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Toward standardizing and reporting colorectal cancer screening indicators on an international level: the International Colorectal Cancer Screening Network

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The International Colorectal Cancer Screening Network was established in 2003 to promote best practice in the delivery of organized colorectal cancer screening programs. To facilitate evaluation of such programs, we defined a set of universally applicable colorectal cancer screening measures and indicators. To test the feasibility of data collection, we requested data on these variables and basic program characteristics from 26 organized full programs and 9 pilot programs in 24 countries. The size of the target population for each program varied considerably from a few thousand to 36 million. The majority of programs used fecal occult blood tests for primary screening, with more using guaiac than immunochemical tests. There was wide variation in the ability of screening programs to report the requested measures and in the values reported. In general, pilot programs were more likely to provide screening measure values than were full programs. As expected, detection rates for polyps and neoplasia were substantially higher in programs screening with endoscopy than in those using fecal occult blood tests. It is hoped that the screening measures and indicators, once revised in the light of this survey, will be adopted and used by existing programs and those in the early planning stages, allowing international comparison with the goal of improved colorectal cancer screening quality.

The International Colorectal Cancer Screening Network (ICRCSN) is a global consortium public health professionals who are focussed on planning and delivering colorectal cancer (CRC) screening to their populations. The ICRCSN is sponsored by the Centers for Disease Control and Prevention and the American Cancer Society, Atlanta, GA. The ICRCSN aims to facilitate the international sharing and comparison of CRC screening data to benefit both existing programs and those in the planning stages. During Phase 1 (2003–2005) organized screening initiatives were identified worldwide and their characteristics documented.[1] It became clear that if CRC screening programs were to be usefully compared, a minimum set of universally applicable CRC screening indicators would be required.

The aim of Phase 2 of the ICRCSN was to establish a minimum set of universally applicable CRC screening measures and indicators to evaluate and compare screening programs on an international level, while contributing to program evaluation at a local level; and to investigate the feasibility of data collection for these screening measures. In this paper, we define these measures and indicators and report data collected in 2008 from 35 screening programs.

Key words: colonoscopy, colorectal cancer screening, fecal occult blood test, flexible sigmoidoscopy, screening evaluation

Abbreviations: CRC: colorectal cancer; FOBt: fecal occult blood test; FS: flexible sigmoidoscopy; gFOBt: guaiac fecal occult blood test; IARC: International Agency for Research on Cancer; ICRCSN: International Colorectal Cancer Screening Network; iFOBt: immunochemical fecal occult blood test; PPV: positive predictive value; TC: total colonoscopy.

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Material and Methods

In Phase 1, we surveyed CRC screening initiatives with varying levels of organization, including full programs, pilot programs, and research projects. In Phase 2, we restricted our survey to full or pilot programs fulfilling at least four of the International Agency for Research on Cancer (IARC) criteria

Table 1. Screening measures and their definitions, as used in the survey

Screening measure	Screening modality to which the measure is applicable	Screening measure definition used in the survey
Target population	FOBt, FS, TC	Total number of people eligible for screening according to the program policy
Invited population	FOBt, FS, TC	Total number of people who received an invitation[1] for screening according to the program policy
Tested population	FOBt, FS, TC	Total number of people who used and returned a FOBt kit or had an endoscopy, as the primary screening test, irrespective of result. This includes people with incomplete/inadequate results. Note that each person is counted once regardless of the number of tests performed
Inadequate FOBt	FOBt	Total number of people who have returned an inadequate FOBt and do not achieve an adequate result in the reporting period. An inadequate test means that, according to the program policy, it cannot be used for recording a result
Positive FOBt	FOBt	Total number of people who have a positive/abnormal result with FOBt. A positive/abnormal result is a result which, according to the program policy, leads directly to a referral
Diagnostic/therapeutic endoscopy	FOBt, FS	Total number of people who have undergone an endoscopy, whether diagnostic or therapeutic, to follow up primary screening according to program policy, including those whose endoscopy was inadequate/incomplete. Note that each person is counted once regardless of the number of endoscopies which were performed
Cancers detected	FOBt, FS, TC	Total number of people diagnosed with colorectal cancer by or as a result of the screening program
Polyps detected	FOBt, FS, TC	Total number of people reported to have had a polyp removed/biopsied at endoscopy or surgery (whether or not they were diagnosed as adenomas)
Adenomas detected	FOBt, FS, TC	Total number of people whose pathological specimens removed at endoscopy or surgery have been reported by a pathologist to be adenomatous
Mortality (all cause)	FOBt, FS, TC	Total number of people who have died within 30 days after having undergone an endoscopic procedure whether screening, diagnostic or therapeutic to follow up primary screening and where the death is NOT attributable to surgical or other curative interventions initiated because of a colorectal cancer diagnosis
Mortality (colonoscopy-specific)	FOBt, FS, TC	Total number of people who have died within 30 days after having undergone a colonoscopy whether screening, diagnostic or therapeutic to follow up primary screening and where the death is attributable to complications caused by the colonoscopy

[1]Processes by which people, eligible for screening according to the program policy, are invited by mail (either standard or personalized or tailored to the individual, perhaps coming from their primary care practitioner [PCP], or based on some prior information about the individual apart from their age) or orally (*e.g.* by PCP).
Abbreviations: FOBt, fecal occult blood test; FS, flexible sigmoidoscopy; TC, total colonoscopy.

for an organized screening program. These include (*i*) an explicit policy with specified eligibility categories, method and interval for screening; (*ii*) a defined target population; (*iii*) a management team responsible for implementation; (*iv*) a health care team for decisions and care; (*v*) a quality assurance structure and (*vi*) a method for identifying cancer occurrence in the target population.[2]

The Expert Working Group for Phase 2, consisting primarily of public health researchers and those responsible for developing and running screening programs, met in September 2007 and drafted an initial set of screening indicators based on those developed for breast cancer screening by such agencies as the IARC,[2,3] the International Breast Screening Network (http://appliedresearch.cancer.gov/icsn), and the UK NHS Breast Screening Programme (http://www.cancerscreening.nhs.uk/breastscreen). Each indicator is a rate calculated as a ratio of two conventional "screening measures" (see Table 1 for a list of all screening measures and their definitions, and Table 2 for a list of screening indicators). For example, the indicator "fecal occult blood test (FOBt) positivity rate" is calculated from the two screening measures "FOBt positive population" and "tested population" (FOBt positivity rate = number of people with positive FOBts/number in the tested population).

Our aim was to define each screening measure, so that it would be applicable to and easily understood in all health care contexts in all countries. The screening measures and indicators were piloted (using a written questionnaire) by seven screening programs representing a broad spectrum of different health systems and different modalities, including FOBt, flexible sigmoidoscopy (FS) and total colonoscopy (TC). Subsequently, a consensus on the definition of each

Table 2. Screening indicators, as defined for the survey

Indicator	Screening modality	Calculation, based on reported screening measures
Coverage rate	All	Invited population/target population
Participation rate	All	Tested population/target OR invited population
FOBt inadequacy rate	FOBt	Number with inadequate FOBt/tested population
FOBt positivity rate	FOBt	Number with positive FOBt/tested population
Diagnostic/therapeutic endoscopy rate	FOBt, FS	Number with diagnostic or therapeutic endoscopy/tested population
Cancer detection rate (Positive predictive value for cancer detection)	All	Number with cancer/tested population (Number with cancer/diagnostic endoscopy)
Polyp detection rate (Positive predictive value for polyp detection)	All	Number with polyps/tested population (Number with polyps/diagnostic endoscopy)
Adenoma detection rate (Positive predictive value for adenoma detection)	All	Number with adenomas/tested population (Number with adenomas/diagnostic endoscopy)
Mortality (all cause)	All	30-day all cause mortality/tested population
Mortality (colonoscopy-specific)	All	30-day colonoscopy specific mortality/tested population

Abbreviations: FOBt, fecal occult blood test; FS, flexible sigmoidoscopy.

screening measure was reached by the Expert Working Group, and the indicator questionnaire was refined.

A representative from each eligible program was emailed the questionnaire in May 2008 and invited to participate in the Phase 2 survey. In addition to the screening measures, we collected information on program characteristics. Programs were asked to provide their most recent data for a minimum period of 12 months. Separate questionnaires were completed for each screening modality within a program. Of the 11 screening measures, eight were applicable to all modalities, one only to either FS or FOBt, and two only to FOBt.

For each modality, programs were asked to provide a value for each screening measure for first (prevalent) screens, subsequent (incident) screens and total screens (the sum of first and subsequent screens) within the reporting period for their screening program. Programs (or modalities within a program) were subsequently classified as those in their first screening round, and therefore only able to report first screens; those that had undergone more than one screening round and were able to report data on first and subsequent screens and those unable to distinguish between first and subsequent screens. Programs (or modalities within a program) for which only total screens could be reported were excluded from screening indicator calculations, as were those with a tested population <100 people. Unclear responses to the questionnaire were clarified by subsequent communication with the program representatives.

Preliminary results from the survey were discussed at a meeting for survey respondents and the Expert Working Group in Oxford, England in September 2008, and proceedings of this meeting were published elsewhere.[4]

Results

In Phase 2, 43 organized screening programs were identified. Of these, eight programs had started screening too recently to be able to provide data for the survey: four in Canada and one in each of China (Hong Kong), Lithuania, Slovenia and Sweden. A total of 35 programs had been collecting data for at least 12 months and were thus eligible for survey. Of the 35 eligible programs, from 24 different countries, 26 were full programs and 9 were pilot programs (Tables 3 and 4). Those programs with published references or websites describing their program details are listed on the ICRCSN website (Supporting Information, E-tables 1a and 1b: http://icrcsn.ceu.ox.ac.uk/).

Four programs used different screening modalities in separate target groups (Tables 3 and 4): New York used both guaiac FOBt (gFOBt) and immunochemical FOBt (iFOBt), Maryland used gFOBt and TC, the Dutch program screening the regions of Amsterdam and Nijmegen used both gFOBt and iFOBt, and the Dutch program screening the Greater area of Rotterdam used gFOBt, iFOBt and FS. Thus, a total of 40 modality-specific survey questionnaires were completed. All results are presented separately by modality within programs, as appropriate.

Characteristics of surveyed screening programs

The size of the target population for each program (or modalities within programs) varied considerably, from a few thousand for the three modalities within the Dutch pilot program screening the Greater area of Rotterdam (gFOBt, iFOBt and FS) and the TC program in the USA (Delaware) to 36 million in the Japanese program. The earliest program began in 1971 in Germany (FOBt program) and the most recent in Croatia in 2008. As shown in Table 3, 28 of the programs used FOBt as their primary screening modality. Of these, 16 used guaiac tests, 9 used immunochemical tests and 3 used both kinds of tests. Most programs (20 [69%]) developed their FOBts in a central laboratory, four [14%] developed tests in the primary care practitioner's office and four (14%)

Table 3. Characteristics of screening programs using fecal occult blood tests as the primary screening modality, presented alphabetically by country within regions defined by the World Health Organization

Country	Region(s)	Program type	Size of target population	Type of test	Where develop test	Define positive test[1]	Year program began	Age range (years)	Screening interval (months)
Europe									
Croatia	All	Full	1,473,281	G[2]	L	1/12	2008	50–74	24
Czech Republic	All	Full	4,782,000	G	O	1/6	2000	50+	24
Denmark	Copenhagen county and Vejle county	Pilot	270,153	G	L	1/6	2005	50–74	Once only
Finland	All	Full	230,604	G	L	1/6	2004	60–66	24[3]
France	All	Full	1,515,666	G	L	1/6	2002	50–74	24
Germany	All	Full	27,800,000	G	O	1/6	1971	50+	12/24[4]
Hungary	All	Pilot	81,348	I	L	1/3	2003	50–70	24
Israel	All	Full	742,839	G[2]	L	1/6	1993	50–74	12
Italy	All	Full	6,168,761	I	L	1/1	1982[5]	44–75[6]	24
Latvia	All	Full	827,033	G	O	1/9	2005	50+	12
The Netherlands[7]	Amsterdam and Nijmegen	Pilot	10.301	G	L	1/6	2006	50–75	Once only
The Netherlands[7]	Amsterdam and Nijmegen	Pilot	10,322	I	L	1/1	2006	50–75	Once only
The Netherlands[8]	Greater area of Rotterdam	Pilot[9]	5,004	G	L	1/6	2006	50–74	Once only
The Netherlands[8]	Greater area of Rotterdam	Pilot[9]	5,007	I	L	1/1	2006	50–74	Once only
Romania	Iasi and Suceava	Full	413,000	G	Both	1/6	2003	50–75	24
Slovak Republic	All	Full	1,181,614	G	O	1/6	2002	50+	51
Spain	Catalonia	Full	65,147	G	L	5/6[10]	2000	50–69	24
UK – England	All	Full	5,300,000	G	L	5/6[10]	2006	60–69	24
UK – Scotland	All	Full	417,619	G	L	5/6 or 1–4/6 plus positive iFOBt	2006	50–74	24
The Americas									
Chile	North and South	Pilot	Variable	I	L	1/2	2007	50+	Once only
Uruguay	All	Full	450,000	I	L	1/1	1997	50–70	24
USA – Maryland[11]	14 counties in Maryland	Full	22,000	G[2]	Both[12]	1/6	2000	50–64[13]	12
USA – Missouri	St Louis City and County, and Franklin, Jefferson, and St Charles Counties	Pilot	10,331	G	L	1/3	2005	50–64	12
USA – New Jersey[14]	All of state	Full	59,285	G[2]	Both	1/3	2001	50+	12
USA – New York[14,15,16]	All of state	Full	293,742[15]	G[2]	Both	1/6	1997	50+	12
USA – New York[15,16]	All of state	Full	293,742[15]	I	Both	1/2	2006	50+	12
USA – Northern California	Northern California	Full	806,634	I	L	1/1	2006	51–70	12
Western Pacific									
Australia	All	Full	1,048,098	I	L	1/2	2006	55/65	Once only[16]
Japan	All	Full	36,290,693	I	L	1/2	1992	40+	12
Singapore	All	Pilot	500,000	I	L	1/2	2002	50+	12
Taiwan	All	Full	4,541,677	I	L	1/1	2004	50–69	24

[1]The minimum number of samples positive/number of samples taken that are required to define a positive FOBt in the program. [2]Use a sensitive guaiac fecal occult blood test. Maryland and New York used both a sensitive and standard test, and New Jersey's test is chosen by the provider. [3]24 months on average. [4]12 month interval between ages 50-55 years, and a 24 month interval at age over 55 years old. [5]The first program began in 1982; 9 others began during 1982–2002, 6 began during 2004, 33 began during 2005, and 16 began during 2006. [6]Dependent on the program (65 programs in total). All programs include age 50–69 years. [7]Part of same program. [8]Part of the same program, and of the Dutch FS pilot in Table 4. [9]Also a randomized clinical trial. [10]Weak positives (1–4/6) are retested to clarify their positivity. [11]Part of the same program as the Maryland colonoscopy program in Table 4. [12]"Office" includes local health department offices. [13]Will also screen those 65+ years. [14]Participants identified as high risk are not included in the program using FOBt and are offered a colonoscopy. [15]Only able to estimate target population for the program, not by each modality. [16]Once only screens, however, there are some people that have been screened previously during a pilot that took place in 2002–2004.

Abbreviations: G, guaiac test; I, immunochemical test; iFOBt, immunochemical fecal occult blood test; L, laboratory; O, General Practitioner's office.

Table 4. Characteristics of screening programs using endoscopy as the primary screening modality, presented alphabetically by country within regions defined by the World Health Organization

Country	Region(s)	Program type	Primary screening modality	Size of target population	Year program began	Age range (years)	Screening interval (months)
Europe							
Germany	All	Full	TC	20,000,000	2002	55+	120
Italy	Piemonte and Veneto	Full	FS	52,057	2003	58/60[1]	Once only
The Netherlands[2]	Greater area of Rotterdam	Pilot[3]	FS	5,001	2006	50–74	Once only
Poland	All	Full	TC	5,000,000	2000	40–65	120
The Americas							
USA – Colorado	All of state	Full	TC	40,000	2006	50–64	120
USA – Delaware	All of state	Full	TC	4,314	2002	50+	120
USA – Maryland[4]	23 counties in Maryland	Full	TC	37,000	2000	50–64[5]	120
USA – Missouri	St Louis City and County, and Franklin, Jefferson, and St Charles Counties	Pilot	TC	10,331	2007	50–64	120
USA – New York	Suffolk County	Pilot	TC	13,545	2006	50–64	120

[1]Begin screening at age 58 years in 5 programs and at age 60 years in 2 programs. [2]Part of the same program as the Dutch FOBt pilots in Table 3. [3]Also a randomized clinical trial. [4]Part of the same program as the Maryland FOBt program in Table 3. [5]Maryland targets age range 50–64 years, but will screen those <50 and 65+ years at increased risk of colorectal cancer.
Abbreviations: FS, flexible sigmoidoscopy; TC, total colonoscopy.

used both sites. Most programs using gFOBt collected six stool samples (two samples from three consecutive bowel movements), whereas programs using iFOBt collected only one or two stool samples (one sample per bowel movement). Regardless of the number of samples taken, most programs defined a test as positive when any one of the samples was considered positive. However, England and Spain defined a test as positive when at least five of the six samples were positive on first tests, or for borderline tests (1–4 samples positive), on repeat testing (any one of 12 samples positive on two further tests). Scotland defined a test as positive when at least five of the six samples taken were positive, or when 1–4 of the six samples and a subsequent iFOBt were positive. Croatia and Israel used a sensitive gFOBt, and three programs using gFOBt in the USA (Maryland, New York and New Jersey) used a combination of standard and sensitive tests on their populations.

The age group invited to screening is influenced by national guidelines, but in some nations also by the test, commitment to on-going *versus* one-time screening, and the screening interval (Tables 3 and 4). For example, in all USA programs included in the survey, screening started at age 50 with criteria for not screening defined by the individual's health status rather than age, and the screening interval varied by the test that was used. In Europe, screening typically started at either age 50 or 60, with upper age limits typically between ages 66 and 75. Upper and lower age limits in the Western Pacific were more variable.

Screening interval varied by screening modality. The two programs using FS screened "once only", whereas the seven programs using TC screened every 10 years (Table 4). For programs using FOBt activities (Table 3), the interval was "once only" for seven programs (six of which were pilot programs), annually for 10, biennially for 12, a combination of both annually and biennially specified by age for the German program, and every 51 months for the Slovak Republic program.

Screening measures

Table 5 shows the number of programs (or modalities within programs) able to give values for each screening measure, separately for those that were able to provide a value for first screens only (no subsequent screens having yet been done), those that were able to provide values for both first and subsequent screens, and those that were able to provide a value only for total screens (including first and subsequent screens). Table 6 shows values for reported screening measures, by program (or modalities within a program).

Reporting of the measures "target population" and "invited population" was inconsistent and incomplete so these measures are not included in Table 6 (or used for indicator calculations, all of which take the tested population as the baseline). All 35 programs were able to report the size of their tested population and almost all (33 [94%]) were able to report number of CRC detected. Around half of the programs were able to provide data on 30-day mortality related to an endoscopic procedure, and 13 programs stated that all or part of their data on screening measures were estimated (with the majority of these programs estimating their target population). Only three programs were able to provide a value for all applicable screening measures (Chile, Hungary and the Dutch program using three modalities); a further five

Table 5. Number of screening programs (or modalities within a program) able to provide values for each screening measure: only for first screens, separately for first and subsequent screens, and only for total screens

Screening measure	Screening programs (or modalities within a program) able to provide a value only for first screens[1] n = 22 (13 FOBt + 2FS + 7TC)	Screening programs (or modalities within a program) able to distinguish between first and subsequent screens n = 10, all FOBt	Screening programs (or modalities within a program) able to provide a value only for total screens[2] n = 8, all FOBt
Target population	Not known[3]	Not known[3]	Not known[3]
Invited population	15/22	7/10	3/8
Tested population	22/22	10/10	8/8
Inadequate FOBt	9/13	10/10	4/8
Positive FOBt	12/13	10/10	7/8
Diagnostic/therapeutic endoscopy	14/15	10/10	7/8
Number of cancers	21/22	10/10	7/8
Number of adenomas	16/22	9/10	4/8
Number of polyps	18/22	9/10	6/8
Number of 30-day deaths	13/22	1/10	3/8
Number of 30-day colonoscopy-specific deaths	15/22	4/10	3/8

[1]Programs (or modalities within programs) only in their first round of screening. [2]These programs (or modalities within programs) were not able to provide screening measures that distinguished between first and subsequent screens, therefore some programs may have reported the number of tests performed and not the number of people tested. [3]Target population was inconsistently reported and many values estimated.
Abbreviations: FOBt, fecal occult blood test; FS, flexible sigmoidoscopy; TC, total colonoscopy.

programs could provide values for all except for the mortality measures (Australia, Finland, Romania, Spain and USA [New York] FOBt). Ability to report screening measures did not appear to vary substantially by geographical region (Europe, The Americas and Western Pacific) or by modality (FOBt and endoscopy). Pilot programs were more likely than full programs to provide values for any screening measure.

Screening indicators

Tables 7 and 8 show the screening indicator values calculated from data reported for first (n = 30 programs or modalities within programs) and subsequent (n = 10 programs or modalities within programs) screens, respectively. Excluded from these tables are the eight programs that did not distinguish between first and subsequent screens (Czech Republic, Germany [FOBt], Slovakia, Japan, Uruguay, Scotland, Singapore and USA [New Jersey]), and two very small programs (both from USA [Missouri]). Indicator rates (such as participation rate) which depend on the target or invited populations are not given, because these measures were inconsistently reported. Mortality rates are also not reported, because only one program (USA – Colorado) reported a value greater than 0 cases (two cases per 40,000 screened).

Detection rates for CRC at the reported screening round were substantially higher for programs using endoscopy as their primary screening method compared with those using FOBt. For first screens, the mean cancer detection rate per 1,000 people tested by FOBt was 2.4 (standard deviation [SD] 1.6); range = 0–7.1), whereas for FS it was 4.9 (SD = 0.5; range = 4.6–5.3), and for TC it was 9.1 (SD = 1.2; range = 7.4–10.7). Results did not vary by type of FOBt (gFOBt: 2.7 [SD 1.6]; iFOBt: 2.2 [SD 1.9] per 1,000 people tested). Polyp and adenoma detection rates were slightly higher for programs using iFOBt than those using gFOBt: for polyp detection, mean rates were 23.6 (SD 16.2) and 11.2 (SD 4.5) per 1,000 people tested using iFOBt and gFOBt, respectively, and for adenoma detection, mean rates were 17.1 (SD 14.1) and 9.1 (SD 3.3) per 1,000 people tested using iFOBt and gFOBt, respectively.

Programs using iFOBt tended to report higher test positivity rates at first screens than those using gFOBts (iFOBt: 6.1% [SD 1.7]; gFOBt: 4.6% [SD 3.3]). Within gFOBts, mean test positivity rate for programs using sensitive gFOBts only was 6.2% [SD 3.6], whereas for programs using standard gFOBts was 4.1% [SD 3.2] (with only one program having a positivity rate greater than 2.7%). Once modality was taken into account, there were no obvious differences in indicator values by region or between full programs and pilot programs, although these analyses were limited by the small number of programs evaluated.

Positive predictive values (PPVs) for polyp, adenoma and cancer detection for FOBt screening are shown in Table 9 for first screens and Table 10 for subsequent screens. For first screens, PPVs of a positive FOBt (in those undergoing subsequent diagnostic endoscopy) ranged from 14% (Romania) to 69% (The Netherlands – Amsterdam and Nijmegen, iFOBt) for polyp detection, 9.5% (Australia) to 62% (The Netherlands – Greater area of Rotterdam, iFOBt) for adenoma

Table 6. Screening measures reported for each program (or modalities within a program), presented alphabetically by country within regions defined by the World Health Organization

Country	Program type	Primary screening modality	Reported period (months)	Tested population	Inadequate FOBt	Positive FOBt	Diagnostic/ therapeutic endoscopy	Polyps detected	Adenomas detected	Cancers detected
Europe										
Croatia[1]	Full	gFOBt	12	36,959	1,534	3,385	1,829	645	Unknown	120
Czech Republic[2]	Full	gFOBt	90	1,720,935	Unknown	58,512	51,585	22,572	15,691	2,790
Denmark[1]	Pilot	gFOBt	16	85,579	915[3]	2,085	1,878	841	Unknown	174
Finland	Full	gFOBt	12	20,422	69	495	438	199	152	36
France[1]	Full	gFOBt	24	686,732	5,479	18,855	14,696	Unknown	4,612	1,615
Germany[2]	Full	gFOBt	12	4,291,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Germany[1]	Full	TC	12	529,699	NA	NA	NA	173,257	112,565	5,240
Hungary[1]	Pilot	iFOBt	24	24,598	152	1,571	732	186	165	23
Israel	Full	gFOBt	12	194,019	1,535	7,033	4,277	1,168	Unknown	347
Italy	Full	iFOBt	12[4]	901,885	3,844	48,653	38,110	Unknown	18,889	2,342
Italy[1]	Full	FS	12	7,589	NA	NA	795	1,717	1,084	35
Latvia[1]	Full	gFOBt	12	53,589	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
The Netherlands – Amsterdam and Nijmegen[1,5]	Pilot	gFOBt	12	4,836	Unknown	117	103	69	46	11
The Netherlands – Amsterdam and Nijmegen[1,5]	Pilot	iFOBt	12	6,157	Unknown	339	280	194	121	24
The Netherlands – Greater area of Rotterdam[1,6]	Pilot	FS	12	1,521	NA	NA	140	563	292	8
The Netherlands – Greater area of Rotterdam[1,6]	Pilot[7]	gFOBt	19	2,375	24	64	61	40	36	6
The Netherlands – Greater area of Rotterdam[1,6]	Pilot[7]	iFOBt	19	2,979	4	241	228	154	142	16
Poland[1]	Full	TC	48	50,148	NA	NA	NA	11,535	6,654	416
Romania	Full	gFOBt	12	3,235	27	295	265	37	30	19
Slovak Republic[2]	Full	gFOBt	51	60,942	2,080	6,787	2,797	718	555	171
Spain	Full	gFOBt	24	17,740	568	189	180	79	72	27
UK – England[1]	Full	gFOBt	24	866,297	Unknown	14,847	10,117	4,338	Unknown	1,211
UK – Scotland[2]	Full	gFOBt	12	221,338	85	4,426	3,541	1,655	1,032	311
The Americas										
Chile[1]	Pilot	iFOBt	6[8]	3,492	59	295	254	122	71	13
Uruguay[2]	Pilot	iFOBt	24	30,000	3,273	2,765	2,133	987	Unknown	808
USA – Colorado[1]	Full	TC	24	4,148	NA	NA	NA	2,032	954	41
USA – Delaware[1]	Full	TC	76	3,454	NA	NA	NA	263	Unknown	29
USA – Maryland[9]	Full	gFOBt	101	6,080[10]	14	615	204	87	35	5
USA – Maryland[1,9]	Full	TC	101	11,488	NA	NA	NA	4,873	2,547	121
USA – Missouri[1]	Pilot	FOBt	13	64	0	6	5	2	1	0
USA – Missouri[1]	Pilot	TC	12	74	NA	NA	NA	28	18	3
USA – New Jersey[2]	Program	gFOBt[11]	36	11,232	Unknown	1,382	629	357	45	8
USA – New York[12]	Full	gFOBt[11]	12	6,330	13	322	234	68	45	8

Table 6. Screening measures reported for each program (or modalities within a program), presented alphabetically by country within regions defined by the World Health Organization (Continued)

Country	Program type	Primary screening modality	Reported period (months)	Tested population	Inadequate FOBt	Positive FOBt	Diagnostic/ therapeutic endoscopy	Polyps detected	Adenomas detected	Cancers detected
USA – New York[12]	Full	iFOBt	12	2,144	67	67	57	27	21	0
USA – New York (Suffolk County only)[1]	Pilot	TC	26	545	NA	NA	NA	209	143	4
USA – Northern California[1]	Full	iFOBt	12	94,981	179	5,394	3,292	Unknown	Unknown	185
Western Pacific										
Australia	Full	iFOBt	18	290,739	3,533	22,152	13,049	4,236	1,311	28
Japan[2]	Full	iFOBt	12	6,824,088	Unknown	488,980	270,768	Unknown	Unknown	11,417
Singapore[2]	Pilot	iFOBt	42	41,060	0	2,108	1,185	326	Unknown	50
Taiwan	Full	iFOBt	36	821,492	12,500	32,269	23,636	8,103	4,615	928

[1]Programs (or modalities within a program) that only reported first screens as they had not yet begun subsequent screens. [2]Programs (or modalities within a program) that were unable to distinguish between first and subsequent screens, therefore reported number of tests and not number of people tested. [3]The number of inadequate fecal occult blood tests is only known for Vejle. [4]Less than 12 months of data from 12 of the area-specific or regional programs activated during 2006. [5]Part of the same program. [6]Part of the same program. [7]Also a randomized clinical trial. [8]Only invites during one month, but takes 6 months to screen those invited. [9]Part of the same program. [10]USA Maryland program tested 6,080 people in total, 1,280 of whom had both a first and a subsequent screen within the reporting period. The outcome values in this table are for the colonoscopies performed on eligible people following a positive FOBt. People with positive FOBts who were not eligible for colonoscopy by income or insurance were referred to other providers. [11]Rehydrate tests (New York does not rehydrate all tests, it is area-specific). [12]Part of the same program.
Abbreviations: FOBt, fecal occult blood test; FS, flexible sigmoidoscopy; gFOBt, guaiac fecal occult blood test; iFOBt, immunochemical fecal occult blood test; TC, total colonoscopy; NA, Not applicable.

detection, and 0% (New York FOBt) to 16% (Spain) for cancer detection.

Discussion

We identified 43 organized CRC screening programs during Phase 2 of the ICRCSN, of which 35 were eligible to participate in the survey. The eligible programs represented 24 countries and consisted of 26 full programs and nine pilot programs. As in Phase 1, the majority of programs conducted primary screening using FOBt with slightly more using guaiac than immunochemical tests.

Of the eligible programs, 26 provided sufficient data to allow calculation of most indicator values based on the tested population, though only three programs were able to report observed values for all the measures requested. A variety of reasons were given for inability to report measures: the screening program was in its early stages; measures were calculated elsewhere outside the screening program and were not easily available; or reporting such measures was not a current priority of the screening program.

On the basis of the survey definitions, many programs had difficulty in reporting invited and target populations. In some cases, no population register was available; others were able to report data for the program screening interval only, but not for the requested reporting period and in some cases, the distinction between target and invited population was misunderstood. It is clear that the definitions of these screening measures in particular need to be refined or more clearly stated to avoid confusion and to allow the calculation of fundamental indicators of screening program performance, such as coverage rate. Measures of 30-day mortality resulting from an endoscopic procedure were also commonly not available, and in many cases were not routinely collected and linked to the program. These important measures of program performance require particular attention.

At the time of data collection, eight programs (or modalities within programs) which had completed both first and subsequent screens were unable to report data separately for the initial and subsequent screening rounds. For the 22 programs (or modalities within programs) still conducting their first round of screening, their ability to distinguish data from future subsequent rounds is not yet known. Distinguishing between previously screened and unscreened groups is important for indicator comparisons, as detection rates for neoplasia are likely to be higher in those who have not been screened previously. This aspect of routine screening program data collection should be emphasized, because the expected cancer detection rate is an important metric in on-going program evaluation and comparison of program performance.

The survey suggests that the ability of a program to report screening measures was somewhat higher for pilot programs than for full programs, and this may reflect a higher emphasis on evaluation in the pilot phase followed by reduced organizational capacity for data collection and analysis in routine practice.

There was sufficient data to allow comparison between indicator values for first screens in 30 programs (or modalities within programs; Table 7), and for subsequent and first screens separately for 10 programs (or modalities within programs; Table 8). As expected, polyp, adenoma and cancer

Table 7. Screening indicators for first (prevalent) screens, presented alphabetically by country within regions defined by the World Health Organization: includes programs able to provide data only for first screens, and those able to distinguish between first and subsequent screens

Country	Program type	Primary screening modality	Reported period (months)	FOBt positivity rate (%)	Positive FOBt follow-up rate (%)	Polyp detection rate (per 1,000)	Adenoma detection rate (per 1,000)	Cancer detection rate (per 1,000)
				Positive test/tested	Diagnostic endoscopy/ positive test	Polyps detected/ tested	Adenomas detected/ tested	Cancers detected/ tested
Europe								
Croatia[1]	Full	gFOBt[2]	12	9.2	54	17.5	Unknown	3.3
Denmark[1]	Pilot	gFOBt	16	2.4	90	9.8	Unknown	2.0
Finland	Full	gFOBt	12	2.4	90	9.8	7.6	1.9
France[1]	Full	gFOBt	24	2.8	78	Unknown	6.7	2.4
Germany[1]	Full	TC	12	NA	NA	327.1	212.5	9.9
Hungary[1]	Pilot	iFOBt	24	6.4	47	7.6	6.7	0.9
Israel	Full	gFOBt[2]	12	4.1	59	6.9	Unknown	2.4
Italy	Full	iFOBt	12[3]	5.8	78	Unknown	20.4	2.9
Italy[1]	Full	FS	12	NA	NA	226	142.8	4.6
Latvia[1]	Full	gFOBt	12	Unknown	Unknown	Unknown	Unknown	Unknown
The Netherlands – Amsterdam and Nijmegen[1,4]	Pilot	gFOBt	12	2.4	88	14.3	9.5	2.3
The Netherlands – Amsterdam and Nijmegen[1,4]	Pilot	iFOBt	12	5.5	83	31.5	19.7	3.9
The Netherlands – Greater area of Rotterdam[1,5]	Pilot[6]	FS	12	NA	NA	370.2	192.0	5.3
The Netherlands – Greater area of Rotterdam[1,5]	Pilot[6]	gFOBt	19	2.7	95	16.8	15.2	2.5
The Netherlands – Greater area of Rotterdam[1,5]	Pilot[6]	iFOBt	19	8.1	95	51.7	47.6	5.4
Poland[1]	Full	TC	48	NA	NA	230.0	132.7	8.3
Romania	Full	gFOBt	12	10.4	91	13.4	11.1	7.1
Spain	Full	gFOBt	24	1.1	96	5.5	4.9	1.6
UK – England[1]	Full	gFOBt	24	1.7	68	5.0	Unknown	1.4
The Americas								
Chile[1]	Pilot	iFOBt	6[7]	8.5	86	34.9	20.3	3.7
USA – Colorado[1]	Full	TC	24	NA	NA	489.9	230.0	9.9
USA – Delaware[1]	Full	TC	76	NA	NA	76.1	Unknown	8.4
USA – Maryland[8]	Full	TC	101	NA	NA	424.2	221.7	10.5
USA – Maryland[8]	Full	gFOBt[2]	101	8.4	35	Unknown[9]	Unknown[9]	Unknown[9]
USA – New York[10]	Full	gFOBt[2,11]	12	7.0	76	13.6	8.9	2.3
USA – New York[10]	Full	iFOBt	12	3.8	83	15.2	12.0	0.0
USA – New York (Suffolk County only)[1]	Pilot	TC	26	NA	NA	379.6	257.4	7.4
USA – Northern California[1]	Full	iFOBt	12	5.7	61	Unknown	Unknown	2.0

Table 7. Screening indicators for first (prevalent) screens, presented alphabetically by country within regions defined by the World Health Organization: includes programs able to provide data only for first screens, and those able to distinguish between first and subsequent screens (Continued)

Country	Program type	Primary screening modality	Reported period (months)	FOBt positivity rate (%) Positive test/tested	Positive FOBt follow-up rate (%) Diagnostic endoscopy/ positive test	Polyp detection rate (per 1,000) Polyps detected/ tested	Adenoma detection rate (per 1,000) Adenomas detected/ tested	Cancer detection rate (per 1,000) Cancers detected/ tested
Western Pacific								
Australia	Full	iFOBt	18	7.5	60	14.5	4.3	0.1
Taiwan	Full	iFOBt	36	3.9	73.3	9.9	5.6	1.1
Pooled data for gFOBt	–	gFOBt	–	4.6	76.6	11.2	9.1	2.7
Pooled data for iFOBT	–	iFOBt	–	6.1	73.9	23.6	17.1	2.2

[1]Programs (or modalities within a program) that only reported first screens as they had not yet begun subsequent screens. [2]Use both sensitive and standard tests. [3]Less than 12 months of data from 12 of the area-specific or regional programs activated during 2006. [4]Part of the same program. [5]Part of the same program. [6]Also a randomized clinical trial. [7]Only invites during one month, but takes 6 months to screen those invited. [8]Part of the same program: people with a positive FOBt who were not eligible for colonoscopy by income or insurance were referred to other providers and outcome of colonoscopy was not known to the program. [9]Unknown because only know the number of polyps, adenomas, and cancers among those that were eligible for colonoscopy within the program. Those that were not eligible for colonoscopy by income or insurance were referred to other providers for follow-up. [10]Part of the same program. [11]Rehydrate some tests (area-specific).
Abbreviations: FOBt, fecal occult blood test; FS, flexible sigmoidoscopy; gFOBt, guaiac fecal occult blood test; iFOBt, immunochemical fecal occult blood test; TC, total colonoscopy; NA, Not applicable.

Table 8. Screening indicators for subsequent (incident) screens, presented alphabetically by country within regions defined by the World Health Organization, in programs able to provide data

Country	Program type	Primary screening modality	Reported period (months)	FOBt positivity rate (%) Positive test/tested	Positive FOBt follow-up rate (%) Diagnostic endoscopy/ positive test	Polyp detection rate (per 1,000) Polyps detected/ tested	Adenoma detection rate (per 1,000) Adenomas detected/ tested	Cancer detection rate (per 1,000) Cancers detected/ tested
Europe								
Finland	Full	gFOBt	12	2.6	81	9.7	6.7	0.9
Israel	Full	gFOBt[1]	12	3.0	65	4.9	Unknown	1.0
Italy	Full	iFOBt	12[2]	3.1	85	Unknown	10.4	1.1
Romania	Full	gFOBt	12	4.3	83	4.3	2.8	1.4
Spain	Full	gFOBt	24	1.1	95	3.7	3.5	1.4
The Americas								
USA -Maryland	Full	gFOBt[1]	101	8.0	26	Unknown[3]	Unknown[3]	Unknown[3]
USA – New York[4]	Full	gFOBt[1,4]	12	3.3	67	8.2	5.4	0.3
USA – New York[4]	Full	iFOBt	12	2.3	90	9.0	6.7	0.0
Western Pacific								
Australia	Full	iFOBt	18	9.1	50	15.0	7.4	0.1
Taiwan	Full	iFOBt	36	3.4	85	10.0	5.4	0.9
Pooled data for gFOBt	–	gFOBt	–	3.7	69.5	6.2	4.6	1.2
Pooled data for iFOBt	–	iFOBt	–	4.5	77.5	11.3	7.5	0.5

[1]Use a sensitive guaiac fecal occult blood test. New York used both a sensitive and standard test. [2]Less than 12 months of data from 12 of the area-specific or regional programs activated during 2006. [3]Unknown because only know the number of polyps, adenomas, and cancers among those that were eligible for colonoscopy within the program. Those that were not eligible for colonoscopy by income or insurance were referred to other providers for follow-up. [4]Part of the same program.[5]Rehydrates some of their tests, it is area-specific.
Abbreviations: FOBt, fecal occult blood test; gFOBt, guaiac fecal occult blood test; iFOBt, immunochemical fecal occult blood test.

Table 9. Positive predictive values for colorectal neoplasia: programs using fecal occult blood tests as their primary screening modality that provided data for first screens, presented alphabetically by country within regions defined by the World Health Organization

Country	Program type	Primary screening modality	Reported period (months)	Positive predictive value for polyp detection (%)	Positive predictive value for adenoma detection (%)	Positive predictive value for cancer detection (%)
				Polyp detected/ diagnostic endoscopy	Adenoma detected/diagnostic endoscopy	Cancer detected/ diagnostic endoscopy
Europe						
Croatia[1]	Full	gFOBt	12	35.3	Unknown	6.6
Denmark[1]	Pilot	gFOBt	16	44.8	Unknown	9.3
Finland	Full	gFOBt	12	45.4	35.3	9.0
France[1]	Full	gFOBt	24	Unknown	31.4	11.0
Hungary[1]	Pilot	iFOBt	24	25.4	22.5	3.1
Israel	Full	gFOBt	12	28.7	Unknown	9.9
Italy	Full	iFOBt	12[2]	Unknown	45.4	6.4
Latvia[1]	Full	gFOBt	12	Unknown	Unknown	Unknown
The Netherlands – Amsterdam and Nijmegen[1,3]	Pilot	gFOBt	12	67.0	44.7	10.7
The Netherlands – Amsterdam and Nijmegen[1,3]	Pilot	iFOBt	12	69.3	43.2	8.6
The Netherlands – Greater area of Rotterdam[1,4]	Pilot[5]	gFOBt	19	65.6	59.0	9.8
The Netherlands – Greater area of Rotterdam[1,4]	Pilot[5]	iFOBt	19	67.5	62.3	7.0
Romania	Full	gFOBt	12	14.2	11.7	7.5
Spain	Full	gFOBt	24	52.0	46.8	15.6
UK – England[1]	Full	gFOBt	24	42.9	Unknown	12.0
The Americas						
Chile[1]	Pilot	iFOBt	6[6]	48.0	28.0	5.1
USA -Maryland	Full	gFOBt	101	42.7	15.7	2.8
USA – New York[7]	Full	gFOBt[8]	12	25.6	16.9	4.4
USA – New York[7]	Full	iFOBt	12	48.7	38.5	0.0
USA – Northern California[1]	Full	iFOBt	12	Unknown	Unknown	5.6
Western Pacific						
Australia	Full	iFOBt	18	32.4	9.5	0.2
Taiwan	Full	iFOBt	36	34.3	19.5	3.9
Pooled data for gFOBt	–	gFOBt	–	42.2	32.7	9.0
Pooled data for iFOBt	–	iFOBt	–	46.5	33.6	4.4

[1]Programs that only reported first screens as they had not yet begun subsequent screens. [2]Less than 12 months of data from 12 of the area-specific or regional programs activated during 2006. [3]Part of the same program. [4]Part of the same program. [5]Also a randomized clinical trial. [6]Only invites during one month, but take 6 months to screen those invited. [7]Part of the same program. [8]Rehydrates some of their tests, it is area-specific. Abbreviations: gFOBt, guaiac fecal occult blood test; iFOBt, immunochemical fecal occult blood test.

detection rates (and the related PPVs) were higher for endoscopy-based than FOBt-based programs; and FOBt positivity rates and cancer detection rates tended to be lower for subsequent than for first screens within the same program. While mean values for the indicators were essentially similar when considered by region and between full programs and pilot programs, for many indicators the range of values between individual programs was very wide. Further information on tests will be needed to make reliable comparisons between programs. As this was a first attempt to collect these data on such a large scale, many of the values for the screening measures were either estimated or incomplete.

Some of the variation in FOBt positivity between programs is explicable in terms of known factors relating to the FOBt used or to the tested population. For example, those

Table 10. Positive predictive values for detection of colorectal neoplasia: programs using fecal occult blood tests as their primary screening modality that provided data for subsequent screens, presented alphabetically by country within regions defined by the World Health Organization

Country	Program type	Primary screening modality	Reported period (months)	Positive predictive value for polyp detection (%)	Positive predictive value for adenoma detection (%)	Positive predictive value for cancer detection (%)
				Polyp detected/ diagnostic endoscopy	Adenoma detected/ diagnostic endoscopy	Cancer detected/ diagnostic endoscopy
Europe						
Finland	Full	gFOBt	12	45.7	31.4	4.3
Israel	Full	gFOBt	12	25.0	Unknown	5.2
Italy	Full	iFOBt	12[1]	Unknown	38.9	4.0
Romania	Full	gFOBt	12	12.0	8.0	4.0
Spain	Full	gFOBt	24	37.9	35.0	14.6
The Americas						
USA – Maryland	Full	gFOBt	101	42.3	26.0	0.0
USA – New York[2]	Full	gFOBt[3]	12	36.5	24.3	1.4
USA – New York[2]	Full	iFOBt	12	44.4	33.3	0.0
Western Pacific						
Australia	Full	iFOBt	18	33.1	16.4	0.3
Taiwan	Full	iFOBt	36	35.0	18.7	3.1
Pooled data for gFOBt	–	gFOBt	–	33.2	24.9	4.2
Pooled data for iFOBt	–	iFOBt	–	37.5	26.8	1.9

[1]Less than 12 months of data from 12 of the area-specific or regional programs activated during 2006. [2]Part of the same program. [3]Rehydrate some tests (area-specific).
Abbreviations: gFOBt, guaiac fecal occult blood test; iFOBt, immunochemical fecal occult blood test.

programs using iFOBts tend to report higher values for test positivity than those using gFOBts. In addition, the higher than average positivity rates seen for the gFOBt programs in Croatia (9.2%) and the USA (New York) (7.0%) may reflect the use of more sensitive gFOBts. The low positivity rates for gFOBts in Spain (1.1%) and England (1.7%) may be due to more stringent criteria for defining test positivity. Information on iFOBt cut-off levels for test positivity was not routinely collected during the survey, but it may help explain the differences between positivity rates among programs using this modality. The wide variation in follow-up rates for diagnostic endoscopy after positive FOBt (35–96% for programs using gFOBt, and 47–95% for programs using iFOBt) may reflect differences in organization of the screening programs and availability of endoscopy services. It should also be noted that the values given are for follow-up within the period reported only; the time lag between FOBt and follow-up colonoscopy means that for some subjects, a positive FOBt but not the subsequent colonoscopy is included in this cross-sectional data.

Using common data indicators in screening programs provides potential for comparing performance across programs with similar designs. The availability of directly comparable performance and outcome data also holds the potential for on-going comparative effectiveness research based on differences in technology, screening intervals, criteria for a positive test result and so forth. Insofar as additional prospective randomized trials of CRC screening are unlikely, policy makers may need to rely on observational studies and the evaluation of service screening for data to inform program design. As in all aspects of clinical practice, screening programs have a responsibility to ensure that the service is of benefit to the targeted population: on-going audit and evaluation is an integral part of their remit. The results of this survey suggest that many programs do not yet have adequate processes in place to collect fundamental measures, such as population coverage and CRC mortality.

We intend to refine some of the screening measure definitions, based on our survey experience and if possible to add other measures such as cancer stage, in the future. It is hoped that existing programs that were unable to complete the survey will use the revised measures and that programs in the planning stages will be able to benefit from the availability of these precise definitions. We would also like to extend an invitation to any interested screening program not already part of the network to contact the ICRCSN.

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APPENDIX – INTERNATIONAL COLORECTAL CANCER SCREENING NETWORK

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