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Laparoscopic Versus Open Surgery for Colorectal Cancer in Elderly Asian Patients: A Systematic Review and Meta-Analysis

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Abstract

As populations across Asia age, colorectal cancer (CRC) is increasingly encountered in patients aged 70 years and older, in whom a lifetime of comorbidity has often tipped the balance against major abdominal surgery. Laparoscopic resection reduces surgical trauma, yet its safety and oncological equivalence in the very elderly rest largely on pooled cohorts that mixed Western and Asian patients and rarely reported both short-term morbidity and long-term survival. We therefore assembled the comparative evidence restricted to elderly Asian patients. We searched PubMed (E-utilities, October 25, 2026), Europe PubMed Central, targeted open-access PubMed searches, and Chinese-language gray literature sources for comparative studies of laparoscopic versus open CRC resection in Asian adults aged 70 years or older, with individual study age cut-offs ranging from 70 to 90; because of this threshold heterogeneity, we analyzed age cutoff as a prespecified subgroup. Eligible studies reported at least one perioperative or survival outcome. Dichotomous outcomes were pooled with the DerSimonian-Laird random-effects odds ratio (OR) as the primary analysis, with the Mantel-Haenszel fixed-effect estimate reported as a sensitivity analysis; continuous outcomes by inverse-variance weighted mean difference; survival by log-hazard inverse variance. Every estimate was computed independently in Python and in R and cross-checked. Seven observational studies, totaling 2,145 patients (laparoscopic 971; open 1,174), contributed to the quantitative synthesis; the primary complication pool comprised six studies (1,999 patients). Overall postoperative complications were less frequent after laparoscopic surgery (DerSimonian-Laird random OR: 0.53, 95% confidence interval (CI): 0.36-0.78, p=0.001; I-squared=44.2%; Mantel-Haenszel fixed-effect OR: 0.65, 95% CI: 0.52-0.82, p=0.0003, as sensitivity). The benefit was concentrated in patients aged 80 years or older (OR: 0.40, 95% CI: 0.26-0.62, I-squared=0%; hypothesis-generating, as this subgroup mixes matched with unmatched cohorts) and in studies using Clavien-Dindo-graded definitions (OR: 0.40, 95% CI: 0.23-0.67). Surgical site infection was reduced (OR: 0.42, 95% CI: 0.27-0.67), whereas 30-day mortality (OR: 0.47, 95% CI: 0.18-1.22) and anastomotic leakage (OR: 0.74, 95% CI: 0.29-1.86) did not differ significantly. Length of stay was 2.1 days shorter (95% CI: -3.0 to -1.1), estimated blood loss was 38 mL lower, and first flatus occurred about one day earlier; operative time was 33 minutes longer. Overall survival did not differ between approaches (pooled hazard ratio (HR): 1.01, 95% CI: 0.86-1.19). Small-study asymmetry for the primary outcome was suggested by Egger's test but was underpowered with six studies and is interpreted cautiously. In elderly Asian patients, laparoscopic CRC resection is associated with fewer overall complications and surgical site infections, a shorter hospital stay, and less blood loss, with no detectable compromise of long-term survival. The evidence base is observational, small for the primary outcome (six studies) and heterogeneous, and the apparent benefit in patients aged 80 years or older is exploratory rather than a definitive subgroup effect. Prospective, registry-based studies in Asian octogenarians are needed.

Categories: General Surgery, Oncology, Gastroenterology
Keywords: asia, colorectal cancer, elderly patients, laparoscopic surgery, meta-analysis, octogenarian, open surgery

Introduction And Background

Asia is aging faster and on a larger scale than almost any other region, and colorectal cancer (CRC) is concentrated at the older end of the age distribution. GLOBOCAN 2022 estimated CRC as the third most common cancer worldwide and second in mortality, with the heaviest projected incidence in the high-population nations of East Asia [1]. In clinical practice, this translates into an expanding stream of patients in their seventies, eighties, and beyond presenting with operable disease, several carrying cardiovascular, renal, or pulmonary comorbidity that once made surgeons reluctant to offer curative resection at all. Open laparotomy for CRC in this group carries a well-described burden of wound complications, cardiopulmonary events, prolonged ileus, and extended hospitalization. The laparoscopic approach was expected to blunt that burden, and trials in younger patients established its oncological safety; however, extrapolation to the very elderly has never been straightforward: octogenarians have less physiological reserve, smaller, more friable vessels, and longer anesthesia exposure with pneumoperitoneum. The question of whether laparoscopy genuinely helps rather than merely looks attractive in older patients therefore remains open. Several meta-analyses have addressed laparoscopy versus open surgery in elderly patients with CRC, but each leaves a gap for an Asian surgical readership. Luo et al. pooled matched studies across all age cutoffs from 65 upward and mixed non-Asian cohorts [2]; a Beijing meta-analysis focused on long-term survival in a similarly mixed

population [3]; a Japanese systematic review defined elderly as 65 years and older across 15 global studies [4]; a meta-analysis of octogenarians reached broadly reassuring conclusions but pooled predominantly non-Asian series [5]; a systematic review restricted to patients over 85 years and a pooled analysis of patients over 70 years emphasized short-term recovery without a sustained Asian focus [6,7]. None of these restricted the synthesis to elderly Asian patients while pooling both perioperative morbidity and long-term overall survival. Because surgical training, body habitus, tumor biology, hospital volume, and access to enhanced recovery programs differ between East Asian and Western centers, the magnitude of benefit should be re-estimated on an Asian evidence base. We therefore conducted a systematic review and meta-analysis of comparative studies of laparoscopic versus open CRC resection in Asian adults aged 70 years or older. Our principal endpoint was overall postoperative complication rate; secondary endpoints were 30-day mortality, anastomotic leakage, surgical site infection, major Clavien-Dindo morbidity, operative time, estimated blood loss, length of hospital stay, time to first flatus, and long-term overall survival. The review question, framed as PICO: population, intervention, comparator, and outcome, was: in elderly Asian patients (population) undergoing elective resection for CRC, including a minority of stage-IV cases (outcome context), does laparoscopic surgery (intervention) versus open surgery (comparator) reduce perioperative morbidity without sacrificing survival?

Review

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement throughout [8]. Eligible studies were comparative cohorts or controlled trials of laparoscopic versus open resection for histologically confirmed CRC in Asian patients aged 70 years or older. Because individual studies used cutoffs of 70, 75, 80, and 90 years, we recorded each study's own threshold and analyzed age cutoff as a subgroup variable. Studies had to report at least one extractable perioperative or survival outcome. We excluded case reports, reviews, comparative-effectiveness reports without a direct laparoscopic-versus-open arm, studies conducted outside East Asia, Southeast Asia, or Singapore, and studies in which the two surgical arms could not be separated in the published results.

Search strategy and selection criteria

We searched PubMed through the NCBI E-utilities interface (esearch/esummary/efetch) on October 25, 2026, using the following string: ((colorectal OR colon OR rectal OR “colonic neoplasms”[MeSH] OR colorectal neoplasms[MeSH]) AND (laparoscopy[MeSH] OR laparoscopic OR “minimally invasive”) AND (“open surgery” OR “open resection” OR laparotomy OR “open approach”) AND (elderly OR aged[MeSH] OR octogenarian OR “80 years” OR “75 years” OR “70 years” OR geriatric OR “very elderly” OR “older patients” OR “advanced age”)). This returned 3,429 records; no country term was built into the string so that the Asia restriction could be applied transparently at screening. No publication-date or language restriction was applied; searches covered records from database inception through October 25, 2026. We additionally queried Europe PubMed Central through its REST API for citation chasing and full-text XML (one record), ran a targeted PubMed search of open-access journals in elderly laparoscopic CRC surgery (10 records), and supplemented with Google Scholar-style web searches including Chinese-language gray literature (two leads). The exact Europe PMC REST query, the targeted PubMed query, and the web/gray queries are reproduced in the Appendices. We were unable to search Embase, Scopus, Web of Science, or the Cochrane Central Register of Controlled Trials: no institutional subscription was available, and an attempted CENTRAL query was blocked by the register's robots policy. This restriction is acknowledged as a limitation. Records were deduplicated on PMID first, then DOI, then title plus first author surname and year. After removing the two cross-source duplicates identified above (the Europe PMC record PMID 39006255 and one targeted-PubMed record, both already present in the PubMed main set), 3,440 records were screened. Title/abstract screening and full-text eligibility assessment were performed independently by two reviewers, with disagreements resolved by consensus or by a third reviewer.

Data extraction and quality assessment

Two reviewers independently extracted study design, patient characteristics, operative details, complication counts, and survival estimates into a standardized workbook; disagreements were resolved by a third reviewer. Study quality for the cohort studies entered into the pooled analysis was assessed with the Newcastle-Ottawa Scale (NOS) [9]. NOS was applied to the seven pooled studies using the retrieved full texts; the 18 unretrieved reports could not be formally assessed and were not scored. When a study reported medians with interquartile ranges or ranges rather than means and standard deviations, we converted to mean and standard deviation (SD) using Wan et al.'s formulas: from median and interquartile range, mean = (Q1 + median + Q3)/3 and SD = (Q3 − Q1)/1.35; from median and range in samples up to 70, mean = (minimum + 2×median + maximum)/4 and SD = (maximum − minimum)/4 [10]. One study reported time to first flatus in hours; we divided by 24 to convert to days before pooling.

Statistical analysis

Given the clinical heterogeneity across studies in age cutoffs, outcome definitions, tumor sites, countries, and adjustment methods, dichotomous outcomes were pooled as odds ratios (ORs) using the DerSimonian-

Laird random-effects model as the primary analysis [11]; the Mantel and Haenszel fixed-effect estimate was reported alongside as a sensitivity analysis [12]. Both estimates were given where they diverge materially. Heterogeneity was quantified with I-squared and tau-squared [13]. Continuous outcomes were pooled as weighted mean differences by inverse variance. Time-to-event outcomes were pooled on the log hazard ratio (HR) scale by inverse variance. Where an HR was reported in the opposite direction to our prespecified contrast (laparoscopic versus open), we inverted the ratio and its confidence interval (CI). A study whose survival model did not define the reference group could not be used directionally and was excluded from the survival pool; where a study's direction was internally ambiguous, we ran a sensitivity analysis under both orientations. Prespecified subgroups were age at least 80 versus under 80, propensity-matched or weighted versus unmatched designs, and Clavien-Dindo-graded versus non-graded complication definitions. We assessed robustness with leave-one-out analysis and small-study bias with Egger's regression and Begg's rank correlation [14,15], interpreted cautiously given the small number of studies. For dichotomous estimates in which one or more studies contained a zero-event cell, a continuity correction of 0.5 was added to all four cells of the affected studies before pooling. Because several studies reported zero postoperative deaths and the pooled estimate was dominated by rare events, we additionally report the Peto OR as a sensitivity analysis for 30-day mortality. To guard against computational error, every pooled estimate was calculated twice, independently, with hand-coded Python 3.13 (Python Software Foundation; Wilmington, Delaware, USA (Mantel-Haenszel, Robins-Breslow-Greenland variance; DerSimonian-Laird and inverse-variance weighting) and with R 4.6.1 (R Core Team; R Foundation for Statistical Computing, Vienna, Austria) using the Meta 8.5-0 (Guido Schwarzer; Institute of Medical Biostatistics and Epidemiology, University of Freiburg, Germany) and Metafor 5.0-1 (Wolfgang Viechtbauer; Department of Psychiatry and Neuropsychology, Maastricht University, Maastricht, the Netherlands) packages, and the two implementations agreed to within an absolute difference of 0.02 on all point estimates, CIs, Q, I-squared and tau-squared. Analyses were two-sided; p below 0.05 was considered significant.

Results

The search identified 3,429 PubMed records plus 13 supplementary records (Europe PMC REST n=1; targeted open-access PubMed n=10; web/gray literature n=2). Two cross-source duplicates were removed before screening - the Europe PMC record (PMID 39006255) and one targeted-PubMed record, both already present in the PubMed main set - leaving 3,440 records screened at title and abstract. Of these, 3,411 were excluded as non-comparative, non-CRC, non-Asian, review or meta-analytic records, same-trial duplicates, or unverifiable gray literature leads. Twenty-nine reports were judged potentially eligible. Full text could not be obtained for 18 reports (no legal open-access copy). They were therefore characterized only at the abstract level, were not formally assessed for eligibility, and contributed no data to any pooled estimate; these are listed with citation-level details in Appendices.

Eleven reports were retrieved in full text and assessed; four were excluded at full-text eligibility after overlap checks: Zhengqiang et al. (2023) [16], a redundant re-publication of the Beijing matched cohort; Zhang et al. (2021) [17], a rectal-only subset of the same institution; Chern et al. (2020) [18], a time-nested report of the same Taiwanese registry; and Wei et al. (2018) [19], whose quantitative tables were embedded as images that could not be transcribed. The remaining seven studies contributed to the quantitative synthesis (Figure *1*).

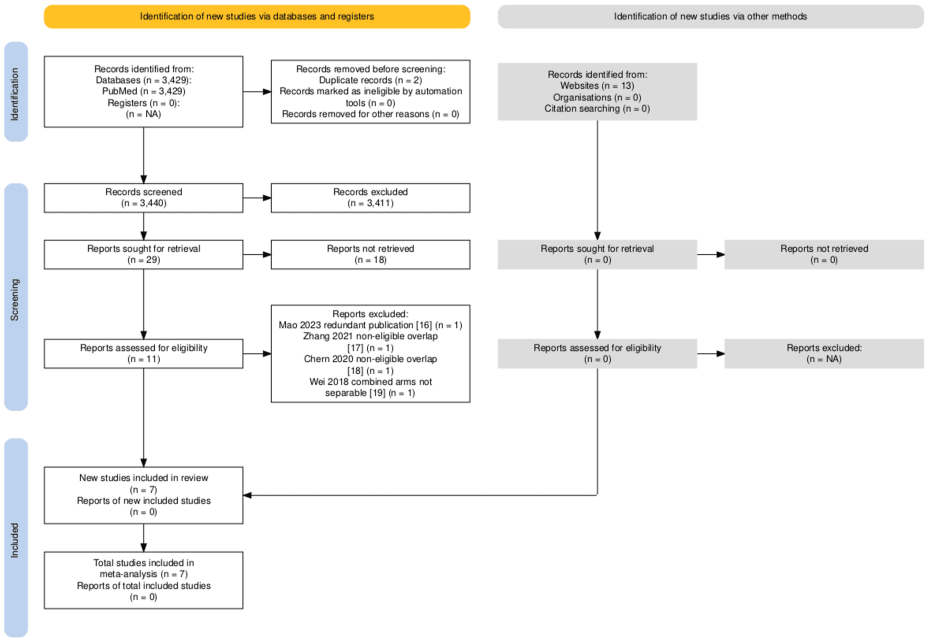


FIGURE 1: PRISMA 2020 flow diagram of study identification, screening, eligibility assessment, and inclusion.

Flow of records through the review. Records were identified via PubMed (n=3,429) and supplementary sources (websites, n=13); 2 duplicate records were removed, leaving 3,440 records screened. Of these, 3,411 were excluded at title/abstract screening. Twenty-nine reports were sought for retrieval, of which 18 were abstract-level only and not retrieved in full text. Eleven full-text reports were assessed for eligibility; four were excluded: Zhengqiang et al. 2023 [16] (redundant publication), Zhang et al. 2021 [17] (non-eligible overlap), Chern et al. 2020 [18] (non-eligible overlap), and Wei et al. 2018 [19] (combined arms not separable). Seven studies were included in the quantitative synthesis.

The seven included studies (Table *1*) enrolled a total of 2,145 patients: 971 after laparoscopic resection and 1,174 after open resection. They were conducted in Korea (Moon et al., 2016) [20], mainland China (Zhou et al., 2019) [21], Li et al. (2023) [22], Wang et al. (2024) [23], Taiwan (Chern et al., 2022) [24], and Japan (Ueda et al., 2020) [25], Yamashita et al. (2024) [26]. Age thresholds were 70 in one study, 75 in two, 80 or over in three, and over 90 in one. Four studies used 1:1 propensity-score matching or propensity-score weighting; three were unmatched cohort comparisons. One study was restricted to rectal cancer. The primary complication endpoint was defined as a generic any-event count in three studies (Moon et al., 2016), Li et al. (2023), Chern et al., 2022), as full-scale Clavien-Dindo all-grade morbidity in one study (Zhou et al., 2019), and as Clavien-Dindo grade II or higher in two studies (Ueda et al., 2020, Yamashita et al., 2024); one study (Wang et al., 2024) did not report an aggregate complication count. Table *2* summarizes per-study event counts and continuous summaries.

Study (year)	Country	Design	Age cutoff	n lap/open	Tumor site	Matching	Primary complication definition
Moon et al. (2016) [20]	Korea	Multicenter retro	≥80	71/71	Colon+rectum	PSM 1:1	Any event requiring treatment within 30 days
Zhou et al. (2019) [21]	China	Single-center retro	>80	93/93	Colon+rectum	PSM 1:1	Full-scale Clavien-Dindo all-grade
Li et al. (2023) [22]	China	Single-center retro	≥70	62/62	Rectum	PSM 1:1	Generic any-event count
Wang et al. (2024) [23]	China	Single-center retro	≥75	91/55	Colon+rectum	None	No aggregate count reported
Chern et al. (2022) [24]	Taiwan	Registry retro	≥75	504/846	Colon+rectum	PS weighting	Generic any-event count
Ueda et al. (2020) [25]	Japan	Single-center retro	≥80	85/25	Colon+rectum	None	Clavien-Dindo ≥2 within 30 days
Yamashita et al. (2024) [26]	Japan	Multicenter retro	>90	65/22	Colon+rectum	None	Clavien-Dindo ≥2 within 30 days

TABLE 1: Characteristics of the seven included studies.

The included studies are cited as follows: Moon et al. (2016) [20], Zhou et al. (2019) [21], Li et al. (2023) [22], Wang et al. (2024) [23], Chern et al. (2022) [24], Ueda et al. (2020) [25], Yamashita et al. (2024) [26].

PSM: propensity-score matching; PS: propensity score; n lap/open: number of patients in laparoscopic/open arms

Study	Complications lap/open	Mortality lap/open	Leak lap/open	SSI lap/open	Op time lap vs open (min)	EBL lap vs open (mL)	LOS lap vs open (d)
Moon et al. (2016) [20]	16/29	0/0	0/0	5/9	182 vs. 130 (median)	100 vs. 100 (median)	9 vs. 10 (median)
Zhou et al. (2019) [21]	10/25	0/0	2/4	1/9	161.2 vs. 149.1	50.9 vs. 108.1	9.6 vs. 12.2
Li et al. (2023) [22]	11/19	0/0	2/1	1/3	204 vs. 192	117 vs. 142	10.25 vs. 11.91
Wang et al. (2024) [23]	NR (categories only)	NR	4/3	4/9	210 vs. 187 (median)	75 vs. 102 (median)	17 vs. 20 (median)
Chern et al. (2022) [24]	82/159	4/16	16/7 (leak/bleed)	14/41	NR	NR	8 vs. 10.5 (median)
Ueda et al. (2020) [25]	12/8	0/0	0/0	NR	249 vs. 223	97 vs. 440 (grams; excluded)	23 vs. 35
Yamashita et al. (2024) [26]	24/11	NR	1/1	3/2	203 vs. 146 (median)	20 vs. 105 (median)	18 vs. 22 (median)

TABLE 2: Per-study outcome data (events/n and continuous summaries).

Outcomes are extracted from Moon et al. (2016) [20], Zhou et al. (2019) [21], Li et al. (2023) [22], Wang et al. (2024) [23], Chern et al. (2022) [24], Ueda et al. (2020) [25], Yamashita et al. (2024) [26].

SSI: surgical-site infection; EBL: estimated blood loss; LOS: length of stay; NR: not reported

The Newcastle-Ottawa scores (NOS) ranged from 6 to 8 of 9 (Table 3). All studies drew representative, well-defined cohorts with objectively ascertained exposure; the principal weaknesses were the absence of an

explicit loss-to-follow-up rate in nearly all studies and, in the unmatched cohorts, limited control of confounding. Overall, postoperative complications were analyzable in six studies (Wang (2024) did not report an aggregate event count). The laparoscopic group fared significantly better: the DerSimonian-Laird random-effects OR was 0.53 (95% CI: 0.36-0.78, p=0.001; I-squared=44.2%), with the Mantel-Haenszel fixed-effect OR of 0.65 (95% CI: 0.52-0.82, z=-3.62, p=0.0003) reported as sensitivity (Figure *2*).

Study	Selection (max. four)	Comparability (max. two)	Outcome assessment	Follow-up length	Follow-up adequacy	Total (/nine)
Moon et al. (2016) [20]	4	2	1	1	0	8
Zhou et al. (2019) [21]	4	2	1	1	0	8
Li et al. (2023) [22]	4	2	1	1	0	8
Wang et al. (2024) [23]	4	0	1	1	0	6
Chern et al. (2022) [24]	4	2	1	0	0	7
Ueda et al. (2020) [25]	4	1	1	1	0	7
Yamashita et al. (2024) [26]	4	1	1	0	0	6

TABLE 3: Newcastle-Ottawa Scale scores for the seven included studies.

Newcastle-Ottawa Scale ratings are reported for Moon et al. (2016) [20], Zhou et al. (2019) [21], Li et al. (2023) [22], Wang et al.(2024) [23], Chern et al. (2022) [24], Ueda et al. (2020) [25], Yamashita et al. (2024) [26].

NOS: Newcastle-Ottawa Scale (total score out of 9)

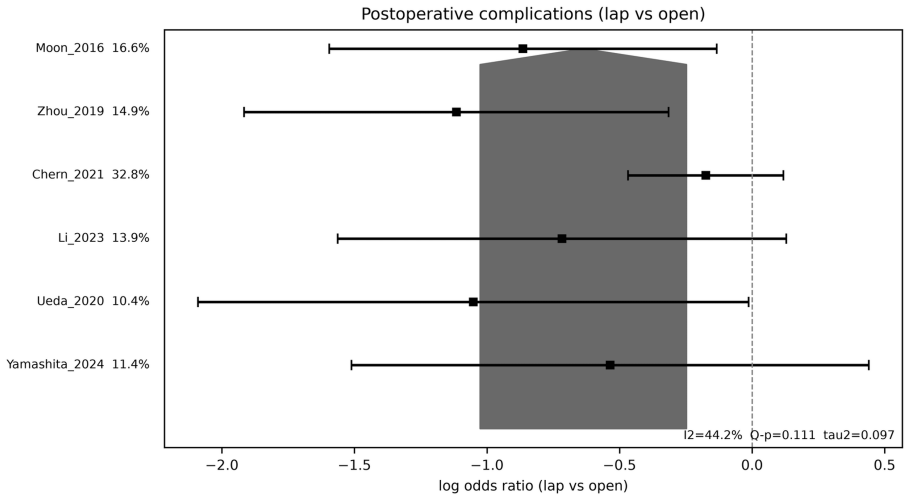


FIGURE 2: Forest plot of overall postoperative complications, laparoscopic versus open.

Mantel-Haenszel fixed-effect odds ratio.

Moon et al. (2016) [20], Zhou et al. (2019) [21], Li et al. (2023) [22], Chern et al. (2022) [24], Ueda et al. (2020) [25], and Yamashita et al. (2024) [26]. Wang et al. (2024) [23] did not report an aggregate event count and were excluded from this pool. Squares represent individual study odds ratios (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical dashed line represents the line of no effect (OR=1).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

CI: confidence interval

Heterogeneity was moderate (Q=8.96, df=5, p=0.111; I-squared=44.2%, 95% CI 0.0-77.9%; tau-squared=0.097), so the fixed-effect estimate is presented as primary; the choice is borderline (Q-p=0.11, just above the 0.10 threshold), and the conclusion is unchanged under the random-effects estimate reported alongside it. The subgroup analysis (Figure *3*) showed the clearest effect in patients aged 80 years or older (OR: 0.40, 95% CI: 0.26-0.62, I-squared=0%; four studies), whereas the under-80 subgroup was not significantly different (OR: 0.79, 95% CI: 0.60-1.04). This 80-plus subgroup combines matched and unmatched octogenarian and nonagenarian cohorts with small open-surgery groups; the apparent magnitude of effect should be read as hypothesis-generating rather than a definitive age-specific effect, and may reflect design differences, selection bias and residual confounding. Matched or weighted studies gave OR: 0.68 (95% CI: 0.53-0.86) and unmatched studies OR: 0.47 (95% CI: 0.23-0.95). Studies using Clavien-Dindo-graded definitions showed a larger effect (OR: 0.40, 95% CI: 0.23-0.67, I-squared=0%) than studies using a broad any-event definition (OR: 0.73, 95% CI: 0.57-0.95). These subgroup contrasts were exploratory, and no formal test of between-subgroup interaction was performed; the CIs overlap, so the apparent gradient should be treated as hypothesis-generating. Leave-one-out analysis moved the pooled random OR only between 0.42 and 0.60, always below 1, indicating the result was not driven by any single study.

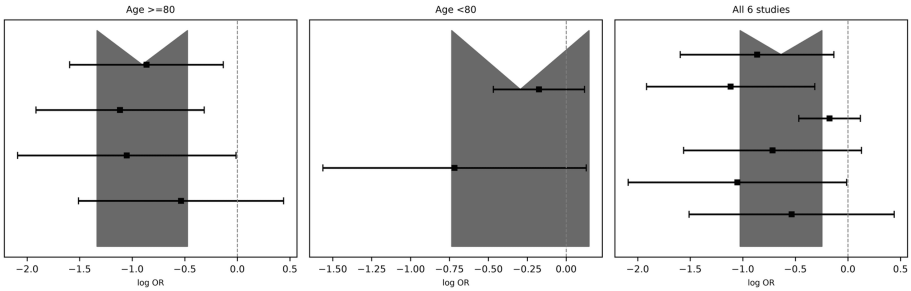


FIGURE 3: Forest plot of subgroup analyses for overall complications.

Subgroup analyses by age stratum, matching design, and outcome definition. Studies as in Figure 2. Squares represent individual study odds ratios (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical dashed line represents the line of no effect (OR=1).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

CI: confidence interval; OR: odds ratio

Thirty-day mortality was low and not significantly different between approaches (fixed OR: 0.47, 95% CI: 0.18-1.22; I-squared=0%; Figure 4).

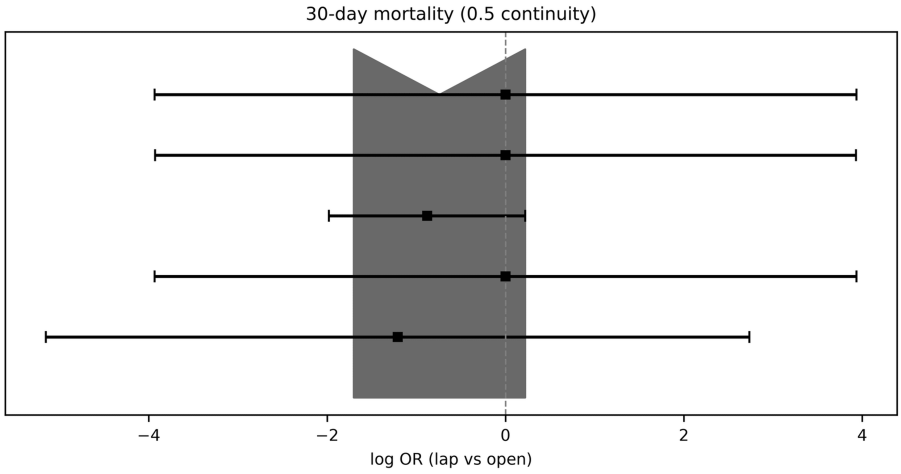


FIGURE 4: Forest plot of 30-day mortality, laparoscopic versus open.

Mantel-Haenszel fixed-effect odds ratio. Studies reporting 30-day mortality. Squares represent individual study odds ratios (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical dashed line represents the line of no effect (OR=1).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

CI: confidence interval; OR: odds ratio

The Peto sensitivity estimate was 0.51 (95% CI: 0.22-1.17). Because four of the five studies reported no deaths, this estimate is essentially driven by the single informative cohort and should be read as imprecise rather than as evidence of equivalence. Anastomotic leakage was similarly non-significant (fixed OR: 0.74, 95% CI: 0.29-1.86, I-squared=0%; Figure 5).

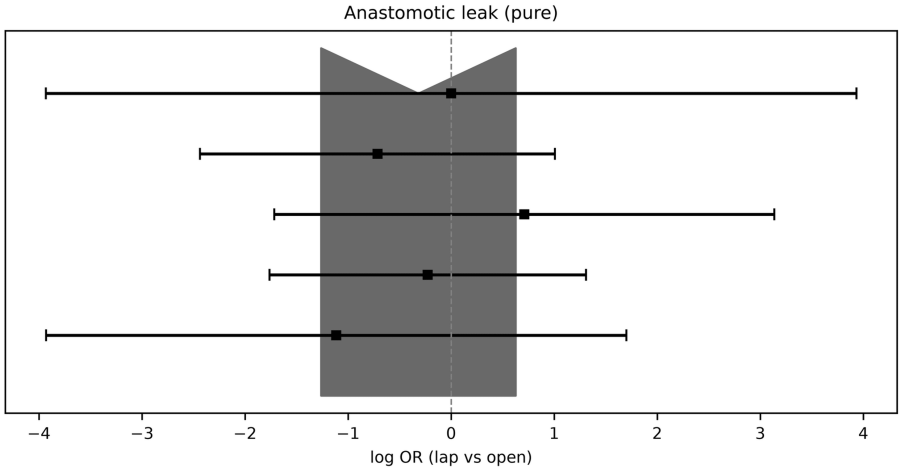


FIGURE 5: Forest plot of anastomotic leakage, laparoscopic versus open.

Mantel-Haenszel odds ratio. Squares represent individual study odds ratios (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical dashed line represents the line of no effect (OR=1).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

CI: confidence interval; OR: odds ratio

The Taiwanese cohort reported only a combined anastomotic-leakage-or-bleeding category (16 laparoscopic vs. 7 open events) and therefore contributed no pure-leak point to the primary pool; adding it as a sensitivity analysis reversed the point estimate (OR: 1.31, 95% CI: 0.52-3.34), showing how sensitive this endpoint is to outcome definition. Surgical site infection was markedly reduced after laparoscopy (fixed OR: 0.42, 95% CI: 0.27-0.67, p<0.001; I-squared=0%; Figure *6*). Two SSI entries used broader definitions (Chern et al., 2022: wound infection or dehiscence; Wang et al., 2024: poor wound healing); excluding Wang et al. (2024) left the estimate essentially unchanged (OR: 0.49, 95% CI: 0.30-0.80). Chern et al. (2022) additionally mixe wound infection with wound dehiscence, which, by CDC/NHSN convention, is a wound complication rather than a surgical-site infection; because the dehiscence events were not separable, this study was retained in the primary SSI pool and its contribution should be read as a wound complication rather than pure infection. True Clavien-Dindo grade III-V morbidity could not be pooled: only two studies reported it, and a third study's “major” category combined leak, intraluminal bleeding and wound dehiscence under a study-specific definition rather than the Clavien-Dindo scale; we therefore present it descriptively only (Zhou et al., 2019: 4/93 vs. 9/93; Chern et al., 2022: 28/504 vs. 46/846).

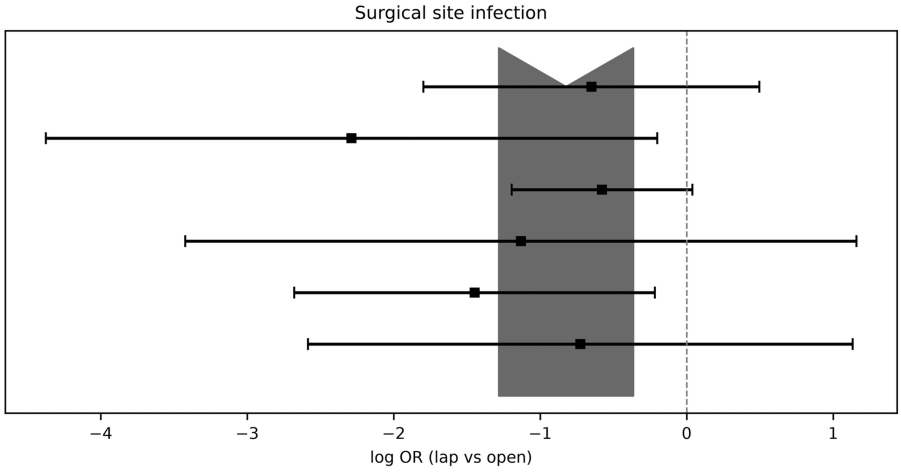


FIGURE 6: Forest plot of surgical-site infection, laparoscopic versus open.

Mantel-Haenszel odds ratio. Squares represent individual study odds ratios (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical dashed line represents the line of no effect (OR=1).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

SSI: surgical-site infection; CI: confidence interval; OR: odds ratio

Figures *7*-*9* summarize operative and recovery outcomes. Laparoscopic procedures took a mean of 33.0 minutes longer (95% CI: 16.1-50.0; I-squared=85.4%, random effects), a difference driven mainly by the Japanese nonagenarian series. After excluding one Japanese study that reported blood loss in grams rather than milliliters, estimated blood loss was a random-effects 38.4 mL lower in the laparoscopic group (95% CI: -53.8 to -22.9; I-squared=53.5%). Hospital stay was 2.06 days shorter (95% CI: -2.99 to -1.13, p<0.001; I-squared=72.3%, random effects). After converting one study's hourly report to days and excluding Wang 2024 (which reported first defecation rather than flatus), time to first flatus was a random-effects 1.12 days earlier (95% CI: -1.67 to -0.56; I-squared=83.1%).

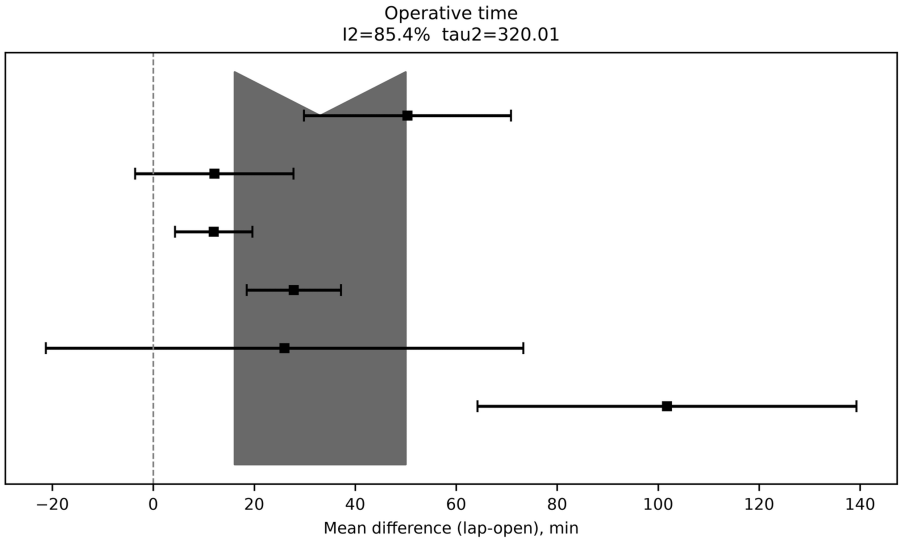


FIGURE 7: Forest plot of operative time, laparoscopic versus open.

Mean difference (minutes), random-effects model. Squares represent individual study mean differences (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical solid line represents the line of no effect (mean difference=0).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

CI: confidence interval

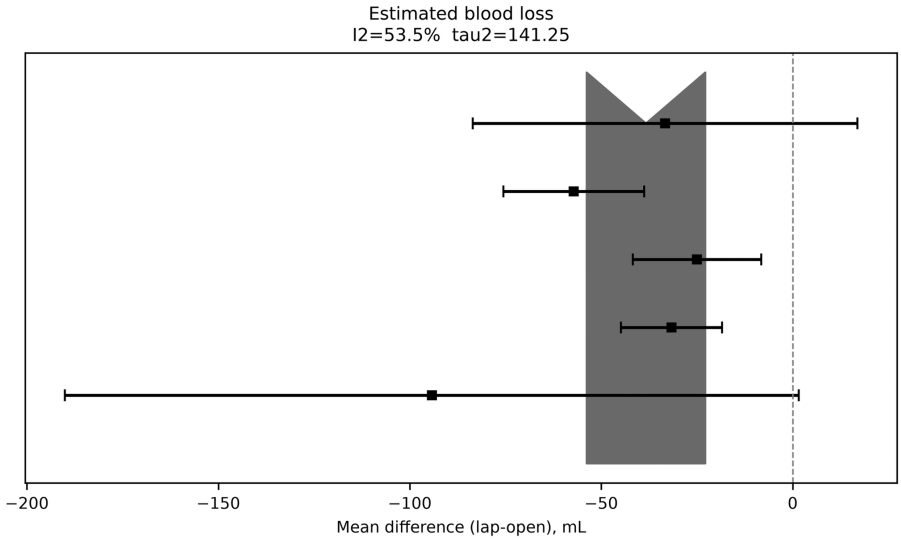


FIGURE 8: Forest plot of estimated blood loss, laparoscopic versus open.

Mean difference (mL), random-effects model. Squares represent individual study mean differences (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical solid line represents the line of no effect (mean difference=0).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

EBL: estimated blood loss; CI: confidence interval

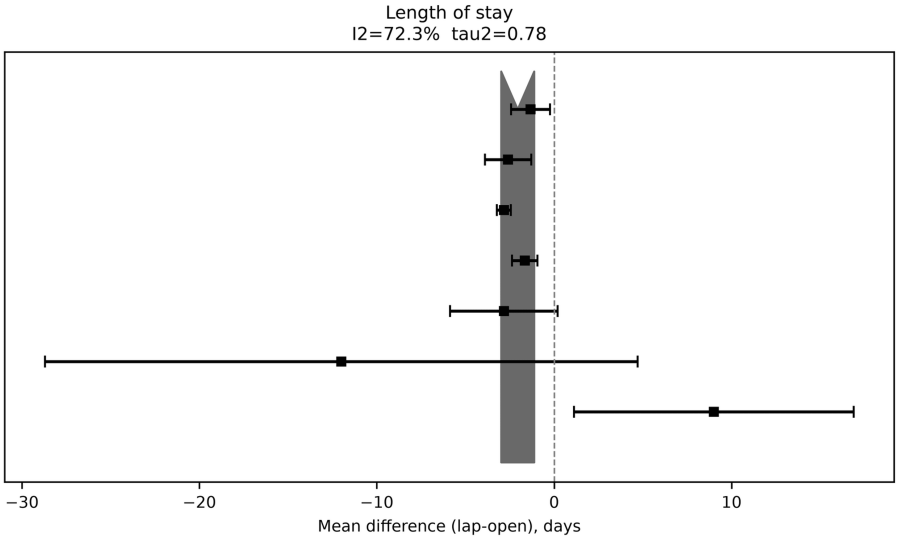


FIGURE 9: Forest plot of length of hospital stay, laparoscopic versus open.

Mean difference (days), random-effects model. Squares represent individual study mean differences (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical solid line represents the line of no effect (mean difference=0).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

LOS: length of stay; CI: confidence interval

Three studies contributed adjusted overall-survival HRs on a common laparoscopic-versus-open orientation, after inverting the one study that had coded the contrast the other way. The pooled HR was 1.04 (fixed, 95% CI: 0.93-1.17) and 1.01 (random, 95% CI: 0.86-1.19), with negligible heterogeneity (I-squared=11.7%; Figure *10*). A sensitivity analysis adopting the reciprocal of the direction-ambiguous Taiwanese hazard ratio gave 0.92 (95% CI: 0.82-1.03, I-squared=0%), again crossing 1. Reported survival proportions differed by follow-up horizon and were not pooled: three-year overall survival was 80.3% versus 74.7% in the Korean series; five-year overall survival was 73.1% versus 63.4% in the Beijing series and 63.5% versus 52.0% in the Japanese octogenarian series, each numerically favoring laparoscopy without reaching significance in the pooled comparison.

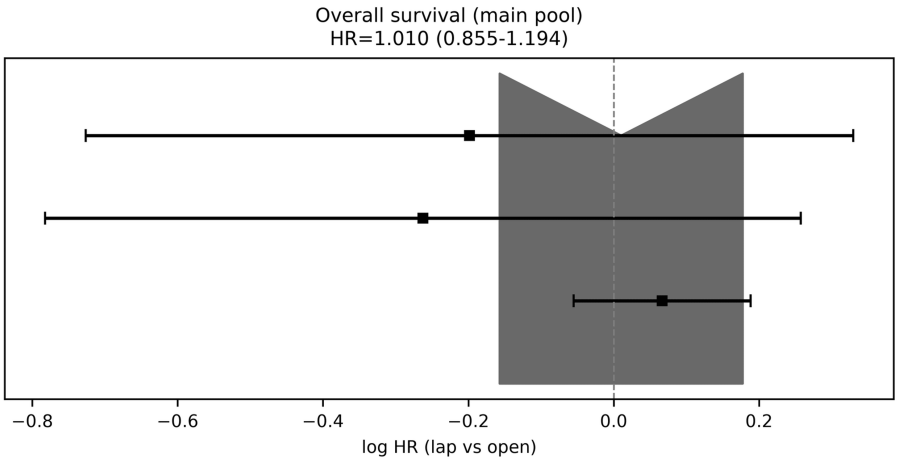


FIGURE 10: Forest plot of overall survival, laparoscopic versus open.

Hazard ratio, inverse-variance random-effects model. Squares represent individual study hazard ratios (size proportional to study weight); horizontal lines represent 95% confidence intervals; the shaded diamond represents the pooled estimate; the vertical dashed line represents the line of no effect (HR=1).

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

CI: confidence interval; HR: hazard ratio

For the primary complication outcome, Egger's regression suggested funnel asymmetry (t=-4.04, p=0.016), whereas Begg's rank test was non-significant (p=0.85) (Figure *11*). With only six studies, this asymmetry estimate is underpowered and fragile, and we do not over-interpret it. For length of stay, neither test reached significance (Egger p=0.35; Begg p=0.88) (Figure *12*).

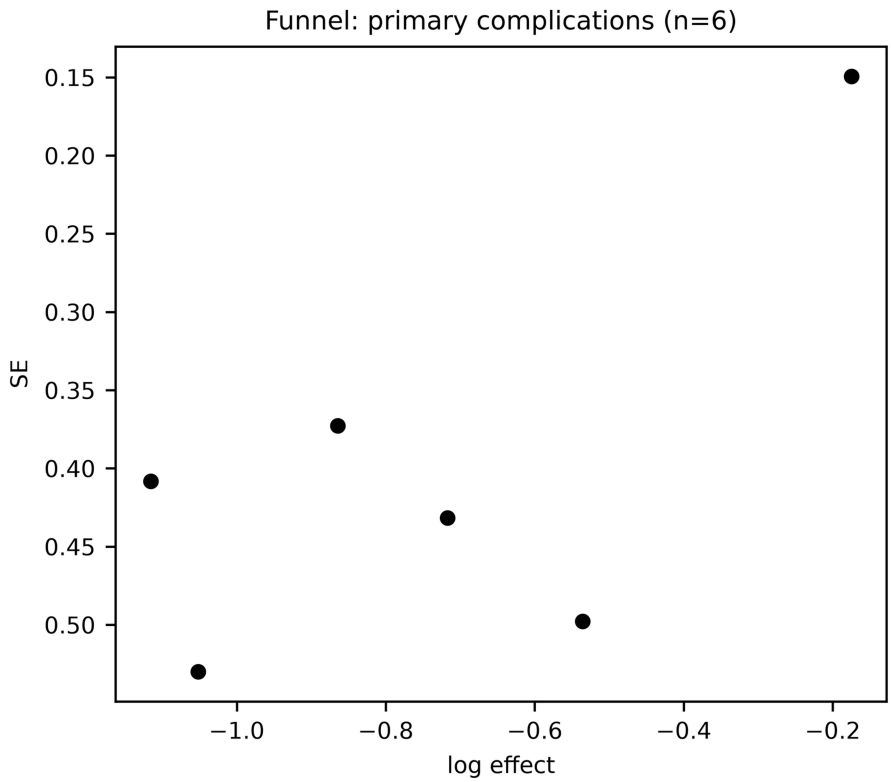


FIGURE 11: Funnel plot for overall postoperative complications.

Egger's regression intercept p=0.016; Begg's rank correlation p=0.85. Underpowered with k = 6 studies.

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

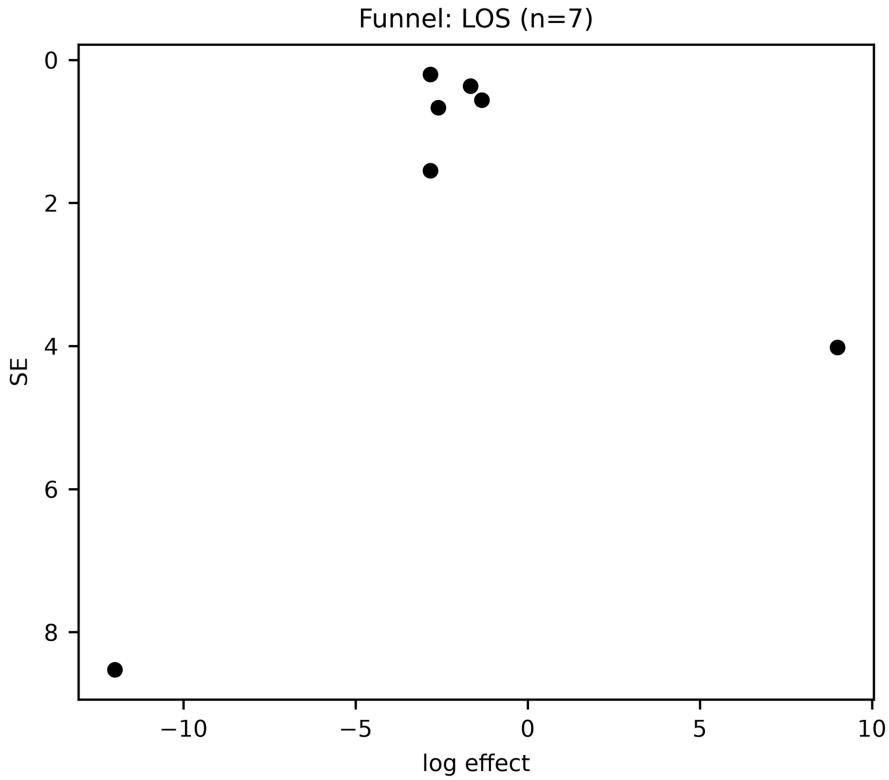


FIGURE 12: Funnel plot for length of hospital stay.

Egger's regression p=0.35; Begg's rank correlation p=0.88.

The figure was generated using R 4.6.1 with the Metafor (version 5.0-1) and Meta (version 8.5-0) packages.

Discussion

Across seven Asian observational studies and more than 2,100 patients, laparoscopic resection for CRC was associated with roughly a third fewer overall postoperative complications and a near-halving of surgical site infections, alongside a two-day shorter hospital stay, less blood loss, and earlier return of bowel function, at the cost of about 33 minutes longer in the operating room. Long-term overall survival was indistinguishable between approaches. These results are directionally consistent with the previous, predominantly non-Asian meta-analyses of elderly CRC surgery [2-7], and with the broader surgical literature showing that minimally invasive resection translates into a shorter, less morbid recovery rather than a survival difference. The new contribution here is that the point estimate is most favorable in Asian patients at least 80 years old, where the pooled OR for complications fell to 0.40; this age-stratified result should be read cautiously rather than as evidence of a stronger treatment effect with age. The ⩾80 subgroup is not design-balanced: it contains the two unmatched Japanese cohorts with very small open arms (Ueda n = 25; Yamashita n = 22, patients aged over 90 years), in whom the open arm is likely enriched for the frailest patients judged unfit for a minimally invasive approach, whereas the under-80 subgroup is dominated by a propensity-matched and a propensity-weighted comparison. The larger point estimate in the very elderly may therefore reflect residual confounding by indication and frailty as much as a true age-dependent benefit, and the nonagenarian series (Yamashita, >90 years) is not physiologically comparable to octogenarians.

Two findings deserve comment. First, a stronger point estimate in the very elderly and in Clavien-Dindo-graded studies is biologically plausible: a large laparotomy incision and prolonged abdominal-wall retraction impose greater physiological stress on elderly patients with thinner skin, diminished pulmonary reserve, and slower tissue repair, which may explain why open surgery carries a higher burden of wound, pulmonary, and infectious complications in this age group. This interpretation is, however, only hypothesis-generating: the subgroup contrasts were underpowered and overlapping and were not formally tested for interaction, and the “graded” subgroup is not a clean major-morbidity contrast because one of its three studies (Zhou, 2019) retained all Clavien-Dindo grades, including minor grade-I events. Second, the null findings for mortality and anastomotic leakage are reassuring rather than disappointing. Both events were rare, and the CIs are consistent with no meaningful difference; the point estimates still favor laparoscopy. The similarly null survival result is the most important reassurance for surgeons contemplating a minimally invasive approach in a patient whose cancer they intend to cure: the recovery advantage is not being bought

at the price of oncological compromise.

Set against the non-Asian meta-analyses cited in the introduction [2-7], the direction and order of magnitude of our pooled estimates are reassuringly consistent: laparoscopy reduces overall complications by roughly a third and surgical site infection by close to a half, with no detectable survival penalty. The novel contribution of this review is not the direction of effect but its magnitude in an Asian elderly population, where body habitus, tumor biology, hospital volume and enhanced-recovery pathways differ systematically from the Western cohorts that dominate earlier syntheses. Two practical points follow. First, the two-day shorter hospital stay and the avoidance of a large laparotomy are likely to matter disproportionately in health systems where inpatient beds are a constrained resource and where early discharge reduces nosocomial complications in patients with reduced reserve. Second, the null survival result, observed across three adjusted analyses with follow-up out to five years, should reassure surgeons who are reluctant to offer a minimally invasive approach to an 80- or 90-year-old: the recovery advantage does not appear to be bought at the price of oncological compromise.

Heterogeneity was substantive for operative time, blood loss, length of stay, and time to flatus, and the random-effects estimates are therefore reported for those outcomes. The drivers are understandable: operative time rose sharply in a Japanese series of patients over 90 years operated by a relatively small open group; blood-loss estimates straddle studies that reported grams rather than milliliters, one of which we excluded; and length of stay reflects very different discharge thresholds between Korean, Chinese, Taiwanese, and Japanese centers. The primary complication and infection outcomes, by contrast, did not show significant residual heterogeneity (although the point estimate of I-squared was moderate and its CI was wide), and the pooled benefit was significant under both fixed- and random-effects models.

The review has several strengths. We worked only from full-text-verified data for the pooled studies, re-extracted independently, and checked every pooled estimate with two independent statistical implementations. We actively hunted overlap between reports. After reading the full texts, we excluded a redundant re-publication (Zhengqiang et al., 2023), which shared the same pre-match sample of 313 patients, the same post-match 93/93 pairs, a numerically identical baseline table, identical complication counts of 10.8% versus 26.9%, and identical Cox HRs of 1.30 (0.76-2.15) for overall survival and 1.41 (0.80-2.47) for disease-free survival as Zhou et al. (2019), together with a rectal-only subset and a time-nested report of the same institutional cohort. We also excluded one study whose quantitative outcomes were embedded in unreadable images rather than risk transcription error. We prespecified subgroups by age threshold, matching design, and outcome definition, which proved informative.

The limitations are real and should be read alongside the point estimates. The review was not registered in PROSPERO; registration was not possible after data collection had begun, and we declare this transparently. We could search only PubMed, Europe PubMed Central, and supplementary open-access and gray literature routes; Embase, Scopus, Web of Science, and the Cochrane register were inaccessible, so some eligible studies may have been missed. Of 29 potentially eligible reports, 18 could not be retrieved in full text and contributed no numeric data; their quality could not be formally rated, and the pooled analysis rests on only seven studies, all observational cohorts. Among the inaccessible reports was the "Eld Lap" conference abstract of a randomized comparison in elderly patients with CRC; because it reported no arm-stratified extractable outcomes and the investigators could not be contacted from the abstract alone, it was not included. We therefore do not claim that no randomized trial met eligibility; rather, no published randomized trial with extractable, arm-stratified perioperative or survival outcomes in elderly Asian patients could be included. Because the inaccessible reports include large propensity-matched and multicenter Asian cohorts, our pooled estimates describe the available evidence rather than the complete evidence base and may shift as these reports become available. Three of the seven used unmatched or poorly adjusted comparisons, and the age thresholds ranged from 70 to over 90 years, which we handled by subgrouping but which limits pooling. One study's survival HR was direction-ambiguous and was tested in sensitivity; another's could not be oriented at all and was excluded. One blood-loss series reported grams rather than milliliters and was excluded from that pool. Small-study bias could not be excluded for the primary outcome (Egger $p = 0.016$), although with six studies the test is underpowered and Begg's test was null. Definitions of mortality (30-day versus in-hospital) and of complications varied between studies. None of the seven studies measured frailty or physiological reserve (for example, the Clinical Frailty Scale); adjustment was limited to age, sex, BMI, comorbidity, ASA grade, and tumor stage. In elderly surgical populations, frailty and reserve are the dominant determinants of who is selected for, and tolerates, a minimally invasive resection, and their omission means residual between-arm confounding cannot be excluded even in the matched cohorts. Conversion to open surgery was reported inconsistently (approximately 7% in the Korean matched series, 1.6% in the Taiwanese weighted cohort, and 1.5% in the Japanese multicenter series), and in the rectal cohort (Li, 2023) patients converted to open were excluded at enrollment rather than analyzed on an intention-to-treat basis; because conversion itself carries added morbidity, excluding conversions from the laparoscopic arm introduces a per-protocol bias that favors laparoscopy, so the pooled estimates should be read as successful-laparoscopy comparisons rather than pure intention-to-treat contrasts. Recruitment spanned 2001-2022 across centers with very different laparoscopic experience and case volume (the Korean matched cohort accrued from 2001), so secular learning-curve and hospital-volume effects are not controlled for and may contribute to the between-study heterogeneity. Pathological oncological adequacy was reported sparsely: lymph-node yield was only partly extractable, and

circumferential and distal margins were not reported across the cohorts. The survival-equivalence conclusion therefore rests on three adjusted HRs rather than on pathological quality metrics. We did not perform a GRADE assessment of certainty. These are cohort data: they support an association, not a randomized causal estimate.

Several practical implications and research gaps follow from these data. On clinical practice, age alone should not be used to deny an otherwise fit elderly patient a minimally invasive resection, but the decision should be made in centers with sufficient laparoscopic volume and an enhanced-recovery program: the 33-minute longer operative time, the small but real conversion rate (1.5-7% across series), and the enrichment of the open arm by the frailest patients all argue for careful preoperative selection rather than blanket offering. In this research, three gaps stand out. First, no study in this pool measured a frailty index (Clinical Frailty Scale, grip strength, gait speed); future cohort and registry work should stratify by frailty rather than by chronological age alone, because the apparent benefit in the >80 subgroup is confounded by design. Second, long-term oncological and patient-reported outcomes - disease-free survival, stoma rate, readmission, return to activities of daily living, and cost - were essentially absent from these reports and should be prespecified in the next generation of Asian elderly CRC studies. Third, conversion predictors and the outcomes of patients who do convert to open laparotomy deserve dedicated analysis, because those patients were excluded at enrollment in one of the seven cohorts and their morbidity is the reason laparoscopic series tend to look favorable.

Conclusions

For elderly Asian patients with operable colorectal cancer, the available observational evidence favors a laparoscopic approach: fewer overall complications and surgical site infections, a shorter hospital stay, less blood loss, and no detectable penalty in long-term survival. The benefit appears most pronounced in patients aged 80 years or older, for whom the avoidance of a large laparotomy is most likely to matter. Age alone should, on this evidence, not be used to withhold a minimally invasive resection from an otherwise fit elderly patient, while acknowledging that operative time is longer and that the underlying evidence is non-randomized. What the field now needs is prospective, multicenter registry data from Asian octogenarians using a standardized Clavien-Dindo grading and a registered protocol, so that the recovery advantage seen here can be confirmed with the certainty a randomized or large-cohort design can provide.

Appendices

Citation	Country	Cutoff	Design/n	Retrieval status/reason
[27] Hinoi et al. Laparoscopic versus open surgery for colorectal cancer in elderly patients: a multicenter matched case-control study. Ann Surg Oncol. 2015;22(6):2040-2050. DOI: 10.1245/s10434-014-4172-x. PMID: 25331007.	Japan	≥80	Multicenter PSM, n=459	Abstract-only; no pooled data
[28] Miguchi et al. Long-term outcomes of laparoscopic surgery in elderly patients with colorectal cancer: a single institutional matched case-control study. Asian J Endosc Surg. 2021;14(2):200-206. DOI: 10.1111/ases.12848. PMID: 33244892.	Japan	≥80	Single-center PSM, 48 pairs	Abstract-only; no pooled data
[29] Miguchi et al. Short-term outcomes of laparoscopic surgery in octogenarians with colorectal cancer: a single-institution analysis. Surg Today. 2018;48(3):292-299. DOI: 10.1007/s00595-017-1584-9. PMID: 28948374.	Japan	≥80	Single-center PSM, 52v52	Abstract-only; no pooled data
[30] Son et al. Clinical and oncologic outcomes of laparoscopic versus open surgery in elderly patients with colorectal cancer: a retrospective multicenter study. Int J Clin Oncol. 2021;26(12):2237-2245. DOI: 10.1007/s10147-021-02009-4. PMID: 34453641.	Korea	≥80	Multicenter retro, n=294	Abstract-only; no pooled data
[31] Chok et al. Clinical outcomes and cost comparison of laparoscopic versus open surgery in elderly colorectal cancer patients over 80 years. Int J Colorectal Dis. 2023;38(1):160. DOI: 10.1007/s00384-023-04459-w. PMID: 37278975.	Singapore	>80	NSQIP retro cohort	Abstract-only; no pooled data
[32] Koh et al. Laparoscopic colorectal surgery is safe and benefits octogenarian patients with malignant disease: a matched case-control study comparing laparoscopic and open colorectal surgery. Int J Colorectal Dis. 2015;30(7):963-968. DOI: 10.1007/s00384-015-2252-4. PMID: 26003115.	Singapore	≥80	Matched case-control, 36v36	Abstract-only; no pooled data

[33] Shigeta et al. Effects of laparoscopic surgery on the patterns of death in elderly colorectal cancer patients: competing risk analysis compared with open surgery. Surg Today. 2016;46(4):422-429. DOI: 10.1007/s00595-015-1171-x. PMID: 25904559.	Japan	≥80	Retro cohort, n=107	Abstract-only; no pooled data
[34] Nishikawa et al. Short-term outcomes of open versus laparoscopic surgery in elderly patients with colorectal cancer. Surg Endosc. 2016;30(12):5550-5557. DOI: 10.1007/s00464-016-4921-y. PMID: 27752818.	Japan	≥80	Retro cohort, n=150	Abstract-only; no pooled data
[35] Wang et al. Safety and efficacy of laparoscopic surgery versus open surgery in elderly patients with colon cancer: a propensity score matching cohort study. Dig Surg. 2022;39(5-6):255-262. DOI: 10.1159/000529223. PMID: 36696894.	China	≥75	PSM, 85v98	Abstract-only; no pooled data
[36] Fujii et al. Long-term results of a randomized study comparing open surgery and laparoscopic surgery in elderly colorectal cancer patients (Eld Lap study). Surg Endosc. 2021;35(10):5686-5697. DOI: 10.1007/s00464-020-08026-0. PMID: 32989541.	Japan	≥75	RCT, n=190	Abstract-only; no pooled data
[37] Horie et al. Laparoscopic versus open colectomy for elderly patients with colon cancer: a propensity score analysis with the CONUT score. Nutr Cancer. 2021;73(2):246-251. DOI: 10.1080/01635581.2020.1743868. PMID: 32252556.	Japan	≥75	PSM colon, n=424	Abstract-only; no pooled data
[38] Zeng et al. Outcome of laparoscopic versus open resection for rectal cancer in elderly patients. J Surg Res. 2015;193(2):613-618. DOI: 10.1016/j.jss.2014.08.012. PMID: 25214259.	China	>=70	Retro rectal, n=294	Abstract-only; no pooled data
[39] Tan et al. Evaluation of laparoscopic versus open colorectal surgery in elderly patients more than 70 years old: an evaluation of 727 patients. Int J Colorectal Dis. 2012;27(6):773-780. DOI: 10.1007/s00384-011-1375-5. PMID: 22134483.	Singapore	≥70	Prospective DB retro, n=727	Abstract-only; no pooled data
[40] Tei et al. Postoperative complications in elderly patients with colorectal cancer: comparison of open and laparoscopic surgical procedures. Surg Laparosc Endosc Percutan Tech. 2009;19(6):488-492. DOI: 10.1097/SLE.0b013e3181bd9562. PMID: 20027093.	Japan	≥71	Retro cohort, n=129	Abstract-only; no pooled data
[41] Huang et al. Comparison of postoperative acute kidney injury between laparoscopic and laparotomy procedures in elderly patients undergoing colorectal surgery. Surg Laparosc Endosc Percutan Tech. 2020;31(2):160-164. DOI: 10.1097/SLE.0000000000000858. PMID: 32890248.	China	≥65	PSM, n=285	Abstract-only; no pooled data
[42] Yoshimatsu et al. Laparoscopic surgery reduces risk of postoperative complications and non cancer-related survival in patients over 80 years old with colorectal cancer. Cancer Diagn Progn. 2021;1(4):297-301. DOI: 10.21873/cdp.10039. PMID: 35403147.	Japan	>80	Retro cohort, n=85	Abstract-only; no pooled data
[43] Takahashi et al. Laparoscopic surgery is acceptable for elderly patients with colorectal cancer: a propensity score-matched study. Anticancer Res. 2021;41(5):2611-2615. DOI: 10.21873/anticanres.15041. PMID: 33952491.	Japan	≥80	PSM, 76v76	Abstract-only; no pooled data
[44] Chern et al. The dark side of laparoscopic surgery for colorectal cancer patients aged 75 years or older. Int J Colorectal Dis. 2018;33(10):1367-1371. DOI: 10.1007/s00384-018-3130-7. PMID: 30008115.	Taiwan	≥75	Retro cohort	Abstract-only; no pooled data
[16] Zhengqiang et al. Short-term outcomes and long-term survival outcomes of elderly patients (over 80 years of age) with colorectal cancer who received laparoscopic versus open surgery. Cancer Res Prev Treat. 2023;50(11):1121-1126. DOI:	China	>80	PSM 93/93 (n=313 pre-match)	EXCLUDED: redundant re-publication of Zhou 2019 cohort (identical n=313, 93/93, baseline, complication counts 10.8% vs 26.9%, Cox HR 1.30 [0.76-2.15] /

10.3971/j.issn.1000-8578.2023.23.0633.				DFS 1.41 [0.80-2.47])
[17] Zhang et al. Outcomes of laparoscopic versus open surgery in elderly patients with rectal cancer. Asian Pac J Cancer Prev. 2021;22(4):1325-1329. DOI: 10.31557/APJCP.2021.22.4.1325. PMID: 33906329.	China	≥80	Retro rectal, 45/39	EXCLUDED: rectal-only subset of Zhou 2019
[18] Chern et al. Advantage of laparoscopy surgery for elderly colorectal cancer patients without compromising oncologic outcome. BMC Surg. 2020;20(1):294. DOI: 10.1186/s12893-020-00967-6. PMID: 33228630.	Taiwan	≥75	Retro, 305/662	EXCLUDED: nested report of the same Chang Gung Memorial Hospital Colorectal Section Tumor Registry (IRB 201801090B0); the 967-patient cohort (2009-2015) is a strict time-subset of Chern 2022's 1,350-patient propensity-score-weighted cohort (2009-2017)
[19] Wei et al. Outcomes of open, laparoscopic, and hand-assisted laparoscopic surgeries in elderly patients with right colon cancers: a case-control study. Medicine (Baltimore). 2018;97(35):e11907. DOI: 10.1097/MD.0000000000011907. PMID: 30170384.	China	≥70	Case-control, right colon	EXCLUDED: image-only quantitative tables

TABLE 4: Eligible reports not retrieved in full text (abstract-level only) and reports excluded at full-text eligibility.

Abstract-level reports (n=18) were cited as [27]-[44] and could not be retrieved in full text. Four full-text reports were excluded: Zhengqiang et al. (2023) [16], Zhang et al. (2021) [17], Chern et al. (2020) [18], Wei et al. (2018) [19].

PSM: propensity-score matching; retro: retrospective; RCT: randomized controlled trial

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Ali Raza, Chunyuan Liu

Acquisition, analysis, or interpretation of data: Ali Raza, Chunyuan Liu

Drafting of the manuscript: Ali Raza

Critical review of the manuscript for important intellectual content: Ali Raza, Chunyuan Liu

Supervision: Ali Raza

Disclosures

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024, 74:229-263. 10.3322/caac.21834

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