The Prevalence of Adenomas, AAs, and CRCs in Colonoscopy Screening Among Average-Risk Individuals in China

Yan Gong

Chinese PLA General Hospital

Yansong Zheng

Chinese PLA General Hospital

Rilige Wu

Chinese PLA General Hospital

Miao Liu

Chinese PLA General Hospital

Hong Li

Chinese PLA General Hospital

Qiang Zeng (✉ zq301@126.com)

Chinese PLA General Hospital

Research Article

Keywords: average-risk population, adenomas, advanced adenomas, colorectal cancer screening

Posted Date: August 24th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-777891/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Screening colonoscopy has historically been recommended starting at the age of 50. However, the recommended age for beginning screening has recently been reduced to 45 independent of sex. However, studies on screening colonoscopies of average-risk individuals in China are sparse. This study aimed to determine and compare the prevalence of adenomas, advanced adenomas (AAs), and colorectal cancers (CRCs) and the number of individuals needing screening in an average-risk Chinese population of different ages and sexes.

Methods: A total of 53,152 individuals undergoing colonoscopy were included from January 2013 to December 2019. We analysed and compared the prevalence of adenomas, AAs, and CRCs and the number of individuals needing screening in different age groups of men and women.

Results: The average age of males was 48.80 years (SD, 8.47 years), that of females was 50.00 years (SD, 9.00 years), and the sex ratio was 66.28% (n=35,226) vs. 33.72% (n=17,926). The prevalence of adenomas, AAs, serrated adenomas and CRCs was 14.51% ([95% CI 14.21–14.81], n=7713), 3.04% ([95% CI 2.90–3.19], n=1617), 1.23% ([95% CI 1.01–1.32], n=653) and 0.59% ([95% CI 0.52–0.65], n=313), respectively. Male sex was significantly associated with a high prevalence of adenomas (17.14% [95% CI 16.74–17.53] vs 9.36% [95% CI 8.94–9.79], $P<0.001$), AAs (3.67% [95% CI 3.47–3.87] vs 1.81% [95% CI 1.61–2.00], $P<0.001$) and serrated adenomas (1.56% [95% CI 1.43–1.69] vs. 0.59% [95% CI 0.47–0.70], $P<0.001$). The prevalence of AAs in 45- to 49-year-old individuals was 3.17% (95% CI 2.80–3.55) in men and 1.49% (95% CI 1.12–1.86) in women. The number of men needing screening (NNS) was 31.55 (95% CI 28.17–35.71), while the number of women was 67.11 (95% CI 53.76–89.29). The prevalence and number of patients needing screening for AAs in men aged 45–49 years were close to those in women aged 65–69 years (31.55 [95% CI, 28.17–35.71] vs. 29.07 [95% CI, 21.05–46.73]).

Conclusions: The prevalence of adenomas, AAs, and serrated adenomas increased with age. Males had a higher prevalence rate than females. The prevalence and NNS of AAs in 45- to 49-year-old men were close to those in 65- to 69-year-old women.

Introduction

Colorectal cancer (CRC) is the third most common cancer worldwide, with an estimated 1.8 million new cases in 2018 [1–3]. The incidence rate varies widely in different regions of the world. In recent years, due to the improvement of living standards, lifestyle changes and the growing elderly population, the incidence of CRC in China has been increasing. In 2018, there were 521,490 new cases and 247,563 deaths in China, accounting for 28.2 and 28.1% of the total number of global cases, respectively [4].

Most CRCs arise from noncancerous, adenomatous polyps. CRC screening programs aim to intervene in the cancer progression process by the detection and subsequent removal of polyps before they progress to cancer and by early detection of CRCs in asymptomatic individuals [5]. Screening for colorectal cancer is cost-effective [6]. Several screening methods are available, including FOBT, FIT tests, CT,

sigmoidoscopy and colonoscopy, in which colonoscopy is a necessary follow-up for a positive screening test. Therefore, colonoscopy has become the preferred screening method for the detection and prevention of CRC in patients at average risk recommended by many medical associations [7, 8]. Optimizing the quality of CRC screening is necessary to improve the level of CRC screening. The adenoma detection rate (ADR) is one of the best indicators to measure the quality of colonoscopy [9]. Additionally, the detection rate of serrated adenoma is also closely related to the quality of colonoscopy[10].

Fifty years has long been the starting age for colonoscopy screening based on the increase in CRC prevalence at 60 years, but the prevalence of CRC is now declining among older adults, while the incidence of CRC is increasing rapidly among younger American adults [11]. Recently, the American Cancer Society proposed that the age of initiation for CRC screening in the general average-risk population be reduced from 50 to 45 years independent of sex [12], while a study from Australia reported that the prevalence of AA and CRC in men was higher than that in women (7.96% vs. 4.65% for AA, 1.5% vs. 0.7% for CRC, respectively), which may result from a larger number of adenomas present in men at the age of 40 [13]. Although a study from China showed that the detection rate of adenomas and AAs gradually increased with age and was higher for men than for women in 25,593 individuals with a high risk of CRC [14], colonoscopy screening for CRC in an asymptomatic average-risk population has not been reported in China. Therefore, our study analysed the prevalence of adenomas, AAs and CRCs in different age groups for men and women and the number needed to screen (NNS) to detect them to provide more evidence for CRC screening in the average-risk population in China.

Methods

Study population

Individuals who come to our physical examination centre (Health Examination Center of PLA General Hospital) for physical examination usually choose general physical examination items and colonoscopy together. The age of physical examination is generally between 40 and 75 years old, but some individuals younger than 40 years also undergo physical examination, including colonoscopy, out of concern for their health. In this cross-sectional study, we recruited 53,943 participants who underwent colonoscopy between January 2013 and December 2019. Participants with no symptoms, changes in bowel habits, and abdominal pain were included, and patients with postoperative follow-ups (n=336) and individuals at increased risk for CRC, including individuals with a personal or family history of CRC, inflammatory bowel disease, weight loss, anaemia, or bleeding (n=455), were excluded. Overall, 53,152 eligible participants were enrolled. The study protocol was approved by the Ethic Committee of the PLA General Hospital, Beijing, China (No: S2017-002-03). Written informed consent was obtained from each patient.

Colonoscopy procedure

All colonoscopies were performed by experienced digestive endoscopists (attending physician or above with more than 5 years of endoscopic experience). Each doctor has performed at least 1,000

colonoscopies. The examination was performed with standard sedation of pethidine midazolam or propofol administered by the anaesthesiologist.

Abnormal lesions found on colonoscopy were carefully examined according to standard clinical procedures, and a small amount of tissue biopsy was taken using biopsy forceps for further pathological diagnosis. Any findings from a colonoscopy were photographed. Clinical information, such as morphological features, location (distance and segment from the anus), macroscopic diagnosis and size, were collected and recorded in the data system. Endoscopy reports were generated by the physician using a Pentax licenced data management system. To complete the colonoscopy, endoscopists used descriptions including "ileocecal valve" and "appendiceal foramen" and an accompanying photograph to record the location of caecal intubation. Intestinal preparations were performed mainly by sodium phosphate and polyethylene glycol. The quality of bowel preparation was determined by the doctor. Participants with inadequate bowel preparation or incomplete colonoscopy were required to re-undergo colonoscopy to meet the criteria for clinical diagnosis.

Result determination and quality control

All abnormal findings found during colonoscopy were confirmed by pathological examination, and standardized pathological results were completed in accordance with the latest clinical guidelines. In this study, the size of the adenoma was determined by gross estimation using open biopsy forceps or after resection. Adenomas that are more than 1 cm in diameter, contain villous features or are highly stunted are considered advanced adenomas (AAs). Serrated adenoma can be divided into proliferative polyp (HP), Sessile serrated adenoma/polyp (SSA/P) and traditional serrated adenoma (TSA). SSA/P and TSA are jointly referred to SA. Serrated adenoma (SA) included in this study included SSA/P and TSA. In cases where individuals had multiple adenomas, we reported information on the largest adenomas, and in cases where two or more adenomas were the same size, we reported information on the farthest adenomas. The proximal colon is considered to include all segments of the splenic curvature and above, while the distal colon is considered to include the descending colon, sigmoid colon, and rectum segments below the splenic curvature.

Data collection

All data, including colonoscopy results and histopathological analyses, were recorded and transferred to the study database using an electronically signed form along with the patient's medical records. Each participant has a unique identification code that was used to track and analyse the relevant file tables of all individuals.

Statistical analysis

Patient characteristics are described with median values and standard deviations (SDs) for nonnormally distributed variables and with frequencies and percentages for categorical variables. We compared these characteristics between men and women using the χ^2 test or Fisher's exact test.

For the purpose of interpretation, the age groups were defined as 5-year periods starting at age <40 years, and the detection of adenomas, AAs, or CRCs was computed. Prevalence, NNS, and corresponding 95% CIs for men and women were also computed. We compared the potential differences between men and women with respect to age. All statistical analyses were performed using STATA statistical software. All tests were double-sided, and a *P* value of <0.05 or less was considered statistically significant.

Results

Characteristics of the study population and screening results

As shown in Table 1, a total of 53,152 subjects, 17,926 women (33.73%) and 35,226 men (66.27%), underwent a screening colonoscopy from 30 provinces, autonomous regions, municipalities and special administrative regions of China from January 2013 to December 2019. The average age was 50 years (SD, 9 years) for women and 48.80 years (SD, 8.47 years) for men.

The findings included colon polyps in 30.36% (*n*= 16137), colorectal cancer in 0.59% (*n*= 313), and other benign lesions in 11.28% (*n*=5994). No abnormalities were found in 61.73% of colonoscopies (*n*= 32,811). The prevalence of colonic polyps and multiple colonic polyps was higher in men than in women (21.54% vs. 14.69% and 14.14% vs. 5.21%, respectively). The prevalence of CRC was not significantly different between men and women (0.57% vs. 0.62%, *P* =0.440).

Colonoscopy findings

The histological analysis indicated that 5.42% of patients (*n*=2873) had hyperplastic polyps, 14.51% (*n*=7713) had adenomas, 0.3% (*n* =159) had high-grade intraepithelial neoplasia, 0.59% (*n*=313) had carcinoma, 1.23% (*n* = 653) had serrated adenomas and 9% (*n*=4783) had other benign lesions. Hyperplastic polyps were found in 6.39% (*n*=2250) of male and 3.49% (*n*=623) of female patients (*P*=0.000), adenomas in 17.14% (*n*=6035) of male and 9.36% (*n*=1678) of female patients (*P*=0.001), high-grade intraepithelial neoplasia in 0.34% (*n*=120) of male and 0.22% (*n*=39) of female patients (*P*=0.014), carcinoma in 0.57% (*n*=201) of male vs. 0.62% (*n*=112) of female patients (*P*=0.440), and serrated adenomas in 1.56% (*n*=548) of male and 0.59% (*n*=105) of female patients (*P*=0.000). Of the 14.51% (95% CI, 14.21%-14.81, *n* = 7,713) adenomas found, 3.04% (95% CI, 2.90%-3.19%, *n* = 1617) were classified as AAs.

Overall, the detection rates for CRCs, AAs, adenomas and serrated adenomas were 0.59%, 3.04%, 14.51% and 1.23%, respectively. Furthermore, we calculated that the numbers of colonoscopies to detect one CRC, AA, adenoma and serrated adenoma were 169, 33, 7 and 81, respectively, as shown in Fig 1.

Figure 2 shows that the detection rates for adenomas, AAs, CRCs and serrated adenomas increased with age and were higher for men than for women. For example, the detection rate of AAs in men aged 60–64 years was 6.35% (95% CI 5.35%-7.35%), which was significantly higher than that in women of the same age range (2.64%, 95% CI 1.85%-3.43%).

Regarding the anatomical location of CRCs and AAs, more neoplasms were identified in the distal colon than in the proximal colon. Among them, 78.8% of CRCs, 64.2% of AAs and 66.4% of AAs ≥ 10 mm were located in the distal colon. The anatomical location distribution of advanced colorectal adenoma is shown in Figure 3.

Prevalence and NNS for adenomas

The prevalence of adenomas was 17.14% (95% CI, 16.74%-17.53%) for men and 9.36% (95% CI, 8.94%-9.79%) for women ($p < 0.001$) (Table 2). The prevalence of adenomas among 45- to 49-year-old men was 16.06% (95% CI, 15.28%-16.84%), which was higher than the prevalence among women in the same age group (7.77% [95% CI, 6.95%-8.59%]) but close to the prevalence among 65- to 69-year-old women (17.22% [95% CI, 14.52%-19.91%]). The prevalence of 19.75% (95% CI, 18.91%-20.61%) among 50- to 55-year-old men was greater than that in women of the same age group (9.47%, [95% CI, 8.60%-10.33%]).

The mean NNS to detect adenomas was 6.89 (95% CI, 6.75–7.04) for all individuals, 5.83 (95% CI, 5.70–5.97) for men, and 10.68 for women (95% CI, 10.21–11.19) ($p < 0.001$). In 45- to 49-year-old women, NNS was nearly twice as high as in men at the same age (12.87 [95% CI, 11.64–14.39] vs. 6.23 [95% CI, 5.94–6.54]). Among 45- to 49-year-old men, the NNS was 6.23 [95% CI, 5.94–6.54], similar to that for women aged 65 to 69 years (5.81 [95% CI, 5.02–6.89]).

Prevalence and NNS for AAs

The prevalence of AAs in men was more than twice that in women (3.67% [95% CI, 3.47%-3.87%] vs. 1.81% [95% CI, 1.61%-2.00%], $P < 0.001$). The prevalence of AAs in 45- to 49-year-old men was 3.17% [95% CI, 2.80%-3.55%], which was twice as high as that in women of the same age group (1.49% [95% CI, 1.12%-1.86%, $P < 0.001$]), while a similar prevalence of 3.44% (95% CI, 2.14% to 4.75%) was found for women aged 65 to 69 years. The prevalence of 4.31% [95% CI, 3.88%-4.74%] in men aged 50–54 years was also more than twice that in women of the same age group (1.69% [95% CI, 1.31%-2.07%]).

The NNS to find an AA was 32.89 (95% CI, 31.35–34.48) for all individuals, 55.25 (95% CI, 50.00–61.11) for women, and 27.25 (95% CI, 25.84–28.82) $P < 0.001$ for men (Table 2). In 45- to 49-year-old women, the NNS to find an AA was 67.11 (95% CI, 53.76–89.29) vs. 31.55 ([95% CI, 28.17–35.71]) for men ($P < 0.001$). Men aged 45 to 49 years had a similar NNS as 65- to 69-year-old women (31.55 [95% CI, 28.17–35.71] vs. 29.07 [95% CI, 21.05–46.73]).

Prevalence and NNS for CRCs

Men had a similar prevalence of CRC compared with women (0.57% [95% CI, 0.49%-0.65%] vs. 0.62% [95% CI, 0.51%-0.74%], $P = 0.440$). The prevalence of 1.76% [95% CI, 1.22%-2.31%] among 60- to 64-year-old men was slightly higher than that among women in the same age group (1.07%, [95% CI,

0.56%-1.57%)). The prevalence of CRC in 65- to 69-year-old men was 3.18% [95% CI, 2.06%-4.31%], which was similar to the prevalence among 70- to 74-year-old women (3.70%, [95% CI, 0.79%-6.62%]).

The mean NNSs for CRC were 169.49 (95% CI, 153.85–192.31) colonoscopies for all individuals, 175.44 (95% CI, 153.85–204.08) colonoscopies for men, and 161.29 (95% CI, 135.14–196.08) for women. The NNS for CRC in men aged 60–64 years was lower than that in women of the same age (56.82 [95% CI, 43.29–81.97] vs. 93.46 [95% CI, 63.69–178.57]).

Prevalence and NNS for serrated adenomas

The prevalence of serrated adenomas in men was more than twice as high as that in women (1.56% [95% CI, 1.43%-1.69%] vs. 0.59% [95% CI, 0.47%-0.70], $P=0.000$) (Table 3). Men had a significantly higher risk of detecting serrated adenomas than women. Similarly, the prevalence of serrated adenomas among 45- to 49-year-old men was twice as high as that among women in the same age group (1.39% [95% CI, 1.14%-1.64%] vs. 0.51% [95% CI, 0.29%-0.73%], $P<0.001$). The prevalence of serrated adenomas was three times higher in men aged 50–54 years than in women of the same age group (1.66% [95% CI, 1.39%-1.93%] vs. 0.54% [95% CI, 0.33%-0.77%], $p<0.001$, respectively).

The NNS to detect a serrated adenoma was 81.30 (95% CI, 75.76–99.01) for all individuals, 64.10 (95% CI, 59.17–69.93) for men, and 169.49 (95% CI, 142.86–212.77) for women (Table 2). In 45- to 49-year-old women, the NNS was 196.08 (95% CI, 136.99–344.83) vs. 71.94 (95% CI, 60.98–87.72) for men ($P=0.001$). Men aged 50 to 54 years had a lower NNS than women of the same age group (60.24 (95% CI, 51.81–71.94) vs. 185.19 [95% CI, 129.87–303.03]).

Discussion

We reported the results of 53,152 participants who underwent CRC screening in an average-risk population in China. The results showed that the detection rates of adenomas, AAs, serrated adenomas and CRCs were 14.19%, 3.08%, 1.23% and 0.59%, respectively. The detection rates for adenomas, AAs, and serrated adenomas increased with age and were higher for men than for women. The majority of AAs were found in the distal colon. The prevalence of AAs in men aged 45–49 was twice that of women in the same age group (3.17% [95% CI, 2.80%-3.55%] vs. 1.49% [95% CI, 1.12%-1.86%], $P<0.001$). The NNS of AAs was 31.55 (95% CI, 28.17–35.71) for men aged 45–49 years and 67.11 (95% CI, 53.76–89.29) for women in the same age group. NNS was similar for men aged 45–49 years and women aged 65–69 years (31.55 [95% CI, 28.17–35.71] vs. 29.07 [95% CI, 21.05–46.73]). To our knowledge, this is the first study to present the prevalence and number of people needing to screen for adenomas, AAs, and CRCs in a general risk population in different age groups for men and women in China.

Effective colonoscopy is necessary for the early diagnosis of CRC precursor lesions, adenomas or serrated lesions. The adenoma detection rate (ADR), which is correlated with the polyp detection rate and the mean number of adenomas per colonoscopy, has been confirmed by endoscopic physicians to be a predictor of the quality of colonoscopy [8]. Simultaneously, the detection rate of serrated lesions is an

important index of colonoscopy quality[9]. In previous studies, the detection rate of adenomas by endoscopists varied greatly [15, 16], and a recent guideline from the American Gastroenterological Society and the American Society of Gastrointestinal Endoscopy suggested that the target ADR should be more than 25% in the population aged 50 years or older undergoing screening colonoscopy [17]. Notably, however, the definition of this target rate is based primarily on evidence from Western populations, which generally have a higher prevalence of colorectal cancer. For example, in a screening cohort of 9989 colonoscopies in the United States, the total ADR was 37.2% [18], and in another opportunistic screening cohort of 4,407,971 colonoscopies in Germany from 2003 to 2012, the ADR of men and women in 2012 was 31.3% and 20.1%, respectively [19]. A recent study from a Chinese population showed that the total ADR of adenomas in a high-risk population was 11.49% [14], and another study suggested that the detection rate of AAs was 1.27% [20]. Our study implied that the detection rates of adenomas, AAs and serrated adenomas were 14.19%, 3.08% and 1.23%, respectively. The detection rate of colorectal adenomas was lower than that in the above reports, possibly because the incidence of CRC in China was lower than that in European and North American countries [21].

A recent study from France showed that the detection rate of adenomas and AAs increased starting from the age of 45, and no significant increase in ADR and ANDR was observed between patients aged 45–49 and those aged 50–54 in a screening cohort with 6027 participants undergoing screening colonoscopies [22]. The study from the New Hampshire Colonoscopy Registry suggested that the AN prevalence was as follows: >40 years (1.1%), 40–44 years (3.0%), 45–49 years (3.7%), 50–54 years (3.6%), 55–59 years (5.1%), and 60+ years (6.7%) ($P < 0.0001$ across all groups). The prevalence of both AN and clinically significant serrated polyps was similar in the 45–49- and 50–54-year age groups [23]. In another study using 6,680 colonoscopy screening records from Korea, there was a significantly greater prevalence of adenomas and AAs in individuals aged 50–59 than in individuals aged 40–49 (26.7% and 2.4% vs. 37.8% and 3.5%, respectively) [24]. Our study indicated that the ADR, ANDR and the detection rate of serrated adenomas among 50- to 54-year-old individuals were 15.92%, 3.44%, and 1.28%, respectively, which were greater than the prevalence among individuals aged 45–49 years (13.09%, 2.68% and 1.10%, respectively). Our data were consistent with those reported by the studies mentioned.

The prevalence of adenomas increased in women aged 60–64 years (11.81% in 55–59 years to 14.32% in 60–64 years), and a similar increase was observed in men 15 years younger, i.e., men aged 45–49 years, from 12.22–16.06%, consistent with the research results of Monika F et al. [25]. The prevalence of AAs in women aged 65–69 years increased (2.64% in 60–64 years to 3.44% in 65–69 years), which was similar to the prevalence of AA in men aged 45–49 years (3.17%). The prevalence of CRCs was similar between men and women in the 60- to 64-year-old age group (1.76% vs. 1.07%) and greater than that in men (0.73%) and women (0.64%) in the 55- to 59-year-old age group. The prevalence of CRCs in women aged over 75 years was significantly higher than that in women aged below 75 years. It takes approximately 10 years from the first abnormality to a possible malignancy. The increase in the number of CRCs diagnosed between the ages of 60 and 64 may reflect a shift from adenomas that were present in individuals in their 50s.

In our study, the NNSs of adenomas and AAs for men aged 50–54 years were 5.06 (95% CI, 4.85–5.29) and 23.20 (95% CI, 21.10–25.77), while the NNSs were 10.56 (95% CI, 9.68–11.63) and 59.17 (95% CI, 48.31–76.34) for women in the same age group. The age at which women reached NNS of adenoma and AAs similar to that of men aged 50–54 years was 65–69 years, and a difference of 15 years between men and women was observed. Although screening at 50 decreased to 45 years old, the detection rate of adenoma and AAs in men was greater than that in women in the same age group. It is important to begin CRC screening in men under the age of 50 years to avoid the higher prevalence in men. Because advanced neoplasms are more common in the distal colon, complete colonoscopy plays an important role as a screening tool to detect and remove all adenomas and AAs [26].

A major advantage of the study is that it was the first to demonstrate the diagnostic efficacy of screening colonoscopy in a large average-risk population-based cohort in China, in which a large amount of data from younger individuals allows analysis of the prevalence of adenoma, AAs and CRC. In addition, detailed clinical examination data (colonoscopy and pathology) were collected in a standardized model by trained researchers to ensure the quality of the data. Another advantage is that all colonoscopies were subject to the same quality control, thus providing comparable data for adenomas, AAs and CRCs.

The limitation of this study was that it was a single-centre study and cannot fully represent the general population in China. Although the included population was from 30 provinces and cities in China, selection bias cannot be excluded. Second, there was no lifestyle information in our study at this time, given the ongoing work on the impact of lifestyle on adenomas and AAs.

Conclusions

In summary, our study showed that the detection rates for adenomas, AAs, serrated adenomas, and CRC were 14.19%, 3.08%, 1.23%, and 0.59%, respectively. The detection rate was higher in men than in women and increased with age. Most AAs were found in the distal colon. The detection rate of AAs in men aged 45–49 was twice as high as that of women in the same age group (3.17% [95% CI, 2.80%–3.55%] vs. 1.49% [95% CI, 1.12%–1.86%]; $P < 0.001$). The NNS of AAs was 31.55 (95% CI, 28.17–35.71) for men aged 45–49 years and 67.11 (95% CI, 53.76–89.29) for women in the same age group. NNS was similar for men aged 45–49 years and women aged 65–69 years (31.55 [95% CI, 28.17–35.71] vs. 29.07 [95% CI, 21.05–46.73]). Further prospective studies are needed to demonstrate the relative clinical effectiveness of screening at different ages.

Abbreviations

AAs: advanced adenomas , CRCs: colorectal cancers, NNS: number needed to screen.

Declarations

Acknowledgements

We thank all the participants for their help in the experiment design and data processing.

Authors' contributions

Author Gong Y and Zheng Y S was responsible for study conception and design, authors Zeng Q and Li H were responsible for acquisition of data, authors Wu Rilige, Liu M and Gong Y were responsible for data analysis, and drafting and revision of the manuscript. All the authors have read and approved the final manuscript.

Funding

This work was supported by the State Science and Technology Support Program (No. 2012BAI37B04), the Joint Project of the National Natural Science Foundation of China and the Australian National Health and Medical Research Council (No .NSFC81561128020-NHMRCAPP1112767).

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study protocol was approved by the Ethic Committee of the PLA General Hospital, Beijing, China (No:S2017-002-03).

Consent for publication

Not applicable.

Competing interests

None.

References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2018, 68(6):394-424. doi: 10.3322/caac.21492. Epub 2018 Sep 12.
2. Arnold M, Sierra MS, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global patterns and trends in colorectal cancer incidence and mortality. *Gut* 2017, 66(4):683-691. doi: 10.1136/gutjnl-2015-310912. Epub 2016 Jan 27.

3. Siegel RL, Fedewa SA, Anderson WF, Miller KD, Ma J, Rosenberg PS, et al. Colorectal Cancer Incidence Patterns in the United States, 1974-2013. *J Natl Cancer Inst* 2017, 109(8):djw322. doi: 10.1093/jnci/djw322.
4. Guo L, Chen H, Wang G, Lyu Z, Feng X, Wei L, et al. Development of a risk score for colorectal cancer in Chinese males: a prospective cohort study. *Cancer Med* 2020, 9:816–23. doi: 10.1002/cam4.2734
5. Shaneda W A, William J. Blot, Loren L, Mark S, Harvey J. M, Wei Z. Association of Race and Socioeconomic Status With Colorectal Cancer Screening, Colorectal Cancer Risk, and Mortality in Southern US Adults. *JAMA Network Open* 2019, 2(12):e1917995. doi:10.1001/jamanetworkopen.2019.17995
6. Sharaf RN, Ladabaum U. Comparative effectiveness and cost-effectiveness of screening colonoscopy vs. sigmoidoscopy and alternative strategies. *Am J Gastroenterol* 2013,108:120-32.
7. Matthew N T , Fernando C, Mushfeka G, Ren C. Detection of Colorectal Neoplasia by Colonoscopy in Average-Risk Patients Age 40–49 Versus 50–59 Years. *Dig Dis Sci* 2011, 56(5):1503-8. doi: 10.1007/s10620-011-1565-6. Epub 2011 Feb 1.
8. Amir Q, Carolyn J C , Reem A M , Lauri A H, Timothy J W , Screening for Colorectal Cancer in Asymptomatic Average-Risk Adults: A Guidance Statement From the American College of Physicians. *Ann Intern Med* 2019, 171(9):643-654. doi: 10.7326/M19-0642.
9. Kaminski MF, Thomas-Gibson S, Bugajski M, Bretthauer M, Rees CJ, Dekker E, et al. Performance measures for lower gastrointestinal endoscopy: a European Society of Gastrointestinal Endoscopy (ESGE) Quality Improvement Initiative. *Endoscopy* 2017, 49: 378- 397.PMID: 28268235 DOI: 10.1055/s-0043-103411
10. Hermann B, Lutz A, Jens K, Thomas R, Christian P, Christian S, et al. Trends in Adenoma Detection Rates During the First 10 Years of the German Screening Colonoscopy Program. *Gastroenterology* 2015, 149:356–366.
11. Rebecca L S , Stacey A F, William F A, Kimberly D M , Jiemin M , Philip S R , et al. Colorectal cancer incidence patterns in the United States, 1974-2013. *J Natl Cancer Inst* 2017, 109(8):djw322. doi: 10.1093/jnci/djw322
12. Wolf AMD, Fontham ETH, Church TR, Flowers CR, Guerra CE, LaMonte SJ, et al. Colorectal Cancer Screening for Average-Risk Adults: 2018 Guideline Update From the American Cancer Society. *Ca Cancer J Clin* 2018,68:250–281
13. Ferlitsch M, Reinhart K, Pramhas S, Wiener C, Gal O, Bannert C, et al. Sex-specific prevalence of adenomas, advanced adenomas, and colorectal cancer in individuals undergoing screening colonoscopy. *JAMA* 2011, 306(12):1352-8. doi: 10.1001/jama.2011.1362.
14. Hongda chen, ni li, Jiansong ren, Xiaoshuang Feng, Zhangyan lyu, luopei Wei,et al. Participation and yield of a population-based colorectal cancer screening programme in China. *Gut* 2018, 0:1–8. doi:10.1136/gutjnl-2018-317124.
15. Corley DA, Jensen CD, Marks AR, Zhao WK, Lee JK, Doubeni CA, et al. Adenoma detection rate and risk of colorectal cancer and death. *N Engl J Med* 2014, 370: 1298-1306.

16. Peters SL, Hasan AG, Jacobson NB, Austin GL. Level of fellowship training increases adenoma detection rates. *Clin Gastroenterol Hepatol* 2010, 8(5):439-42. doi: 10.1016/j.cgh.2010.01.013. Epub 2010 Feb 1.
17. Greenspan M, Rajan KB, Baig A, Beck T, Mobarhan S, Melson J. Advanced adenoma detection rate is independent of nonadvanced adenoma detection rate. *Am J Gastroenterol* 2013, 108(8):1286-92. doi: 10.1038/ajg.2013.149. Epub 2013 May 28.
18. Imperiale TF, Ransohoff DF, Itzkowitz SH, Levin TR, Lavin P, Lidgard GP, et al. Multitarget stool DNA testing for colorectal-cancer screening. *N Engl J Med* 2014, 370(14):1287-97. doi: 10.1056/NEJMoa1311194. Epub 2014 Mar 19.
19. Joseph C A, Lynn F B, Martha G, Christina M R, Julia E W. Differences in detection rates of adenomas and serrated polyps in screening versus surveillance colonoscopies, based on the new hampshire colonoscopy registry. *Clin Gastroenterol Hepatol* 2013,11(10):1308-12. doi: 10.1016/j.cgh.2013.04.042.
20. Jiangong Zhang , Huifang Xu , Liyang Zheng , Juan Yu , Qiong Chen , Xiaoqin Cao ,et al. Determinants of Participation and Detection Rate of Colorectal Cancer From a Population-Based Screening Program in China. *Front. Oncol.* 2020,10:1173. doi: 10.3389/fonc.2020.01173. eCollection 2020.
21. Jinzhou Zhu , Zhengqi Tan , Kelseanna Hollis-Hansen , Yong Zhang, Chaohui Yu, Youming Li. Epidemiological Trends in Colorectal Cancer in China: An Ecological Study. *Dig Dis Sci.*2017, 62(1):235-243. doi: 10.1007/s10620-016-4362-4. Epub 2016 Oct 31.
22. David K, Gaelle T, Pascal B, Franck V, Gilles T, Agnès G, et al. Adenoma and advanced neoplasia detection rates increase from 45 years of age. *World J Gastroenterol* 2019, 25(4): 447-456.
23. Lynn F B, Rebecca L S, Stacey F , Christina M R, Ahmedin J, Joseph C A . Colonoscopy Outcomes in Average-Risk Screening Equivalent Young Adults: Data From the New Hampshire Colonoscopy Registry. *Am J Gastroenterol* 2020. doi: 10.14309/ajg.0000000000000820
24. Ja Eun Koo, Kyung-Jo Kim , Hye Won Park , Hong-Kyu Kim, Jae Won Choe , Hye-Sook Chang, et al. Prevalence and risk factors of advanced colorectal neoplasms in asymptomatic Korean people between 40 and 49 years of age. *J Gastroenterol Hepatol* 2017,32:98–105.
25. Monika F , Karoline R, Sibylle P, Caspar W, Orsolya G, Christina B, et al. Sex-Specific Prevalence of Adenomas,Advanced Adenomas, and Colorectal Cancer inIndividuals Undergoing Screening Colonoscopy. *JAMA* 2011, 306(12):1352-8. doi: 10.1001/jama.2011.1362.
26. Su Jin Chung , Young Sun Kim, Sun Young Yang, Ji Hyun Song, Min Jung Park, Joo Sung Kim, , et al. Prevalence and risk of colorectal adenoma in asymptomatic Koreans aged 40-49 years undergoing screening colonoscopy. *J Gastroenterol Hepatol* 2010, 25(3):519-25. doi: 10.1111/j.1440-1746.2009.06147.x.

Tables

Table1. The general characteristics of individuals

	Total, No. (%)	Men, No. (%)	Women, No. (%)	P value
Subjects, No.	53152	35226 (66.27)	17926 (33.73)	0.0000
Average age ,y				0.0000
Median (SD)	49.21(8.67)	48.80(8.47)	50.00(9.00)	
Age groups,y				0.000
<40	6,119(11.51)	4,270(12.12)	1,849(10.31)	
40-44	8,499(15.99)	5,968(16.94)	2,531(14.12)	
45-49	12,601(23.71)	8,510(24.16)	4,091(22.82)	
50-54	12,830(24.14)	8,447(23.98)	4,383(24.45)	
55-59	7,017(13.20)	4,519(12.83)	2,498(13.94)	
60-64	3,860(7.26)	2,268(6.44)	1,592(8.88)	
65-69	1,696(3.19)	941(2.67)	755(4.21)	
70-74	400(0.75)	238(0.68)	162(0.90)	
>75	130(0.24)	65(0.18)	65(0.36)	
Polyp number				
Mini-	10,222(19.23)	7,588(21.54)	2,634(14.69)	0.000
Multi-	5,915(11.13)	4,981(14.14)	934(5.21)	0.000
Colorectal cancer	313(0.59)	201(0.57)	112(0.62)	0.440
Other lesions	5,994(11.28)	4,067(11.55)	1,927(10.75)	0.006
No abnormalities	32,811(61.73)	19,862(56.38)	12,949(72.24)	0.000

Table 2.Prevalence and NNS for Adenoma, AA and CRC in different age group and sex

	Men		Women	
	Prevalence, n(%) [95%CI]	NNS[95%CI]	Prevalence, n(%) [95%CI]	NNS[95%CI]
Adenoma				
Total	6035(17.14)[16.74-17.53]	5.83(5.70-5.97)	1678(9.36)[8.94-9.79]	10.68(10.21-11.19)
Age, y				
<40	309(7.25)[6.47-8.02]	13.79(12.47-15.46)	67(3.63)[2.77-4.48]	27.55(22.32-36.10)
40-44	729(12.22)[11.38-13.05]	8.18(7.66-8.79)	166(6.56)[5.59-7.52]	15.24(13.30-17.89)
45-49	1367(16.06)[15.28-16.84]	6.23(5.94-6.54)	318(7.77)[6.95-8.59]	12.87(11.64-14.39)
50-54	1669(19.75)[18.91-20.61]	5.06(4.85-5.29)	415(9.47)[8.60-10.33]	10.56(9.68-11.63)
55-59	1037(22.95)[21.73-24.18]	4.36(4.14-4.60)	295(11.81)[10.54-13.08]	8.47(7.65-9.49)
60-64	568(25.04)[23.26-26.83]	3.99(3.73-4.30)	228(14.32)[12.60-16.04]	6.98(6.23-7.94)
65-69	249(26.46)[23.64-29.28]	3.78(3.42-4.23)	130(17.22)[14.52-19.91]	5.81(5.02-6.89)
70-74	82(34.45)[28.40-40.50]	2.90(2.47-3.52)	37(22.84)[16.35-29.32]	4.38(3.41-6.12)
≥75	25(38.46)[26.54-50.38]	2.60(1.98-3.77)	22(33.84)[22.25-45.44]	2.96(2.20-4.49)
Advanced adenoma				
Total	1293(3.67)[3.47-3.87]	27.25(25.84-28.82)	324(1.81)[1.61-2.00]	55.25(50.00-61.11)
Age, y				
<40	53(1.24)[0.91-1.58]	80.65(63.29-109.89)	17(0.92)[0.48-1.36]	108.70(73.53-208.33)
40-44	136(2.28)[1.90-2.66]	43.86(37.59-52.63)	32(1.26)[0.83-1.70]	79.37(58.82-120.48)
45-49	270(3.17)[2.80-3.55]	31.55(28.17-35.71)	619(1.49)[1.12-1.86]	67.11(53.76-89.29)
50-54	364(4.31)[3.88-4.74]	23.20(21.10-25.77)	74(1.69)[1.31-2.07]	59.17(48.31-76.34)

55-59	241(5.33)[4.68-5.99]	18.76(16.69-21.37)	60(2.40)[1.80-3.00]	41.67(33.33-55.56)
60-64	144(6.35)[5.35-7.35]	15.75(13.61-18.69)	42(2.64)[1.85-3.43]	37.88(29.15-54.05)
65-69	58(6.16)[4.63-7.70]	16.23(12.99-21.60)	26(3.44)[2.14-4.75]	29.07(21.05-46.73)
70-74	23(9.66)[5.90-13.43]	10.35(7.45-16.95)	5(3.09)[0.41-5.76]	32.36(17.36-243.90)
≥75	4(6.15)[0.27-12.04]	16.26(8.31-370.37)	7(10.77)[3.17-18.36]	9.29(5.45-31.55)
Colorectal cancer				
Total	201(0.57)[0.49-0.65]	175.44(153.85-204.08)	112(0.62)[0.51-0.74]	161.29(135.14-196.08)
Age, y				
<40	3(0.07)[0.01-0.15]	1428.57(666.67-10000.00)	12(0.65)[0.28-1.02]	153.85(98.04-357.14)
40-44	18(0.30)[0.16-0.44]	333.33(227.27-625.00)	12(0.47)[0.21-0.74]	212.77(135.14-476.19)
45-49	21(0.25)[0.14-0.35]	400.00(285.71-714.29)	15(0.37)[0.18-0.55]	270.27(181.82-555.56)
50-54	40(0.47)[0.33-0.62]	212.77(161.29-303.03)	11(0.25)[0.10-0.40]	400.00(250.00-1000.00)
55-59	33(0.73)[0.48-0.98]	136.99(102.04-208.33)	16(0.64)[0.33-0.95]	156.25(105.26-303.03)
60-64	40(1.76)[1.22-2.31]	56.82(43.29-81.97)	17(1.07)[0.56-1.57]	93.46(63.69-178.57)
65-69	30(3.18)[2.06-4.31]	31.45(23.30-48.54)	17(2.25)[1.19-3.31]	44.44(30.21-84.03)
70-74	11(4.62)[1.95-7.29]	21.65(13.72-51.28)	6(3.70)[0.79-6.62]	27.03(15.11-126.58)
≥75	5(7.69)[1.16-14.22]	13.00(7.03-86.21)	6(9.23)[2.13-16.32]	10.83(6.13-46.95)

NNS: number needed to screen

Table3. Prevalence and NNS for serrated adenomas in different age group and sex

	Men		Women	
	Prevalence, n(%) [95%CI]	NNS[95%CI]	Prevalence, n(%) [95%CI]	NNS[95%CI]
Serrated adenoma				
Total	548(1.56)[1.43-1.69]	64.10(59.17-69.93)	105(0.59)[0.47-0.70]	169.49(142.86-212.77)
<40	36(0.84)[0.57-1.12]	119.05(89.29-175.44)	8(0.43)[0.13-0.73]	232.56(136.99-769.23)
40-44	75(1.26)[0.97-1.54]	79.37(64.94-103.09)	9(0.36)[0.12-0.59]	277.78(169.49-833.33)
45-49	118(1.39)[1.14-1.64]	71.94(60.98-87.72)	21(0.51)[0.29-0.73]	196.08(136.99-344.83)
50-54	140(1.66)[1.39-1.93]	60.24(51.81-71.94)	24(0.54)[0.33-0.77]	185.19(129.87-303.03)
55-59	88(1.95)[1.54-2.35]	51.28(42.55-64.94)	14(0.56)[0.27-0.85]	178.57(117.65-370.37)
60-64	52(2.29)[1.68-2.91]	43.67(34.36-59.52)	18(1.13)[0.61-1.65]	88.50(60.61-163.93)
65-69	29(3.08)[1.98-4.19]	32.47(23.87-50.51)	9(1.19)[0.42-1.97]	84.03(50.76-238.10)
70-74	8(3.36)[1.07-5.66]	29.76(17.67-93.46)	2(1.23)[0.47-2.94]	81.30(34.01-212.77)
≥75	2(3.08)[0.01-7.31]	32.47(13.68-10000.00)	0(0.00)[-]	–

NNS: number needed to screen

Figures

Findings	Prevalence, No. (%) [95% CI]	NNS [95% CI]
Colorectal cancer	313 (0.59) [0.52-0.65]	169.49 (153.85-192.31)
Adenoma	7713 (14.51) [14.21-14.81]	6.89 (6.75-7.04)
Advanced adenoma	1617 (3.04) [2.90-3.19]	32.89 (31.35-34.48)
Non-advanced adenoma	6255 (11.77) [11.50-12.04]	8.50 (8.31-8.70)
Hyperplastic polyp	2873 (5.42) [5.12-5.63]	18.45 (17.76-19.53)
Serrated adenoma	653 (1.23) [1.01-1.32]	81.30 (75.76-99.01)
Other benign lesions	4783 (9.00) [8.76-9.24]	11.11 (10.82-11.42)

Figure 1

Colonic lesions detected by colonoscopy and number needed to screen for each lesion

Figure 2

Detection rates of adenomas, advanced adenomas, CRCs and serrated adenomas in different age groups for men and women

Figure 3

Anatomical location of CRCs, advanced adenomas and serrated adenomas