9.6)	12,233 (9.4)	3,665 (2.8)	28,414 (21.8)
Area					
Urban	542,430	57,441 (10.6)	46,974 (8.7)	11,518 (2.1)	115,933 (21.4)
Rural	267,098	17,700 (6.6)	41,248 (15.4)	5,213 (2.0)	64,161 (24.0)

Abbreviation: FIT, immunological fecal occult blood test.

Statistical Analysis

SPSS 22.0 (IBM, Armonk, NY) was used for statistical analysis. Chi-square test was used for comparison between groups; $\alpha <$ .05 was statistically significant.

RESULTS

By the end of 2013, a total of 828,302 individuals were registered; they signed the informed consent, and their personal information was recorded by the screening system. Among the registered populations, 809,528 (97.7%) participants completed both FIT and risk assessment (Fig. 1).

Of the screened participants, 39.1% were men and 60.9% were women, the majority of the participants were in age group 50–59 (36.4%) and 60–69 (51.4%), almost all the participants were married, and the major education level was middle school or lower. For the occupation of participants, 40.4% were

workers and 30.3% were in agriculture, and 67.0% were in urban and 33.0% in rural areas (Table 1).

Among the participants who completed the initial screening, 180,094 (22.2%) tested positive. Similar proportions of men and women had positive results: 71,049 (22.4%) for men and 109,045 (22.1%) for women. The positive rate of only risk assessment was 9.4%, only FOBT was 10.9%, and both positive was 2.2%. The positive rates were different among age groups and were higher in rural than in urban areas (Table 2).

All the participants with a positive initial screening result received a referral letter for colonoscopy. By the end of the first round, 71,733 (39.8%) participants with a positive initial screening result completed a colonoscopy test. Women had a lower proportion than men (odds ratio [OR] = 0.923, $p = .0001$). For different age groups, the proportion decreased with the increasing of age. Married people had the highest participation rate in all marital status. Participation rate decreased with the

Table 3. Proportion of colonoscopy among initial screening-positive participants

Characteristics	Initial screen positive	Attended colonoscopy, n (%)	Adjusted OR[a] (95% CI)	p value
Overall	180,094	71,733 (39.8)		
Sex				
Men	71,049	29,052 (40.9)	1.000	
Women	109,045	42,681 (39.1)	0.923 (0.905–0.941)	.000
Age at screening, years				
50–59	60,195	24,854 (41.3)	1.000	
60–69	95,429	38,391 (40.2)	0.957 (0.937–0.977)	.000
70–74	24,470	8,488 (34.7)	0.755 (0.732–0.779)	.000
Marital status				
Married	161,969	65,450 (40.4)	1.000	
Unmarried	4,749	1,508 (31.8)	0.848 (0.795–0.906)	.000
Divorced	2,232	754 (33.8)	0.864 (0.790–0.944)	.001
Widowed	9,343	3,486 (37.3)	0.874 (0.836–0.913)	.000
Unknown	1,801	535 (29.7)	0.733 (0.661–0.812)	.000
Education				
Illiteracy	15,853	7,331 (46.2)	1.000	
Primary school	50,794	23,023 (45.3)	1.003 (0.967–1.040)	.880
Middle school	94,924	35,369 (37.3)	0.909(0.875–0.944)	.000
High school	18,128	5,905 (32.6)	0.821 (0.780–0.864)	.000
College/university	395	105 (26.6)	0.608 (0.484–0.764)	.000
Occupation				
Organizations/institutions	13,749	4,701 (34.2)	1.000	
Industrial enterprises	71,641	25,659 (35.8)	1.045 (1.004–1.087)	.030
Agriculture	53,430	24,781 (46.4)	1.237 (1.184–1.293)	.000
Free occupation	4,236	1,999 (47.2)	1.361(1.267–1.462)	.000
Unemployment	8,624	3,905 (45.3)	1.229 (1.159–1.303)	.000
Others	28,414	10,688 (37.6)	1.091 (1.043–1.141)	.007
Area				
Urban	115,933	40,962 (35.3)	1.000	.000
Rural	64,161	30,771 (48.0)	1.429 (1.395–1.465)	.000
Initial screening method				
Questionnaire	75,141	22,394 (29.8)	1.000	
FIT	88,222	40,482 (45.9)	1.773 (1.735–1.811)	.000
Both	16,731	8,857 (52.9)	2.638 (2.548–2.731)	.000

[a]A characteristic factor adjusted for other characteristics.
Abbreviations: CI, confidence interval; FIT, immunological fecal occult blood test; OR, odds ratio.

increasing of education level from middle school. Participation rate in rural areas was higher than in urban areas (OR = 1.429, p = .000). For initial screening method, the participants with only questionnaire positive showed the lowest proportion of colonoscopy, whereas both questionnaire and FIT positive showed the highest proportion of colonoscopy in different screening method (OR = 2.638, p = .000; Table 3).

Among the 71,733 participants who underwent colonoscopy, 6,668 had adenoma (4,472 among males and 3,439 among females). The overall detection rate for adenomas is 847.91 per 100,000 people. A total of 1,630 CRC cases were diagnosed. The detection rate of CRC was 201.35/100,000. The detection rate of adenomas was much higher in males than in females (p = .000); 70–74 years showed the highest detection rate in different age groups; and rural areas had higher detection rates of adenomas than urban areas. For CRC, the detection rate showed a similar situation with adenomas (Table 4).

According to the information collected from the Shanghai CRC screening registry and management system, and data linkage with the Shanghai Cancer Registry, detailed staging information has been identified for 1,205 (73.9%) cases. There were 622 (51.6%) early-stage (0–I) cases. The proportion of later-stage (II–IV) cases in the screened population was lower than that in the Shanghai Cancer Registry 2012 (Table 5).

Table 4. Detection of adenomas and cancers

Characteristics	Screening individuals	Adenomas			Cancers		
		Cases	Detection rate (1/100,000)	p value	Cases	Detection rate (1/100,000)	p value
Sex							
Male	316,903	3,734	1,178.28		886	279.58	
Female	492,625	2,934	595.58	.000	744	151.03	.000
Age, years							
50–59	294,339	1,864	633.28		348	118.23	
60–69	416,019	3,842	923.52	.000	945	227.15	.000
70–74	99,170	962	970.05	.000	337	339.82	.000
Area							
Urban	542,430	3,044	561.18		1,026	189.15	
Rural	267,098	3,624	1,356.81	.000	604	226.13	.000
Total	809,528	6,668	823.69		1,630	201.35	

Table 5. Comparison of colorectal cancer staging with Shanghai Cancer Registry 2012

Stage	Screening participants, n (%)[a]	Cancer registry 2012 (50–74 years), n (%)[a]
0–I	622 (51.6)	442 (16.2)
II	265 (22.0)	879 (32.2)
III	269 (22.3)	834 (30.6)
IV	49 (4.1)	571 (20.9)
Unknown stage	425 (—)	1726 (—)

[a]The proportion of CRC in early stage was calculated by CRC cases with detailed stage information; cases with unknown stage were excluded.
Abbreviations: —, data excluded; CRC, colorectal cancer.

DISCUSSION

During the program implementation in 2013, there were a total of 828,302 individuals registered; 97.7% (809,528) of the registered individuals completed initial screening. Overall initial screening-positive rate was 22.2%; 180,094 participants tested positive. A total of 71,733 initial screening-positive participants underwent colonoscopy. Adenomas were detected in 6,668 participants, and 1,630 participants were diagnosed with CRC; among 1,205 CRC cases with detailed stage information, 51.6% were in early stage, more than four times higher than the data of the Shanghai Cancer Registry 2012. A total of 6,668 adenoma cases were detected by this program; the detection rate of adenomas was underestimated because of the compliance of colonoscopy and information collection. The early diagnosis of CRC could improve prognosis and quality of life of patients and ultimately reduce the mortality of CRC in the future.

In the Shanghai CRC screening program, the completion rate of initial screening was high, compared with a similar screening program in Germany during 2014 (97.7% vs. 71.3%) [38]. The main explanation is the effect of the reminder system, in which participants who did not return fecal samples on time would be reminded twice within the interval of 7 days through

telephone by CHC staff. Another explanation may be that participants in Germany received FIT kit passively, whereas participants in Shanghai were registered initiatively [39].

When prioritizing the CRC screening program, the data from SCR provided strong evidence that the accessibility of data in a screening program is important so that the public and policy makers are able to understand the real situation. Local statistics help to show variation in risk factor prevalence and hence cancer burden and outcomes [40]. The census should be used to determine the size of the target population and expected number of participants.

For the consideration of introducing a population-based screening program, regarding its public service characteristics, the capacity of the current medical system must be considered. All the hospitals with colonoscopy capabilities allocate the facilities and capacity according to medical needs. A screening program will inevitably bring more colonoscopy examinations than usual [41]. It was necessary to carefully examine the gap between the current capacity of colonoscopy and the need produced by the proposed screening program. A survey was conducted to collect information on the current colonoscopy capacity, including number of colonoscopies and trained physicians and the actual number and expected number of examinations. It was found that there was around 25% spare capacity, which meant the workload space to undertake the colonoscopy of the program. Most of the spare capacity existed in the tier-2 hospitals. It was also found that the spare capacity accounted for over 80% of the needs for the colonoscopy examination from the screening program. The obstacle can be overcome by well-designed referral systems between the CHCs and the hospitals.

Limitations and Disadvantages

Although great progress has been achieved, as a large-scale public health service program for millions of the target population, there were several disadvantages that still need to be improved. The main weakness of the screening program was the low compliance rate of colonoscopy among initial screening-positive participants. The overall proportion of compliance to colonoscopy was 39.8%; the low compliance rate

might affect the effect of CRC screening, because initial screening-positive participants who did not attend colonoscopy might have never received a diagnosis of CRC or adenomas.

The compliance to colonoscopy in the Shanghai CRC screening program was lower than that in the U.S. (53%) [42] and Australian (68%) programs [43]; however, the proportion was higher than the programs without colonoscopy subsidy in other cities in similar CRC screening program in China, which was 2.8% in Hangzhou [44], 11.8% in Beijing [45], and 20.5% [46] in Tianjing, but lower than most of the programs with colonoscopy subsidy, which was 76.2% in Haining [47] and 78.7% in Jingzhou [48]. The result showed that the proportion of compliance to colonoscopy decreased with the increasing of age, which may be caused by the fear of colonoscopy examination risk in elder people. Elder people have higher risk of undergoing colonoscopy. The U.S. Preventive Services Task Force recommends that the decision to screen for colorectal cancer in adults aged >75 years should be an individual one, depending on personal health and prior screening history [49]. As the cost of anesthesia is not covered by health insurance, elder people were less likely to tolerate the discomfort of colonoscopy. Populations with higher education levels showed lower participation rates of colonoscopy. Higher education level commonly means higher income, which could allow for more resources for medical examination. Similar results could be found in different occupation groups and different areas: agriculture, free occupation, and unemployed people were more likely to attend colonoscopy because no employer can provide additional medical examination for that population.

To compare the characteristics of populations with and without colonoscopy, it was found that there were significant differences between the two populations. Factors included sex, age, marital status, education level, areas, and initial screening methods. More detailed investigations will be needed to confirm the factor of colonoscopy compliance. The question of how to improve the participation rate of colonoscopy among initial screening-positive populations, and especially promote particular populations such as high education level or single/unmarried to attend colonoscopy, may have great significance in improving early-stage rate of CRC and the effect of screening.

The collection of colonoscopy, diagnosis, and treatment information was limited. There were 50 official designated hospitals in the Shanghai CRC screening program, which had the responsibility to collect information. However, 70% of the designated hospitals were tier-2 hospitals, and some participants chose higher-level, but nondesignated, hospitals for further examinations. Among all the participants who attended colonoscopy, 34.8% chose nondesignated hospitals that lacked corresponding information collection mechanisms, so the information could only be obtained from community CHCs by follow-up. Diagnosis information of CRC cases could be collected by data linkage with SCR, but the detection of adenomas was not registered, which means the number of adenoma cases might be underestimated. To comprehensively evaluate the effectiveness of the screening program, more efficient mechanisms are needed to improve the collection of diagnosis information.

For sustainability of the CRC screening program, it is necessary to improve the compliance of colonoscopy. The monitoring of adverse events is a relevant negative performance indicator that should be followed in further implementation, and the performance of colonoscopy, such as adenoma detection rate, will be evaluated to ensure the quality of colonoscopy.

Launching the colorectal cancer screening program in Shanghai is a good example of transforming a mature population intervention technique into a health service, by careful design and organization. The experience and methods detailed in this program will help to scale up the program.

CONCLUSION

This paper focuses on the first round of CRC screening in 2013. A series of studies, such as detection rate of different initial screening methods, compliance of colonoscopy, and change of mortality, will follow. The next report of screening outcomes of the second round should be released in 2019; we are going to pay more attention to indicators of colonoscopy performance and cost-effectiveness of screening.

AUTHOR CONTRIBUTIONS

Conception/design: Pingping Bao, Weijian Zhong, Yan Shi, Ying Zheng, Sanjun Cai, Ye Xu, Jun Sheng, Fan Wua
Collection and/or assembly of data: Yangming Gong, Peng Peng, Kai Gu, Chunxiao Wu
Data analysis and interpretation: Yangming Gong, Peng Peng, Pingping Bao, Kai Gu
Manuscript writing: Yangming Gong
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Editor's Note:
See the related commentary, "Important Role of Health Surveillance Systems in Community-Based Colorectal Cancer Screening," by Ann Chao and Sudha Sivaram, on p. 871 of this issue.