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Areas of improvement for colorectal cancer screening: Results of a screening initiative for 10,000 health care employees in Austria

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ABSTRACT

Background and study aims Participation in and quality of colorectal cancer (CRC) screening varies greatly and it is unclear how much of CRC screening guideline quality metrics reach patients. The aims of this prospective observational study were to provide data from everyday practice in Austria.

Patients and methods All employees aged ≥50 years were invited and received a stool-based-test (FIT (cut-off 25 mcg Hb/g) and M2PK), which could be dropped off at the workplace. All individuals with positive tests were called and offered a colonoscopy near their workplace/home in ≤ 3 weeks performed by unselected endoscopists. Non-attendees received email and telephone reminders.

Results Of 10,239 eligible employees (2706 males, 7533 females), 2390 (23%) (plus 673 <50 years) median age 53 (interquartile range 50;56) participated in the stool-based screening (18% males, 25% females). Of 3063 tests, 747 (24%) were positive. The follow-up rate for 616 individuals who accepted or eventually underwent colonoscopy was 84% (n =517). The adenoma detection rate (ADR) was 20.5% (31% in men, 17% in women) and varied substantially, ranging from 15% in hospitals (excluding the study center) to 18.5% among office-based endoscopists, and up to 36% in the study center. Most European Society of Gastrointestinal Endoscopy-recommended performance indicators were unmet, including the polyp detection rate (PDR), ADR, reporting of polyp characteristics, and bowel preparation adequacy.

Conclusions There is a serious gap between recommended standards and real-world CRC screening colonoscopy quality. Implementation of CRC screening should not only be accompanied by strategies to increase participation rates but focus on implementation of rigorous, mandatory colonoscopy quality assurance programs.

Introduction

Colorectal cancer (CRC) is the third most common cancer worldwide with survival rates that are heavily dependent on the pathologic stage at presentation [1, 2]. Consequently, many countries have established organized CRC screening programs [3] based on evidence from epidemiological and sigmoidoscopy trials that has demonstrated significant reductions in CRC incidence and mortality with screening efforts [1]. The only high-quality randomized controlled trial on screening colonoscopy published so far [4] has incited much discussion because it failed to show a significant reduction in overall and CRC-related mortality and effects were significant only in the adjusted per-protocol analysis. The NordICC trial has shed light on significant issues concerning screening endoscopy. Essential prerequisites for effective screening are the participation rate, with the recommended target uptake being above 65% [5], and colonoscopy service quality. Unfortunately, uptake and acceptance in the general population varies greatly, ranging from 1% to 73% [3] and depends on factors such as high invitation coverage, easy expedited access to recommended tests, timely follow-up examinations, direct mail outreach with reminders, recent health care contact, as well as stool-based screening [6, 7, 8]. To improve quality, the European Society of Gastroenterology (ESGE) has proposed several key performance indicators (KPIs), such as the adenoma detection rate (ADR), to measure and determine high-quality screening colonoscopy [9]. These recommendations have only been implemented systemically by some, for example, in the context of the Dutch national CRC screening program [10].

In Austria, no organized national CRC screening program exists, and the exact uptake of opportunistic screening is mostly unknown, but not higher than 18% [11]. Furthermore, no mandatory quality assurance for any gastrointestinal endoscopy service exists in Austria. Thus, the performance quality of screening colonoscopy outside of high-performance, self-evaluating centers and endoscopists is unknown. The intent of this study was to assess two critical aspects of CRC screening in the context of a pragmatic, direct, corporate-based screening initiative by measuring participation rates of a well-defined target population with facilitated follow-up test access and assessing performance and quality of unselected screening colonoscopy in the state of Lower Austria. We aimed to provide prospective, real-world data to allow for more realistic calculations of effects of CRC screening based on screening uptake and unselected endoscopist service quality and to guide future efforts of screening implementation.

Methods

This observational study was conducted alongside a corporate preventive health initiative from September 2021 through summer of 2023 organized by the study team and supported and funded by the Landesgesundheitsagentur (LGA) for its employees. The LGA is a state-wide, public health care provider in the state of Lower Austria with ~28,000 employees. All employees aged ≥ 50 years were eligible and personally invited (target population) to participate in the screening. The current retirement age in Austria (maximum age of eligible persons) is 65 for men and 60 for women. Employees younger than age 50 years were not invited; however, they were not prohibited from participating. The study was approved by the Ethics Committee of the state of Lower Austria (GS4-EK-4/735–2021).

Setting and population

The LGA operates hospitals and nursing care facilities across the state. All employees aged ≥ 50 years received an email invitation and personal letter to participate in a CRC screening program. All facilities across the state were divided into (administrative) regions and included consecutively over the period of approximately 18 months. Regions were “active” for a defined period (time for stool test drop-off). To promote the preventive health initiative and provide further information, members of the study team traveled to larger facilities within the regions and handed out promotional materials and could be approached in case of questions.

Screening protocol and logistics

The CRC screening protocol consisted of a stepwise approach with a stool test and a follow-up colonoscopy in case of a positive result. Eligible employees collected a stool-based CRC screening test (comprising a fecal immunochemical test [FIT], ScheBo Hb Smart ELISA, cut-off 25 mcg Hb/g stool; and a M2-PK test ScheBo Tumor M2-PK ELISA, cut-off 4 U/mL [12, 13]) at their workplace. To maximize simplicity and convenience for participants, drop-off boxes were set up at each facility where stool tests could be dropped off during weekdays during the active phase, together with the informed consent form and contact information. Tests were collected several times a week and transported to a central laboratory (at the study center), where they were stored and analyzed according to manufacturer instructions.

In case of a positive result, the participant was called personally to be offered a colonoscopy near their workplace/home at an office-based endoscopist. Alternatively (especially if no endoscopists operated in the vicinity), the participant could opt to undergo colonoscopy at a nearby hospital (e. g., their workplace). Participants were offered a timely slot within 2 to 4 weeks of the phone call (i. e., prioritized, as was part of the incentive to participate). If participants were initially undecided or had accepted the colonoscopy offer, but no colonoscopy had been performed according to a centralized list, participants received a reminder email as well as a personal phone call with another offer.

After the colonoscopy was performed, the study team collected the colonoscopy and histology reports.

Outcomes and statistical analysis

Descriptive statistics were calculated to summarize the target and screening population, as well as results from the colonoscopy reports.

The participation rate was calculated as: [persons aged ≥ 50 with a stool test/eligible population]. The colonoscopy acceptance rate was calculated as: [stool test-positive persons with

colonoscopy report available/persons with a positive stool test]. To account for possible non-participants or persons lost to follow-up having undergone colonoscopy outside of the health initiative, the maximum possible acceptance rate was calculated also: i.e [everyone with a colonoscopy + everyone lost to follow-up + everyone reportedly having undergone colonoscopy recently before the study + everyone who refused to participate in the study] divided by [the number of persons with a positive stool test].

Analysis of quality metrics was based on published ESGE guidelines on performance measures for lower gastrointestinal endoscopy [9]. Main outcome measures were the polyp detection rate (PDR), adenoma detection rate (ADR), cecum intubation rate, rate of adequate bowel preparation (defined as Boston Bowel Preparation Scale (BBPS) > 5 or equivalent according to the description in the report), and reporting of polyp size and classification. Successful cecum intubation was derived from the report, because photo-confirmation was impossible in many instances due to low quality of photographs taken or none being included in the report. Because of repeated cases where bowel preparation was reported to be adequate and the cecum reportedly intubated, but inadequate visualization of the mucosa was mentioned due to "extensive looping of the colon," "extensive curving of the colon," or "extensive folds reducing vision" a combined endpoint of "cecum intubated and adequate visualization of the mucosa" was also calculated. Furthermore, the advanced adenoma detection rate (AADR) was calculated according to the 2012 US Multi-Society Task Force on Colorectal Cancer definition [14], i. e., villous histology, high-grade dysplasia, size ≥ 10 mm, or ≥ 3 adenomas, but also including tubulovillous histology, because it often is included in current publication.

Categorical variables are reported as absolute and relative frequencies and continuous variables as arithmetic mean and standard deviation (SD) or median and 25% to 75% interquartile range (IQR) as appropriate. Continuous variables were compared using the *t*-test or Mann-Whitney test, for categorical data, Fisher's exact test was used, where odds ratios (OR) were derived from. Statistical significance was defined by $P < 0.05$. All analyses were conducted as two-sided tests. Data were analyzed and graphics were produced in Graphpad Prism 10 for Windows (GraphPad Software, Boston, Massachusetts, United States).

Results

Population and stool testing

The health initiative was active from September 2021 through spring of 2023, with colonoscopy reports being collected until August 2023. Of 10,239 eligible employees (7533 females [73.6%], 2706 males [26.4%]) older than age 50 years, 2390 (23.3%) participated in the stool-based screening (▶ **Table 1**). The participation rate was 25% (n = 1890) for women and 18% (n = 500) for men. The median age was 54 years (IQR 52–57), 51 (IQR 51–58) for men and 53 (IQR 50–56) for women. Furthermore, 673 people younger than age 50 years opted to participate. Of those, 584 (84%) were women and 109 (16%) men. In total, 3063 individuals participated in stool testing, the median age was 53 years (IQR 50;56), 2454 (80%) were women, and 609 (19.9%) were men. Women were statistically significantly more likely to participate than men (OR 1.48, 95% confidence interval [CI] 1.32–1.65, $P < 0.0001$), and were younger than men ($P < 0.0001$).

Of the 3063 stool tests performed, 747 (24.4%) were positive. The positivity rate was 23.3% among women and 28.7% among men. Tests of women were less likely to be positive (RR 0.79, 95% CI 0.69–0.94 $P < 0.01$) and men older than age 50 years had the highest rate of positive tests (30%). Most tests were M2PK positive (23.3% of persons who underwent testing and 95.4% of positive tests), and M2PK-only positive (18.5% of persons who underwent testing, and 76% of positive tests), a minority were FIT-positive (5.8% of persons who underwent testing, and 24% of positive tests). The rate of FIT positivity was numerically higher among participants older than age 50 years vs younger than age 50 years (6.2% vs. 4.8%, $P = 0.20$).

Seven hundred forty-seven people with positive tests were offered a colonoscopy, of which 593 individuals (79.4%) initially accepted the offer (▶ **Table 1**). The acceptance rate was higher in women (80%) than men (77%). Eventually, 616 (82.5%) accepted and/or had a colonoscopy performed and 131 (17.5%) refused or are still undecided (calculated maximum possible acceptance rate 89%). The follow-up rate for individuals who accepted and/or had a colonoscopy performed was 84.1% (n = 518; 1 person had a virtual colonoscopy), i. e., they underwent colonoscopy and a colonoscopy report (including histology, if applicable) was available for analysis. The median age was 53 years (IQR 50;56), 398 (77%) were female and 119 (23%) were male, and 480 (92.8%) were older than age 45.

Colonoscopies

In total, 58 office-based and 24 hospital-based endoscopy units performed the 517 colonoscopies. Most were performed by office-based physicians (n = 340, 65.8%) and the rest were performed at hospitals (34.2%). More colonoscopies were performed by internists and/or gastroenterologists (58.8%) than by surgeons (41.2%).

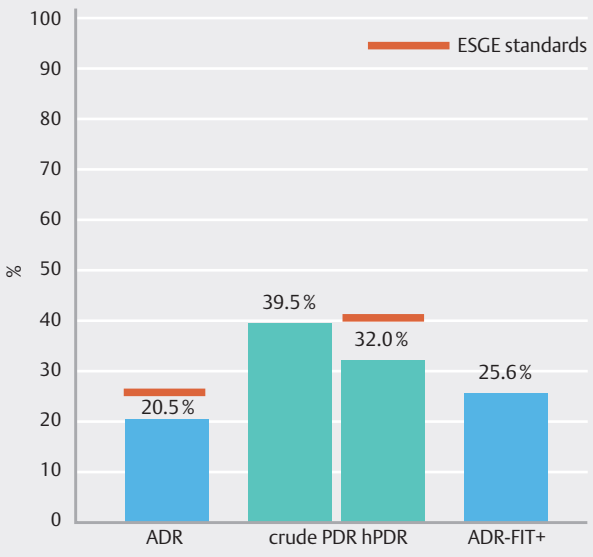
Among 517 colonoscopies, an adenoma was detected in 106 (20.5%, ADR) (▶ **Fig. 1** and ▶ **Table 2**). A polyp was reportedly found in 204 (39.5%) colonoscopies; however, the (histological) PDR was 32.5%. The AADR was 3.9%, consisting mostly of ≥ 3 adenomas (11/20 cases). No sessile serrated lesions with dysplasia, no polyps with villous histology, and no high-grade dysplasias were detected. No CRCs were detected. The majority of detected polyps were diminutive, i. e. 52% were < 5 mm in size, 16.7% were 5 to 10 mm, and 5.4% were > 10 mm. In 27.5% of cases, no size at all was mentioned in the report.

The ADR was higher among men (31.1%) than women (17.3%) (OR 2.15, 95%CI 1.34–3.44, $P < 0.01$), and numerically higher in people older than age 50 years (21.2%) than younger than age 50 years (17.8%) ($P = 0.16$). The highest ADR of all subgroups was among men older than age 50 years with a positive FIT (32.3%), while among women older than age 50 years with a positive FIT, the ADR was 16.2%.

▶ **Table 1** Epidemiological information.

Eligible population		
Total	n = 10,239	
▪ Women, n (%)		7,533 (73.6%)
▪ Men, n (%)		2,706 (26.4%)
Participants		
Total	n = 3,063	
▪ Women, n (% of participants)		2,454 (80.1%)
▪ Men, n (% of participants)		609 (19.9%)
▪ Age (years), median (IQR)		53 (50–56)
Participants aged > 50, total	n = 2,390	
Participation rate (of invited)		23.3%
▪ Women, n (% of invited*)		1,890 (25.1%)
▪ Men, n (% of invited*)		500 (18.5%)
▪ Age (years), median (IQR)		54 (52–57)
Participants aged < 50, total (not invited)	n = 673	
▪ Women, n (% of aged < 50)		564 (83.8%)
▪ Men, n (% of aged < 50)		109 (16.2%)
▪ Age (years), median (IQR)		47 (42–49)
Stool tests positive	n = 747	
		% of persons who underwent testing
M2PK positive % (n)		23.3% (713/3063)
M2PK only positive % (n)		18.5% (568/3063)
FIT-positive % (n)		5.8% (179/3063)
Subgroups of stool test-positive individuals		
▪ Test-positive women, n (%‡)		572/2,454 (23.3%)
▪ Test-positive men, n (%‡)		175/609 (28.7%)
▪ Test-positive aged > 50, n (%‡)		590 (24.7%)
▪ Test-positive aged< 50, n (%‡)		159 (23.6%)
Colonoscopy initially accepted	616	
Colonoscopy accepted & performed†	n = 518 (84.1%)	
▪ Women, n (%§)		398 (77.0%; 80.2%)
▪ Men, n (%§)		119 (23.0%; 76.6%)
▪ Aged > 50, n (%§)		410 (79.3%; 78.6%)
▪ Aged < 50, n (%§)		107 (20.7%; 81.1%)
▪ Age (years), median (IQR)		53 (50–56)

*Equals participation rates for men and women.
†Report available for analysis = follow-up rate of people who accepted.
‡Percentage of the respective group.
§Percentage of colonoscopy group and percentage of respective subgroup with positive stool test.



▶ **Fig. 1** Major quality metrics. ESGE standards are target performance measures as defined by the European Society of Gastrointestinal Endoscopy. ADR, adenoma detection rate; crude PDR, polyp detection rate as reported in the colonoscopy reports; hPDR, histologically confirmed polyp detection rate; ADR-FIT+, adenoma detection rate in the fecal immunochemical test-positive group.

Quality criteria

Concerning published quality indicators, the following results were obtained (▶ **Table 2**). The cecum intubation rate was 96.7% (independent verification including visual confirmation could not be obtained). Bowel preparation was estimated to be adequate (corresponding to a BBPS > 5) in 87.8% of cases. However, the complete colonoscopy rate – i. e., a combined endpoint of cecum intubated and adequate visualization of the mucosa – was 84.7% (▶ **Fig. 2**). A BBPS score was reported in 48.7% and the withdrawal time was reported in only 10.1% of endoscopies.

Although required/recommended by guidelines, a PARIS classification was reported in only 25.5%. A PARIS and NICE/JNET classification was reported in only 21.1% (12.2%, when excluding the study center) (▶ **Fig. 2** and ▶ **Table 2**). When considering only polyps > 5 mm, a PARIS and NICE/JNET classification was mentioned in 46.5% (17.2%, when excluding the study center). Polyp size was also only mentioned in 48.0% (72.5% if "diminutive polyp" was counted as size reported). Concerning polypectomy method, when looking at polyps < 10 mm, most were removed via forceps (54.0%), while 5.8% were removed via hot snare (endoscopic mucosal resection [EMR]). Only 54.5% (6/11) of polyps > 10 mm were removed during the index colonoscopy. Most polyps (4/11) were removed using hot snare (EMR), one with cold snare, one without reporting the method and five were not removed (▶ **Table 2**).

The overall ADR was 20.5%. However, it varied substantially by endoscopist. The ADR tended to be higher among endoscopies performed at a hospital than by office-based physicians (24.3% vs. 18.3%, $P = 0.13$). Also, internists and/or gastroenterologists had significantly higher ADRs than surgeons (23.0% vs. 16.9%, $P = 0.012$). The highest ADR was achieved at the study center (35.6%), the lowest ADR was among hospitals excluding the study center (15.3%) or surgeons (16.9%), respectively. If the study center was excluded, the average study-wide ADR was 19.1%.

Discussion

This observational study on stool test-based CRC screening of a large, defined, target population and unselected endoscopists performing follow-up colonoscopies reveals moderate-to-poor quality of endoscopies in a region without mandatory quality assurance and low participation rates despite considerable efforts directed at increasing screening participation.

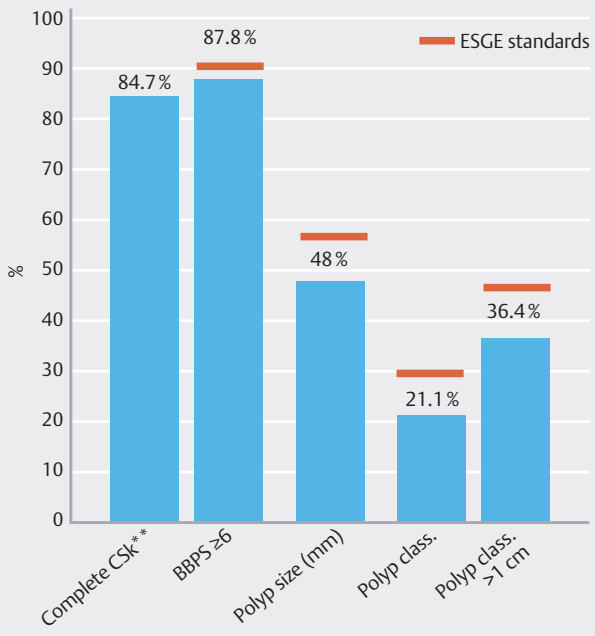
An important factor for effective CRC screening (FIT-based or not) is high-quality colonoscopy. Robust quality metrics, such as the ADR, have been shown to be inversely linked to interval cancers [15]. Hence, the ESGE recommends several key performance indicators to be met for screening colonoscopy [9]. In our study, the average ADR was 20.5% and the histologically confirmed PDR was 33%, below the recommended 25% and 40% respective (overall screening) margins. Colonoscopy was performed in a pre-screened (stool test) population, with studies reporting average ADRs in a FIT-positive population ranging from 47% to 73% [16, 17, 18, 19]. The ADRs of endoscopist subgroups in our study ranged from 15% to 36%, with the latter in the study center, where colonoscopies were performed also by trainees (mostly artificial intelligence-assisted) versus only board-certified endoscopists elsewhere. Collectively, this points to a systematic quality issue of provided colonoscopies. However, it is crucial to exercise caution when directly comparing our data and other FIT-positive screening populations. First, most referrals came from M2PK-positive tests, which are associated with lower ADRs compared with FIT [12, 13] – accordingly the FIT-positive ADR was 26% (vs. 19% M2PK-only positive). Second, the expected ADR in prescreened populations is dependent on the FIT positivity cutoff; therefore, ADRs cannot be compared indiscriminately between studies [17, 20], and FIT cutoffs might need to be different in males and females (and possibly according to age) [21]. Third, and most importantly, our population was young (median age 53 years) and female predominant (77%). Both factors are associated with lower expected overall ADRs [19, 22]. Data on unselected (hence not stool pretested) populations around 50 years of age show an ADR around 16%, closer to our 20.5% [22]. Data on sex-specific ADRs report the adenoma prevalence as almost two times more likely in males [22]. Nonetheless, critical issues remain. Looking at detailed data, the advanced adenoma rates of unselected younger populations are still reported to be around 4% to 5% using very stringent definitions [22], compared with 3.9% in our prescreened population with looser definitions (or 1.2% applying the same definition). Furthermore, most other (age-/prescreening-independent) KPIs and reporting standards were also not met, such as adequate bowel preparation, complete colonoscopy rates, or appropriate polyp characterization. Important factors such as withdrawal times

▶ **Table 2** Quality indicators.

Colonoscopies	**n = 517**		
Cecum intubated*, n (%)	500 (96.7%)		
Adequate bowel preparation†, n (%)	454 (87.8%)		
Complete colonoscopy‡, n (%)	438 (84.7%)		
BBPS reported, n (%)	252 (48.7%)		
Withdrawal time reported, n (%)	52 (10.1%)		
Sedation provided, n (%)	492 (95.2%)		
▪ Sedation medication reported, n (%)		454 (87.8%)	
▪ Propofol only, n (%)		191 (36.9%)	
▪ Propofol and midazolam, n (%)		165 (31.9%)	
ADR % (n)	20.5% (106)		
▪ ADR age > 50 % (n)		21.2% (87)	
▪ ADR age < 50 % (n)		17.8% (19)	
▪ FIT-positive % (n)		25.6% (32)	
▪ M2PK-only age > 50 % (n)		18.9% (74)	
PDR % (n), histologically confirmed	32.3% (167)		
Colonoscopies with polyps reported	204		
Polyp size reported, n (%)	98 (48.0%)		
Polyp size reported ("diminutive" counted as size reported), n (%)	148 (72.5%)		
PARIS and NICE/JNET classification reported	43 (21.1%)		
▪ PARIS and JNET or NICE for polyps > 10 mm§		4/11 (36.4%)	
Polypectomy method	Forceps	Cold snare	Hot snare (EMR)
Polyps < 5 mm (including "diminutive")	74 (70.5%)	22 (21.0%)	2 (1.9%)
Polyps 1–10 mm (including "diminutive")	93 (57.8%)	30 (24.8%)	6 (3.7%)
Polyps > 10 mm	0	1/11	4/11

ADR, adenoma detection rate; BBPS, Boston Bowel Preparation Scale; EMR, endoscopic mucosal resection; FIT, fecal immunochemical test; JNET, Japan NBI Expert Team; NICE, NBI International Colorectal Endoscopic; PDR, polyp detection rate.
*Reportedly, visual photo documentation verification could not be performed
†As reported
‡Composite of cecum intubated and adequate mucosa visualization reported (see "outcomes and statistical analysis" in full text).
§JNET was never reported.

were mostly not reported and could not be calculated based on reports. This underscores the importance of report quality as an important factor, especially in quality control. The efficacy of endoscopy screening has been demonstrated in clinical trials, per-protocol analyses of trials, and simulation studies [1, 4, 23]. Screening reduces incidence of and morbidity and mortality from CRC [1, 24]. Cancers are detected at an earlier stage [24] and surgical data in high-uptake countries [25] show that patients with screening-detected cancers have reduced 30-day postoperative mortality. However, looking at surgical referral pathways, only 10.6% of CRC surgeries result from screening [2]. Trying to reconcile these data, there seems to be a disconnect between intended outcomes of colonoscopy screening and real-world results for the general population. Analyses exploring causes of post-colonoscopy CRC point toward quality issues at the heart of the problem [26, 27]. While screening may be effective, the effect size of morbidity and mortality reduction can be expected to be considerably smaller if the average, real-world performance of colonoscopies falls significantly short of the published KPIs [1, 4, 10, 28]. Some countries have reacted and established mandatory quality assurance [10, 29]. Our data support the indispensability of such measures to deliver minimum quality endoscopy, which usually is the basis for calculations of cost-effectiveness calculations of large-scale CRC screening. We believe that rigorous regular benchmarking/quality control followed by training and education offers are the only effective measures for improving and maintaining quality standards. Crucially, this should be accom-



▶ **Fig. 2** Key performance indicators. ESGE standards are target performance measures as defined by the European Society of Gastrointestinal Endoscopy. Complete colonoscopy, composite of cecum intubated and adequate mucosa visualization reported (see full text); BBPS, Boston Bowel Preparation Scale; Polyp class., PARIS and NICE (or JNET) reported; Polyp class. > 1 cm, PARIS and NICE (or JNET) reported in polyps > 1 cm.

panied by a mandatory centralized CRC database, which is to be implemented with the currently planned Austrian colorectal cancer screening program.

Structured or unstructured CRC screening programs have been established in most European countries. Unfortunately, uptake is highly variable, ranging from 1% to 73%, even in organized programs [3, 20]. To increase effectiveness, the European guidelines [5] recommend a well-defined target population, an exhaustive population registry, and invitation coverage of at least 95%. Further factors associated with increased participation are FIT-based screening, easy access to recommended tests, timely follow-up examinations, and direct mail outreach with reminders [6, 7, 8]. All these were present in this screening initiative. Even more so, a public relations effort accompanied the screening, and one could argue for a more aware (healthcare-associated) population [30] and personal setting within a corporate framework. Nonetheless, uptake was only 23%, far below the 65% needed for effective screening [5]. Apart from stool test screening participation, follow-up colonoscopy after a positive test is a critical issue due to the high-risk setting of this population (and uselessness of a stool test alone). The colonoscopy follow-up rate was approximately 73% despite reminder phone calls and emails, well below the 90% recommended by the European guidelines [5]. A recent study investigated a patient navigation program to increase follow-up colonoscopy adherence and with considerable effort, 79.7% of patients were reached after up to 18 phone call attempts [31]. Unfortunately, only 59.2% of patients reached underwent follow-up colonoscopy within 12 months. Regrettably, CRC screening efforts generally are plagued by low participation rates [3, 4, 7, 32], one of the focal points of the heated debate around the NordICC trial. Data on the CRC screening uptake of health care providers, although very scarce, show uptakes of up to 70% for physicians [33]. Studies comparing CRC screening interventions for different occupational backgrounds do not exist. However, few studies investigated occupational screening in general, reporting participation rates of 4% to 33% [34, 35]. For example, in a US study distributing stool tests to employees through educational seminars, the authors estimated that a stool kit reached 8.7% of eligible employees and 4.4% were successfully screened [34]. On the other hand, a workplace screening initiative for firefighters achieved a 33% stool test return rate, but only 55% of respondents were aged 50 years or older [35]. Data on occupational background and screening participation indicate that compared with healthcare professionals, other professions are 9% to 30% less likely to be up to date with cervical, breast, and CRC screening, but these data do not stem from corporate interventional studies [30].

This study has several limitations. First, reasons for not participating in the stool screening and not undergoing colonoscopy after a positive test are mostly unknown, because they could not be recorded. It is possible that some participants had recently undergone colonoscopy. Due to data protection and privacy legislation, it was not possible to link the target population with insurance billing data. Second, the number of colonoscopies per individual endoscopist was low, making a more granular analysis impossible. Nevertheless, the main aim of the study was to assess the overall effectiveness of unselected endoscopies, and selection of specific endoscopists to increase case numbers could have introduced significant bias and reduced generalizability. Lastly, despite a target population of ~10,000, the final number of colonoscopies was low. On the other hand, low participation rates in CRC screening are quite common and this finding is in line with reports from many organized screening programs in various countries [3, 7, 32].

Conclusions

In conclusion, although data have shown that CRC screening with FIT or colonoscopy has the potential to substantially reduce morbidity and mortality, results of this study expose the heart of the matter – low participation rates despite great efforts to facilitate initial and follow-up test access and moderate-to-poor performance of unselected endoscopists. The low overall service quality of unselected endoscopists providing everyday public health care screening is a critical issue. Implementation of CRC screening should not only be accompanied by strategies to increase participation rates but focus on implementation of rigorous colonoscopy quality assurance programs and regular benchmarking with feedback. Otherwise, health care systems risk significant reductions in effectiveness in comparison to risk-benefit calculations assuming high-quality endoscopy services.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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