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Article

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Colorectal cancer screening and subsequent care across four communities within a medical consortium in southern Jiangsu

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Abstract

We examined colorectal cancer screening and subsequent care in four communities within a hospital-led medical consortium in Kunshan, China. This retrospective cohort study linked 2023–2025 screening records for residents aged 40–74 years with colonoscopy, pathology and subsequent-care records. The main outcome was documented colonoscopy after the earliest dated positive questionnaire or fecal immunochemical test (FIT), without a 180-day limit. Among 12,388 residents, 4,000 had a dated positive screen and 867 had a subsequent colonoscopy record (21.7%, 95% confidence interval 20.4–23.0%), including 64 beyond 180 days. Annual proportions were 20.8%, 20.2% and 26.6%. The adjusted odds ratio for 2025 versus 2023 was 1.46 (1.08–1.97), with Holm-adjusted P = 0.018. In independent first-FIT-positive cohorts, annual proportions were 71.3%, 61.8% and 38.6%. The wider clinical series comprised 999 colonoscopy recipients, including 14 with recorded cancer and 336 with adenoma or high-grade dysplasia without recorded cancer. Pathology was unavailable for 384, and later examination findings were recorded for 54. These records describe differences in diagnostic assessment and subsequent care across communities and years. Incomplete report retrieval and unequal observation time limit their interpretation.

Keywords: colorectal cancer; community screening; medical consortium; fecal immunochemical test; colonoscopy; follow-up

Introduction

Colorectal cancer remains a major cause of cancer morbidity and mortality in China (1). Screening can detect cancer and precursor lesions before clinical presentation, although its benefits and harms depend on the test and the care that follows (2, 3, 4). Fecal immunochemical testing (FIT) offers a noninvasive initial test with diagnostic advantages over guaiac-based fecal occult blood testing (5). A positive result requires diagnostic assessment. If a lesion is detected, care may include resection, other treatment and subsequent surveillance.

Delivering these services across community and hospital settings is a continuing challenge. Chinese screening programs have reported that not all residents undergo colonoscopy after a positive initial screen (6, 7). Risk-adapted approaches and combinations of FIT with questionnaire assessment have been evaluated in randomized trials and population cohorts (8, 9). Implementing these approaches also requires reliable transfer of results, access to colonoscopy and contact with residents whose examinations or treatment take place elsewhere. Initial-screening coverage alone cannot describe continuity of care through this process.

In Kunshan, southern Jiangsu, the First People's Hospital of Kunshan coordinated colorectal cancer screening with community health services in Penglang, Zhenchuan, Qingyang and Bingxi. The medical consortium linked community recruitment and initial testing with hospital endoscopy, pathology and specialist care. Penglang also established a community endoscopy center and a dedicated screening clinic. Family doctors helped communicate results and encourage further care. Routine registers and subsequently retrieved reports offer an opportunity to examine this service in practice.

We analyzed screening records for residents aged 40–74 during 2023–2025, linking positive initial screens to subsequent colonoscopy and describing pathology, interventions and later examinations. We compared communities and annual first-positive cohorts, with a separate analysis starting at the first positive FIT. An administrative summary for Penglang provided a complementary estimate of cumulative initial-screening coverage. The study evaluates documented care within an existing program. It was not designed to isolate the effect of the medical consortium or validate the screening questionnaires.

Materials and Methods

Setting and participants

The study was a retrospective analysis of routinely collected records in Penglang, Zhenchuan, Qingyang and Bingxi, Kunshan, Jiangsu. Penglang, Zhenchuan and Qingyang contributed registers for 2023–2025, and Bingxi contributed registers for 2024–2025. No 2023 Bingxi register was available for analysis. Reporting was informed by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statements (10, 11).

The Independent Ethics Committee at the First People's Hospital of Kunshan (Affiliated Kunshan Hospital of Jiangsu University) approved the study (2021-03-003-H01). All methods were performed in accordance with the relevant guidelines and regulations. Participants provided written informed consent. Continuing approvals and the applicable scope are detailed in the ethics statement. The parent screening study was recorded in China's Medical Research Registration and Filing Information System (record number MR-32-22-012491).

The program's age-defined priority population comprised men and women aged 40–74. Invitations were incorporated into annual health examinations for retirees and older residents, contacts with people receiving chronic-disease care, and notifications by community staff. Age eligibility did not itself constitute a high-risk questionnaire result. Recruitment was service-based rather than a random population sample. Some participants were not household-registered residents. Although SMS notifications were reported to have been sent to the household-registered population, receipt and the number of unique people successfully invited could not be established.

We included identifiable residents within the eligible age range who had evidence of initial screening, such as recorded questionnaire or FIT information, a score, or a linked clinical screening record. Where possible, age was derived from a valid identity number and the screening date. Otherwise, a compatible recorded age or an age interval wholly within 40–74 was used. Records with unresolved identities, ineligible or indeterminate ages, or

insufficient screening evidence were excluded from the primary cohort. Registers were grouped by program year, with the original individual dates retained. Implausible or out-of-period dates could not be used to define the temporal index. A separate clinical series retained all identified colonoscopy recipients, including those outside the primary cohort.

Consortium organization and care coordination

The First People's Hospital of Kunshan, a tertiary Grade A general hospital, led the program in collaboration with community health services in Penglang, Zhenchuan, Qingyang and Bingxi. The study protocol specified hospital–community coordination, periodic guidance at community sites, access to colonoscopy appointments and referral for people with positive initial results, and links to specialist care. It also required collection of endoscopy, pathology, treatment and follow-up information. The study examined screening services delivered through this hospital–community collaboration.

In practice, community teams invited residents through existing health examinations and chronic-disease services, assessed risk using local questionnaires and organized fecal immunochemical testing (FIT). The Penglang laboratory tested specimens from all four communities, while questionnaire rules and high-risk thresholds reflected local practice. Penglang's endoscopy center and dedicated screening clinic began operating in April 2023, providing local colonoscopy and guidance on subsequent examination and treatment for residents with positive results. Residents of the other three communities could also be referred to this center or to the First People's Hospital of Kunshan, with further care arranged according to clinical need. Periodic quality-control activities and community health education were conducted in Penglang.

Program staff communicated examination results and recommendations to family doctors, who contacted residents and encouraged further examination or treatment. Some subsequent care took place outside the screening service, and endoscopy and pathology reports retrieved later were added to the registers. Individual referral appointments, communication of results and family-doctor contacts were not systematically recorded. Neither were residents' exposure to educational activities or changes in their knowledge. Requirements in the protocol for follow-up frequency and return of results were therefore not treated as evidence of completed services.

Questionnaires and laboratory testing

Penglang used the high-risk factor questionnaire (HRFQ), covering personal cancer or polyp history, first-degree family history of colorectal cancer and combinations of bowel symptoms and other specified histories. Under the supplied operational rule, a person was classified as high risk if any of the three major histories or at least two of the remaining specified factors were present. The questionnaire used combinations of histories and symptoms to classify risk rather than calculating a numerical score. Such history- and symptom-based criteria have been used in Chinese screening research (12).

The other three communities used a local five-factor modified Asia-Pacific Colorectal Screening (APCS) questionnaire. It assigned 0, 1 and 2 points for ages 40–49, 50–59 and at least 60 years, respectively, with one point each for male sex, first-degree family history, current or previous smoking, and body mass index of at least 23 kg/m². Scores ranged from 0 to 6. The original APCS score and modified instruments have been studied previously, but their scoring rules should be distinguished from those on the local forms (13, 14). We described each community's rules using its local forms and referral thresholds. The available Qingyang form specified a threshold of at least 3 points, whereas the Zhenchuan and Bingxi forms specified at least 4 points. Zhenchuan personnel confirmed use of the same standard during all three years. Table 1 summarizes the community rules. The Zhenchuan and Bingxi form headings also specify recruitment at ages 50–74, although the scoring table retains an age 40–49 category. The analysis includes actual registrations within the investigator-confirmed 40–74 range and does not assume identical local recruitment ages.

The primary analysis retained the historically recorded positive, negative or risk category for each resident rather than reclassifying residents from partially recorded scores. When a score lacked an interpretable classification, questionnaire-positive status remained unknown. This approach describes the people classified for referral in routine practice and preserves differences in local implementation.

FIT specimens from all four communities were tested at the Penglang Community Health Service Center laboratory, according to the laboratory information supplied by the investigators. The laboratory used the OC-SENSOR io system (Eiken Chemical, Japan) with latex agglutination immunoturbidimetry (15). Results were expressed as ng hemoglobin/mL of collection buffer. The recorded negative range was 0–99 ng/mL and integer results of at least 100 ng/mL were positive. A historical instrument parameter printout and results around the reporting boundary supported this threshold. No conversion to hemoglobin per gram of feces was made without verified collection-volume and sample-mass information.

The laboratory reported no change in instrument, reagent system or reporting boundary during 2023–2025. Its calibration standard operating procedure specified five calibration concentrations of 0, 50, 200, 500 and 1,000 ng/mL and two control levels. The procedure required control results to satisfy the specified ranges before specimen testing. Dated calibration and maintenance records were available from the study years. These records document the method and examples of quality control, although independent audits were not established for every analytical batch. Historical information on individual specimen transport times and temperatures was incomplete.

Linkage and outcomes

Identity numbers were retained as text and linked across years and communities. A one-character discrepancy was reconciled only when name and telephone number supported a unique valid identifier. Records with missing identifiers required an exact name-and-telephone match to one identified resident. Source-supported corrections were reconciled before deduplication. Names alone did not determine linkage, and unresolved conflicts were excluded or flagged. Identifiers remained local and analytical records used pseudonymous keys.

Each resident appeared once in the pooled analysis. Baseline community was the community of the earliest eligible registration. Annual participation summaries counted each person once per program year, allowing the same person to recur across years. In contrast, temporal comparisons assigned each person once to the year and community of the earliest qualifying dated positive screen. A pooled questionnaire or FIT result was positive if any available eligible registration recorded a positive result. Unknown results were not treated as negative.

A qualifying initial result was a high-risk questionnaire or a positive FIT. For the temporal outcome, the index was the earliest qualifying dated initial screen between 1 January 2023 and 31 December 2025 in the eligible records. We identified the earliest documented colonoscopy after that date. Intervals exceeding 180 days were included. A same-day date without evidence of sequence did not establish a subsequent examination. Month-and-day entries were interpreted using the register year only when that interpretation was coherent. Ambiguous entries remained unresolved.

A separate FIT-positive analysis used each person's earliest dated positive FIT in 2023–2025, irrespective of an earlier high-risk questionnaire. It required a colonoscopy strictly after that FIT result and was not restricted to FIT positivity at the first any-positive screen. Endoscopy quality was evaluated at each person's first qualifying post-positive colonoscopy, grouped by actual examination year. Availability of cecal intubation status, Boston Bowel Preparation Scale (BBPS) total (16) and pathology was reported separately from the observed quality results. A BBPS total of at least 6 was assessed only where a score was available.

The September 2026 record collection was reconciled with supplementary annual screening entries, endoscopy-register records, reports and identifier corrections available by 9 October 2026. Recorded colonoscopy dates extended from 18 February 2023 to 29 August 2026. These dates describe available records, not complete observation to a common closing date. Uncertain screening dates were retained only when supported by source evidence. Dates completed using the register year remained distinguishable from an original full date. We report documented subsequent colonoscopy rather than fixed-window adherence.

In the clinical series, mutually exclusive pathology categories were assigned in the following order of priority: recorded cancer, adenoma or high-grade dysplasia without recorded cancer, other serrated lesions, other available pathology, and no available pathology. Diagnoses were abstracted from clinical text without independent slide review. Later examinations were identified from updated registers and transcribed report content, but original reports were not independently re-reviewed for every later event. One internally discordant entry described tubular adenocarcinoma with low-grade dysplasia without corroboration from treatment pathology. It was not counted as cancer pending confirmation of the original report. Missing pathology was assessed alongside endoscopic

descriptions, and wording indicating normal findings did not prove that no specimen had been taken. An advanced-adenoma rate was not calculated because lesion size and histology could not always be assigned to the same lesion. Surveillance depends on examination quality, lesion characteristics and completeness of removal (17).

Intervention documentation was classified into three mutually exclusive categories per person. The first required explicit evidence in the initial-examination or treatment narrative that resection or another therapeutic procedure had been performed. Entries in treatment-method or status fields had to state that treatment had been carried out. A method name, a date or biopsy alone was insufficient. Among the remaining recipients, the second category required a treatment method that was not merely a recommendation and usable treatment-pathology text in the same register row. The third comprised recipients meeting neither definition and did not imply absence of treatment. Classification followed this order of priority. Same-row entries were not independently linked at specimen or lesion level and did not establish completion of all necessary treatment.

In the wider clinical series, a later examination required a date after the first known colonoscopy and actual findings. In the temporal cohort, repeat colonoscopy additionally had to occur after the first qualifying post-positive examination. Later procedures were considered in an expanded person-level intervention classification. Annual intervention and repeat-examination summaries were grouped by positive-index year, not procedure year. Plans, predicted recall dates, recommendations to defer screening, duplicate reports and pathology dates referring to the same procedure were not counted as completed repeat examinations. No surveillance completion rate or cure rate was estimated.

Population coverage and statistics

Penglang staff compared the household roster with prior screening lists. The supplied administrative summary counted unique household-registered residents aged 45–75 who completed both the questionnaire and FIT during 2023–2025, some of whom also underwent colonoscopy. The data provider confirmed the date and deduplication across years. Individual roster information was not transferred for this analysis. Coverage was reported separately because its denominator differs from that of the primary cohort aged 40–74. No equivalent population denominator was available for the other communities, and an invitation-response rate could not be calculated.

Analyses were performed in R 4.6.0. Means and standard deviations or medians and interquartile ranges described continuous variables. Person-level proportions were accompanied by Wilson 95% confidence intervals. Pearson chi-square tests compared questionnaire and FIT proportions across baseline communities. Annual initial-screening result availability was descriptive because participants could recur across years. Comparisons of mutually exclusive first-positive annual cohorts used Pearson chi-square or Fisher exact tests, with an exploratory Cochran–Armitage trend test. Pairwise year and Penglang-versus-community comparisons used Fisher exact tests with Holm adjustment within each comparison family. Holm adjustment was also applied to the four community-specific annual tests, the ten within-community year contrasts, and the five endoscopy-quality comparisons. Intervals among recipients were compared using the Kruskal–Wallis test. Tests were two-sided. Treatment and repeat-examination summaries were descriptive. Missing results and examinations were not imputed.

An exploratory logistic model examined recorded subsequent colonoscopy among people with a dated positive index. Covariates were age per ten years, sex, index community, categorical index year and the questionnaire–FIT combination at the index, with separate categories for a missing companion result. Person-level heteroscedasticity-consistent standard errors were used. Year contrasts and Penglang-versus-community contrasts received separate Holm corrections. A joint Wald test assessed year effects. A likelihood-ratio comparison of categorical and linear year terms assessed nonlinearity. Community-by-year interactions were examined over the common 2024–2025 period and, separately, across all three years in the three continuously represented communities. Odds ratios describe associations with recorded examinations, not causal effects or relative risks. Community and questionnaire type could not be separated statistically. Sensitivity analyses restricted identity linkage to checksum-valid initial identifiers, required explicit full dates, excluded incompletely dated candidate first events, and restricted annual comparisons to the three communities with records in every year.

ChatGPT and Codex (OpenAI, https://openai.com) were used to assist with drafting, translation, source checking, and development and checking of data-processing, statistical and figure-generation scripts. Numerical results were

calculated from study records using reproducible code. The authors are responsible for the accuracy and integrity of the manuscript.

Results

Screening participation

Of 17,520 initial-screening registrations, 17 had unresolved identity, 676 had ineligible or indeterminate age, and 2,382 lacked sufficient screening evidence. The remaining 14,445 registrations represented 12,388 residents and 13,966 annual participation records, counting each resident once per year. 1,481 residents participated in more than one year. 129 residents appeared in more than one community (Figure 1).

Women accounted for 8,073 residents (65.2%). Mean age was 60.4 years (standard deviation, 7.0). For 35 residents, an age interval established eligibility, but exact age was unavailable. The questionnaire classified 3,639/11,622 assessable residents as high risk (31.3%), and FIT was positive in 676/8,832 (7.7%). Both results were known for 8,111 residents, and 4,053 had at least one positive result (Tables 2 and 3).

Questionnaire high-risk proportions ranged from 26.8% in Zhenchuan to 36.7% in Qingyang (P<0.001). FIT positivity ranged from 4.4% in Bingxi to 9.2% in Qingyang (P<0.001). These differences reflect recorded classifications within community-specific screening practice.

FIT results were unavailable for 3,556 residents (28.7%), including 2,601 from Penglang. Mean age was 58.2 years in this group versus 61.2 years when both results were known. Questionnaire classifications were unavailable for 766 residents (6.2%), including 648 from Zhenchuan (Supplementary Table 2).

Colonoscopy after positive screening

Among 4,053 residents with a positive initial result, 4,000 had a qualifying dated index and 867 had subsequent colonoscopy documented (21.7%; 95% confidence interval, 20.4–23.0%). No linked later examination was identified for 3,133. Another 53 positive residents lacked a qualifying dated index. A simple linkage to any colonoscopy would count 889, including examinations without established post-positive sequence. The primary outcome includes 64 examinations more than 180 days after the positive result; the median interval was 15 days (interquartile range, 8–33; range, 1–1230).

By positive-index community, subsequent colonoscopy was documented for 606/2,002 residents in Penglang (30.3%), 143/913 in Zhenchuan (15.7%), 93/886 in Qingyang (10.5%) and 25/199 in Bingxi (12.6%) (Table 4; Supplementary Figure 1). These community assignments were based on the positive index and can differ from the baseline community. Observation time and report retrieval also varied. Adjusted odds ratios for Penglang versus Zhenchuan, Qingyang and Bingxi were 6.18 (4.75–8.04), 9.38 (6.93–12.70) and 9.24 (5.25–16.25), respectively (95% confidence intervals in parentheses; all Holm-adjusted P<0.001).

The exploratory model included 4,000 residents and 867 outcomes. The adjusted odds ratio per ten years of age was 0.72 (0.63–0.82). Using a high-risk questionnaire result with a negative FIT as the reference, odds ratios were 0.07 (0.04–0.10) when FIT was missing, 11.53 (8.59–15.48) for FIT positivity without a high-risk questionnaire result, and 8.92 (5.92–13.45) when both were positive (Supplementary Table 3). The associations do not imply causal effects.

Subsequent colonoscopy was recorded for 839/3,904 residents (21.5%) under the strict identity definition, 848/3,989 (21.3%) under the explicit dates definition and 862/3,990 (21.6%) under the definition requiring certainty about the first event (Supplementary Table 4). The sensitivity analysis restricted to ages 45–74 is reported separately from the primary cohort aged 40–74.

Annual differences in documented care

Subsequent colonoscopy was documented in 385/1,854 (20.8%), 282/1,394 (20.2%) and 200/752 (26.6%) for residents indexed in 2023, 2024 and 2025, respectively (Table 5). Annual heterogeneity was present (χ^2=13.34, 2 degrees of freedom; P=0.001), but the pattern was not monotonically increasing. In unadjusted comparisons, 2025 exceeded 2023 and 2024 (Holm-adjusted P=0.003 and 0.003). The adjusted odds ratio for 2025 versus 2023 was

1.46 (1.08–1.97) (Holm-adjusted P=0.018). This association does not establish improved adherence or a program effect.

The annual proportions of residents with documented subsequent colonoscopy were 27.2%, 40.8% and 27.6% in Penglang, 14.8%, 12.1% and 30.6% in Zhenchuan, and 6.6%, 8.2% and 44.9% in Qingyang. The corresponding proportions in Bingxi were 5.6% and 13.3%, as Bingxi has no 2023 register. Community-specific estimates have unequal denominators and observation opportunities (Supplementary Table 5; Supplementary Figure 2).

In the three continuously represented communities, annual proportions were 20.8%, 20.4%, 30.8% (P<0.001). Requiring original full dates for the positive index and colonoscopy gave 20.8%, 20.2%, 24.4% (overall P=0.063; linear-trend P=0.097; Supplementary Table 6). Median intervals by index year were 11, 21, 15 days, with 45, 12, 7 examinations after 180 days. These intervals did not progressively shorten.

The independent first-FIT-positive analysis included 652 residents. A further 24 residents with a positive FIT at any time lacked a qualifying dated FIT index. Subsequent colonoscopy was documented for 149/209 (71.3%), 176/285 (61.8%) and 61/158 (38.6%) residents in 2023, 2024 and 2025, respectively (Table 5). These cohorts were defined independently by the first positive FIT and should not be interpreted as subsets of the any-positive index-year groups.

BBPS totals were recorded for 291/343 (84.8%), 272/285 (95.4%), 200/219 (91.3%) first qualifying examinations in 2023–2025 (Holm-adjusted P<0.001). Among scored examinations, totals of at least 6 occurred in 96.9%, 97.1%, 94.0% (P=0.332); cecal intubation among assessable examinations was 100.0%, 98.9%, 99.0% (P=0.263). Annual initial-screening FIT availability was 45.8%, 86.8%, 65.0% (Supplementary Table 7), a record-availability measure rather than population coverage.

By positive-index year, explicit therapeutic-procedure documentation occurred in 77/385 (20.0%), 80/282 (28.4%), 68/200 (34.0%) qualifying colonoscopy recipients. Including same-row method and treatment-pathology evidence gave 193/385 (50.1%), 171/282 (60.6%), 124/200 (62.0%). Further examinations with findings were documented for 16, 18, 13 recipients, including repeat pathology in 10, 12, 6 (Supplementary Table 8). Treatment indications and observation opportunities were not uniform; these records do not demonstrate cure or completed surveillance.

Pathology and subsequent care

The wider clinical series included 999 unique colonoscopy recipients, 968 in the primary cohort and 31 outside it. Pathology was available for 615. Mutually exclusive categories comprised recorded cancer in 14, adenoma or high-grade dysplasia without recorded cancer in 336, other serrated lesions in 5, other pathology in 260, and no available pathology in 384 (Table 6).

Among recipients without pathology, endoscopy descriptions indicated normal findings or no abnormality in 161, other findings in 118, a polyp or mass in 50, and sampling or resection in 42. Findings were unavailable for 13. These descriptions cannot distinguish, in every case, between no tissue sampling and a specimen report that was not retrieved.

Initial-examination or treatment entries explicitly documented therapeutic procedures for 259 recipients. Another 283 had same-row method and treatment-pathology evidence without explicit implementation wording, and 457 met neither definition. Including later procedures changed the three counts to 266, 277 and 456. Pathology at a newly retrieved examination alone did not verify a separately registered treatment. These categories do not establish completion of every indicated treatment or cure.

At the first recorded colonoscopy, cecal intubation was documented for 862/867 (99.4%) assessable recipients. BBPS totals were available for 812, of whom 781 had totals of at least 6 (96.2%). Segment scores were incomplete; an adequate total cannot establish adequate cleansing throughout the colon (18, 19). Withdrawal time and endoscopist-level performance were unavailable.

Dated later colonoscopy findings were documented for 54 recipients in the wider clinical series, including pathology in 30. Within the 867-person temporal outcome group, 47 had another examination with findings after the first qualifying post-positive colonoscopy and 28 had repeat pathology. Another 5 had a later date without findings and 1 had dated nonendoscopic treatment follow-up (Table 7). Planned recalls were not counted as

completed examinations; the population due for surveillance and capture of outside examinations were insufficiently defined to calculate completion.

Among recipients of a qualifying post-positive colonoscopy, therapeutic procedures were explicitly documented for 163/606 in Penglang (26.9%), 31/143 in Zhenchuan (21.7%), 21/93 in Qingyang (22.6%) and 10/25 in Bingxi (40.0%). With same-row method and pathology evidence, the respective proportions were 52.1%, 58.0%, 74.2% and 80.0%. Further examinations with findings were recorded for 37, 6, 3 and 1 residents, respectively (Supplementary Table 9). These differences concern available care records and do not confirm treatment completion.

Penglang household-register coverage

At the end of 2025, the administrative roster contained 14,061 household-registered residents aged 45–75. Of these, 4,244 had completed initial screening during 2023–2025, corresponding to cumulative coverage of 30.2%. For the remaining 9,817 residents, no matching record of completion appeared in the administrative summary. This did not establish that all had declined screening or had never been screened elsewhere. Counts in the separate 2026 column were excluded. This coverage estimate cannot be extended to the other communities or substituted for coverage among the analytical cohort aged 40–74.

Discussion

This hospital–community screening program reached 12,388 age-eligible residents and documented subsequent colonoscopy in 21.7% of those with a dated positive initial screen. Retrieved pathology identified colorectal neoplasia, and later examinations documented continued care for some participants. Penglang's separate household-register comparison estimated cumulative initial-screening coverage at 30.2% by the end of 2025 among residents aged 45–75. This administrative estimate has a different denominator from the 40–74-year analytical cohort.

The overall recorded subsequent-colonoscopy proportion was higher in 2025 than in 2023, whereas the independent first-FIT-positive proportions declined. Community patterns varied. The adjusted 2025-versus-2023 association was statistically significant after Holm correction (P=0.018), but the annual pattern was not a steady increase. Changing referral mix, unequal observation time and differences in report retrieval limit causal interpretation. The observed difference cannot be attributed to screening education. FIT-positive residents without linked examinations merit active record reconciliation.

The Guangzhou community colorectal cancer screening program in 2015–2017 reported colonoscopy uptake of 18.9% among residents with a positive questionnaire or FIT (6). Documented subsequent colonoscopy in this study was 21.7%. Differences in age range, risk tools, payment and report capture preclude conclusions about relative program effectiveness. Referral tracking and outside-report retrieval are needed to clarify care after positive initial screening.

Questionnaire positivity helps describe the referral population. Overall, 3,639/11,622 assessable residents were classified as high risk (31.3%). Penglang's HRFQ positivity was 31.8%, compared with 19.9% (13,912/69,809) in a Guangzhou first-screening cohort (20). Zhenchuan and Bingxi recorded 26.8% and 27.2%, compared with 18.9% (1,453/7,672) in the modified-APCS arm of TARGET-C (21). The studies differed in period, age range and scoring rules. Our cumulative classifications also include any eligible positive result across years. Penglang's 2025 proportion was 21.1%. These are contextual comparisons, not standardized effectiveness contrasts.

Questionnaire-driven referrals formed a large part of the positive-index population, while FIT-positive groups had different subsequent-colonoscopy patterns. A Zhejiang program likewise reported lower colonoscopy participation after questionnaire-high/FIT-negative screening (16.4%) than after FIT-positive/questionnaire-low screening (38.7%) or dual positivity (41.4%) (22). The result combinations, community mix and available observation time may contribute to the pooled estimate. The study does not establish a causal effect of referral type.

Local questionnaire practice also matters. The original APCS score and its modified versions use different predictors or scoring rules, and their performance is not interchangeable (13, 23, 24). We retained the classifications used when residents were screened, including local referral thresholds, to describe actual practice. Partially recorded scores cannot establish that the original classification was wrong. Nor does a high referral proportion establish poor specificity when colonoscopy outcomes are unavailable for most screened residents.

Raising a threshold retrospectively would change the population being evaluated without resolving these uncertainties.

The consortium organized care through a tertiary hospital that coordinated specialist services, community teams that recruited residents and assessed risk, and a shared laboratory that processed FIT specimens. Penglang's endoscopy center and dedicated clinic brought examination and post-screening advice closer to local residents. The pooled proportion of Penglang residents with documented subsequent colonoscopy exceeded those of the other communities, although the proportion fell in 2025 relative to 2024. Residents of the other communities could also use the same center. Differences in recruitment, questionnaire rules and capture of outside examinations therefore limit attribution of the community contrast to the center itself. Educational activities were part of the service, but individual exposure and changes in knowledge were not measured.

Risk perception, other health problems and advice from clinicians may influence whether a person completes colonoscopy after a positive test, as described in qualitative research (25). Our records did not measure these factors or determine whether service capacity constrained access. A randomized trial has shown that patient navigation can improve colonoscopy completion after an abnormal stool test (26). This supports evaluating structured contact and appointment assistance within the family-doctor service, with questionnaire-only and FIT-positive referrals followed separately. Such an evaluation would need to record successful contact, appointments, examinations at outside providers and returned reports.

Timeliness remains clinically important even though this analysis retained examinations more than 180 days after the initial positive result. Observational studies have associated prolonged delay with colorectal cancer and advanced stage at diagnosis, and noncompletion after a positive FIT with colorectal cancer mortality (27, 28). Late examinations are included to describe eventual documented care. Their inclusion does not make the delay acceptable or establish 180 days as a universal clinical cutoff. Our available dates were insufficient to compare fixed-window completion across all participants, and a missing linked report did not establish nonattendance.

More complete bowel-preparation scoring was the clearest annual change in endoscopy quality documentation. Preparation and cecal intubation among assessable examinations did not show corresponding improvement. Current quality recommendations address preparation, complete examination and lesion detection, while observational evidence links endoscopist adenoma detection with subsequent cancer risk (19, 29). We could not assess withdrawal time or endoscopist-level performance. Segment scores were also incomplete, so an adequate BBPS total could not confirm adequate cleansing in every segment (18). Because a normal examination may require no biopsy, pathology availability needs to be interpreted alongside the endoscopic findings.

The additional dates, endoscopic findings and pathology reports documented continued care after the initial examination. They also showed why a surveillance plan must be distinguished from a completed examination. Post-polypectomy recommendations depend on lesion characteristics, examination quality and completeness of removal (17). These details were not consistently available, and the population actually due for surveillance could not be defined. Similarly, a performed procedure or a paired method and pathology entry provides evidence of treatment documentation without establishing cure or treatment of every relevant lesion. Recording the recommendation, responsible team, actual return visit and linked report would make it easier to assess subsequent care, including care delivered outside the screening service.

Penglang plans to invite approximately 2,000 household-registered residents for initial screening each year from 2026 through 2030, using roster comparison, SMS and community notifications to contact those without prior completion. Five rounds would provide approximately 10,000 planned opportunities, close to the 9,817 residents remaining in the 2025 summary. Organized outreach has increased initial-screening participation in a randomized trial, but that evidence does not predict the effect of SMS or community notification alone here (30). Diagnostic colonoscopy would depend on the initial result and clinical indication. The program will need to distinguish invitations from completed questionnaire and FIT, and to update its denominator as residents age, move or participate again. These are prospective service plans, not observed screening or cancer-prevention outcomes.

Several features limit interpretation. Recruitment through existing services yielded a cohort in which nearly two-thirds were women, and community case mix and annual participation differed. All four communities belonged to the same program and shared some referral services. There was no comparison group outside the consortium. Questionnaire type and community could not be separated analytically. Missing FIT classifications and clinical

reports were associated with measured participant characteristics. Unequal observation and incomplete ascertainment of outside care prevented estimation of fixed-window adherence and surveillance completion.

Pathology was unavailable for 384 colonoscopy recipients, and register descriptions did not consistently connect lesion size, histology, specimen site and resection completeness. We therefore did not estimate advanced-adenoma yield, recurrence, cure or mortality benefit. Linkage lacked an external validation sample. Penglang's administrative coverage estimate relied on a distinct local roster and age range. Routine-record ascertainment and unequal observation constrain interpretation.

Conclusions

The First People's Hospital of Kunshan and four community services linked initial colorectal cancer screening with endoscopic diagnosis and subsequent care. Among residents with a dated positive screen, subsequent colonoscopy was documented in 21.7%. The adjusted 2025-versus-2023 association was statistically significant after Holm correction, but annual and FIT-positive patterns differed, and the records do not establish improvements in adherence or treatment outcomes. Cumulative initial-screening coverage in Penglang's separately defined household-registered population was 30.2% by the end of 2025. Priorities are to confirm examinations after a positive FIT and return treatment and surveillance reports to community teams.

Declarations

Ethics approval and consent to participate

The Kunshan colorectal cancer early diagnosis and treatment screening study was approved by the Independent Ethics Committee at the First People's Hospital of Kunshan (2021-03-003-H01, signed 6 May 2021). Subsequent approval documents were 2021-03-003-H01-F01, 2021-03-003-H01-K02 (7 May 2025) and 2021-03-003-H01-K03 (6 May 2026). The principal investigator confirmed that the approval covers all residents aged 40–74 included in this initial-screening analysis, irrespective of questionnaire risk classification. The protocol and consent documents provided for the collection of questionnaire, endoscopy, pathology, treatment and follow-up information. The investigators confirmed that all participants were informed and gave written consent. Signed examples from 2023, 2024 and 2025 were available. Analytical records were pseudonymized, and identifying information was retained locally for linkage. No waiver of consent was claimed.

Consent for publication

Not applicable. No identifiable individual details or patient images are presented.

Data availability

Aggregate results and analytical materials can be made available by the corresponding authors following institutional approval. Individual records contain sensitive health information and are not publicly available.

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Competing interests

The authors declare no competing interests.

Author contributions

Xiaoyang Wu conceived and supervised the study. Tianqing Wu, Sijie Zheng, Xiaoyang Wu and Rongzhu Lu contributed to study design, interpretation and manuscript development. Yueqing Wu, Yuanwei Chen, Yu Zhou, Xiaoyan Liang, Wenyu Wang, Jie Zhao, Junyang Xu, Yanan Dong and Chen Zhou contributed to community

coordination, data collection and verification. Tianqing Wu, Lin Lv and Xiaoyang Wu contributed to data reconciliation and statistical analysis.

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Table 1. Community questionnaires and recorded classification

Community	Instrument	Local high-risk rule	Analysis
Penglang	HRFQ	Specified histories or combinations of factors	Historical recorded classification
Zhenchuan	Five-factor modified APCS	≥4	Historical recorded classification
Qingyang	Five-factor modified APCS	≥3	Historical recorded classification
Bingxi	Five-factor modified APCS	≥4	Historical recorded classification

HRFQ, high-risk factor questionnaire. APCS, Asia-Pacific Colorectal Screening. Modified APCS scores range from 0 to 6 and include age, sex, first-degree family history, smoking and body mass index. Historical classifications were retained without reclassification using local form thresholds. Bingxi contributed records for 2024–2025.

Table 2. Participants and cumulative screening results

Measure	Penglang	Zhenchuan	Qingyang	Bingxi
Residents	5,848	3,443	2,402	695
Men, n (%)	1,772 (30.3)	1,267 (36.8)	993 (41.3)	283 (40.7)
Age, mean (SD)	59.3 (7.2)	61.2 (6.4)	61.2 (7.0)	62.9 (7.1)
Questionnaire high / known (%)	1,833/5,769 (31.8%)	748/2,795 (26.8%)	870/2,368 (36.7%)	188/690 (27.2%)
FIT positive / known (%)	256/3,247 (7.9%)	206/2,918 (7.1%)	185/2,004 (9.2%)	29/663 (4.4%)

Each resident was counted once and assigned to the earliest eligible registration community. Any eligible positive result was retained. Residents whose age could be placed within the eligible interval but not determined exactly were excluded only from age summaries. Community assignment in this table refers to baseline registration and may differ from the community at the positive index screen.

Table 3. Cumulative questionnaire and FIT combinations

Questionnaire	FIT negative	FIT positive	FIT unknown	Total
Not high risk	5,052	329	2,602	7,983
High risk	2,468	262	909	3,639
Unknown	636	85	45	766
Total	8,156	676	3,556	12,388

Unknown results were not classified as negative. 45 residents with neither classification met other initial-screening evidence criteria. Combinations are cumulative and need not represent tests performed on the same day.

Table 4. Colonoscopy recorded after a positive index screen

Index community	Dated positive index	Subsequent colonoscopy	No linked later examination	Percentage (95% CI)
Penglang	2,002	606	1,396	30.3 (28.3–32.3)
Zhenchuan	913	143	770	15.7 (13.4–18.2)
Qingyang	886	93	793	10.5 (8.6–12.7)
Bingxi	199	25	174	12.6 (8.7–17.9)
Overall	4,000	867	3,133	21.7 (20.4–23.0)

CI, confidence interval. Community was assigned at the earliest qualifying dated positive screen and may differ from the baseline registration community. Percentages include examinations beyond 180 days. Absence of a linked examination does not establish nonattendance. Observation time and report retrieval varied.

Table 5. Annual colonoscopy documentation and examination quality

Measure	2023	2024	2025	P
After first any-positive screen	385/1,854 (20.8%)	282/1,394 (20.2%)	200/752 (26.6%)	0.001
After first positive FIT	149/209 (71.3%)	176/285 (61.8%)	61/158 (38.6%)	<0.001
Interval, days; median (IQR)	11 (7–46)	21 (11–33)	15 (9–28.25)	0.001
Cecal status available	338/343 (98.5%)	276/285 (96.8%)	201/219 (91.8%)	<0.001
Cecal intubation / assessable	338/338 (100.0%)	273/276 (98.9%)	199/201 (99.0%)	0.263
BBPS total available	291/343 (84.8%)	272/285 (95.4%)	200/219 (91.3%)	<0.001
BBPS ≥6 / scored	282/291 (96.9%)	264/272 (97.1%)	188/200 (94.0%)	0.332
First-examination pathology available	235/343 (68.5%)	188/285 (66.0%)	151/219 (68.9%)	0.722

Entries are n/N (%) unless stated otherwise. The first two rows use separate person-level definitions of the first positive screen. Intervals are reported for colonoscopy recipients in the any-positive cohorts. Quality indicators are grouped by examination year (343, 285, 219), with 20 examinations in 2026 not shown. The five quality comparisons are Holm-adjusted. Annual outcome and interval tests are unadjusted overall comparisons. BBPS, Boston Bowel Preparation Scale. IQR, interquartile range. Unavailable pathology does not establish inadequate care or absence of disease.

Table 6. Pathology documentation among colonoscopy recipients

Mutually exclusive category	People	Percentage	95% CI
Cancer	14	1.4	0.8–2.3
Adenoma or high-grade dysplasia without recorded cancer	336	33.6	30.8–36.6
Other serrated lesions	5	0.5	0.2–1.2
Other available pathology	260	26.0	23.4–28.8
No available pathology	384	38.4	35.5–41.5

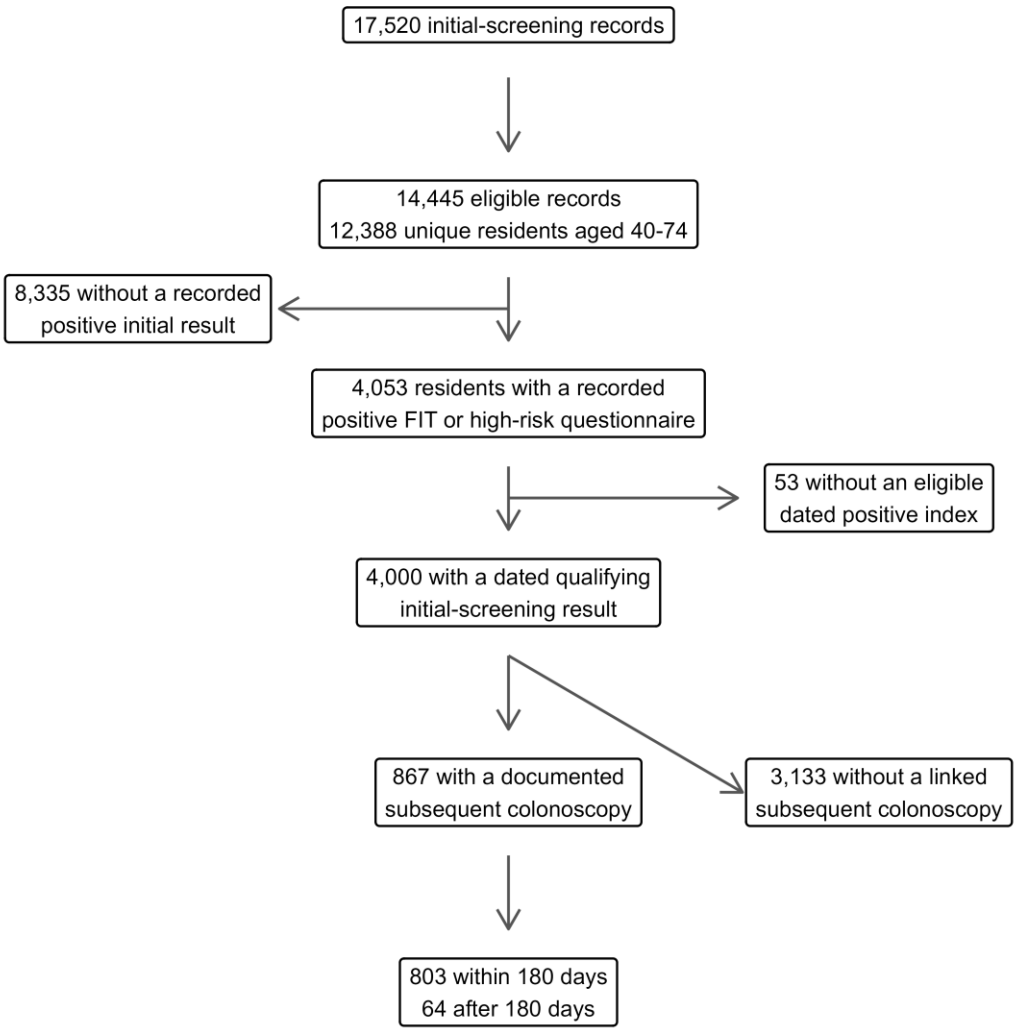
Categories follow the listed hierarchy and sum to 999. The 336 adenoma/high-grade-dysplasia records are not all advanced adenomas. Other pathology includes a discordant diagnostic entry not counted as cancer pending confirmation. The series includes 31 recipients outside the primary cohort. Percentages describe colonoscopy recipients, not disease yield among all screened residents.

Table 7. Intervention and later-examination evidence

Documentation	People	Interpretation
Explicitly performed therapeutic procedure in initial or treatment entries	259	Does not prove all required treatment was completed
Treatment method and pathology recorded together, without explicit confirmation of the procedure	283	No independent specimen-level correspondence
Neither of the above documentation categories	457	Does not establish absence of intervention
Dated later colonoscopy with findings	54	47 had another examination after the first qualifying post-positive colonoscopy
Colorectal pathology at later colonoscopy	30	28 had pathology from an examination after the first qualifying colonoscopy
Later date without findings	5	Not counted as confirmed repeat colonoscopy
Dated nonendoscopic treatment follow-up	1	Reported separately from repeat colonoscopy

The first three categories are mutually exclusive and total 999. People in the later rows may also appear in these categories. Including procedures at later examinations gives 266, 277 and 456 in the three categories. Later examinations may represent reassessment or treatment and do not establish guideline-concordant surveillance. Plans and deferrals are not completed examinations.

Figure 1. Participants and colonoscopy after positive screening



Sequential exclusions were unresolved identity (17), ineligible or indeterminate age (676) and insufficient screening evidence (2,382). No recorded positive result does not imply two negative tests. The 999-person clinical series differs from the 867-person temporal outcome group.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterialEN.docx