Systematic Review and Meta-Analysis

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Transcutaneous electrical acupoint stimulation for the recovery of postoperative gastrointestinal function in patients with colorectal cancer

A systematic review and meta-analysis

Yanan Li, MD[a], Xiaona Xu, MD[b], Yiheng Chen, MD[a], Wenchao Li, MM[c], Nan Zhang, PhD[a], Rui Zhang, PhD[a], Erping Xu, PhD[a,*]

Abstract

Background: This systematic review and meta-analysis aimed to assess whether transcutaneous electrical acupoint stimulation (TEAS) assists in the recovery of gastrointestinal function after colorectal cancer surgery.

Methods: A comprehensive search for randomized controlled trials from inception to June 10th, 2025, was performed using the following databases: PubMed, Cochrane Library (CENTRAL), Excerpta Medica Database, China National Knowledge Infrastructure, VIP Database for Chinese Technical Periodicals, WanFang Database, and China Biomedical Literature. We assessed the risk of bias in the included studies using the Cochrane risk-of-bias tool. RevMan5.4.1 software was used to perform the meta-analysis. Sensitivity analysis, Begg test, and Egger test were conducted using Stata12.0.

Results: Twenty-four eligible articles involving 2409 participants were included in the meta-analysis. Our analysis found that TEAS significantly reduced the time to first defecation (mean difference [MD] = –15.74, 95% confidence intervals [CI]: –20.49 to –10.99, P <.001), time to first flatus (MD = –13.39, 95% CI: –16.28 to –10.50, P < .001), time to first bowel movement (MD = –11.12, 95% CI: –13.94 to –8.30, P <.001), time of postoperative feeding (MD = –11.91, 95% CI: –17.62 to –6.21, P <.001), the incidence of postoperative nausea and vomiting (risk ratio: 0.40, 95% CI: 0.31–0.52, P < .001). Sensitivity analysis indicated that the results remained constant after the exclusion of any individual study. Funnel plots and Egger tests revealed no significant publication bias.

Conclusion: TEAS can assist in the recovery of gastrointestinal function after colorectal cancer surgery.

Abbreviations: 95% CI = 95% confidence interval, CRC = colorectal cancer, MD = mean difference, TEAS = transcutaneous electrical acupoint stimulation.

Keywords: colorectal cancer, meta-analysis, postoperative gastrointestinal function, systematic review, transcutaneous electrical acupoint stimulation

1. Introduction

Colorectal cancer (CRC) is one of the leading causes of cancer-related deaths worldwide.[1] Surgery is the baseline treatment for curative intent treatment in CRC.[2] However, patients may develop gastrointestinal dysfunction presenting with a variety of symptoms such as delayed flatus and defecation, nausea, vomiting and intolerance to an oral diet due to the impact of intestinal reconstruction during surgery, intestinal pulling, anesthetic drugs, and postoperative pain. Delayed recovery of gastrointestinal function is one of the most common complications after abdominal surgery, including colorectal cancer surgery, which lengthens hospital stay and places strain on the healthcare system.[3,4]

Complementary and integrative medicine, which encompasses many diverse therapies including acupuncture, has been used for improving health-related quality of life in patients with cancer.[5] Over the past decade, an increasing number of studies on the use of acupuncture in perioperative medicine have concentrated on the rehabilitation of postoperative gastrointestinal function.[6] A meta-analysis found low- to moderate-quality evidence of acupuncture after surgery in colorectal cancer.[7]

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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[a] School of Traditional Chinese Medicine (Zhongjing College), Henan University of Traditional Chinese Medicine, Zhengzhou, China, [b] International Education College, Henan University of Traditional Chinese Medicine, Zhengzhou, China, [c] Kezhou Housing and Urban Rural Development Bureau, Kezhou, China.

** Correspondence: Erping Xu, School of Traditional Chinese Medicine (Zhongjing College), Henan University of Traditional Chinese Medicine, 156 Jinshui East Road, Zhengzhou 450018, Henan, China (e-mail: xuerping@hactcm.edu.cn).*

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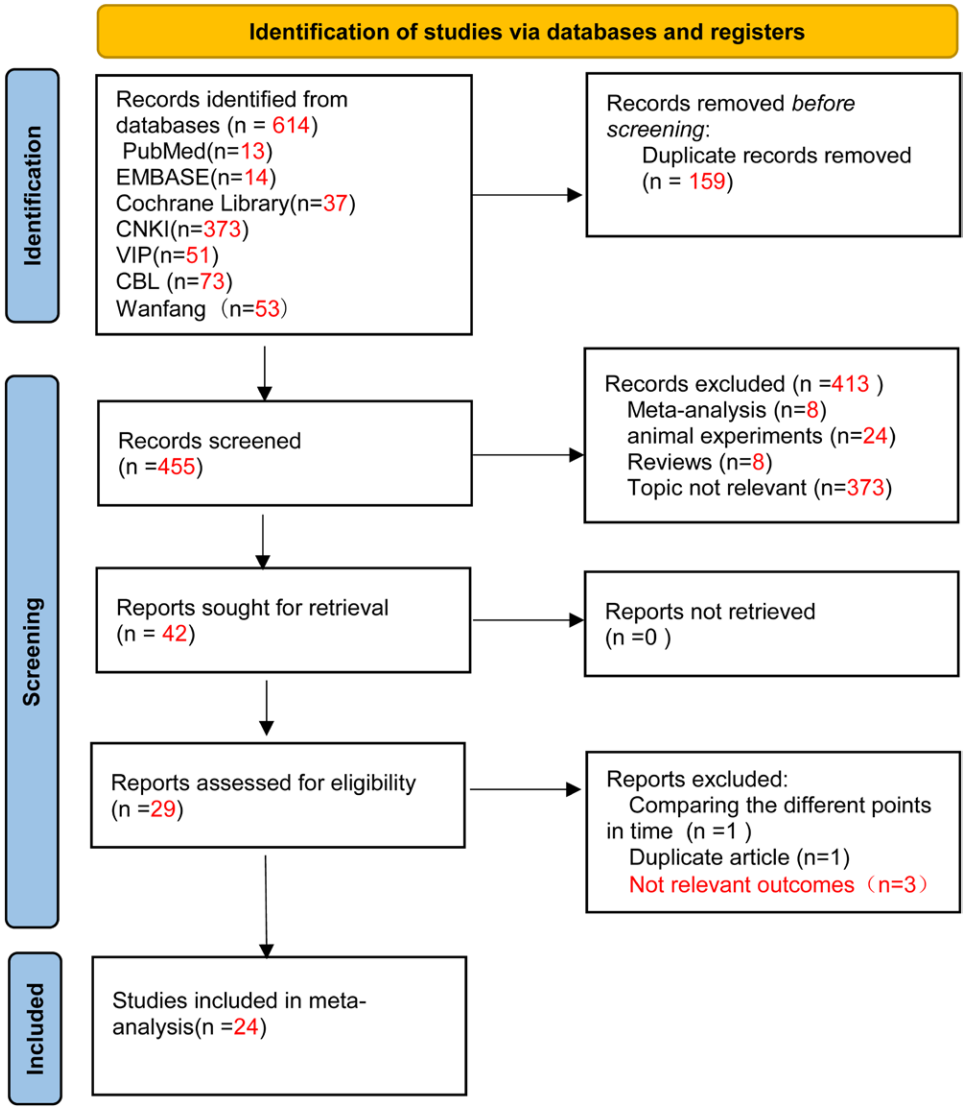

Figure 1. Flow chart of study identification and selection.

Another study concluded that interventions which included electroacupuncture provided the best evidence in improving gastrointestinal function after colorectal cancer surgery.[4] Transcutaneous electrical acupoint stimulation (TEAS), which stimulates specific acupoints with electrical currents of different frequencies and intensities through electrode pads attached to the acupoints, is an effective clinical treatment technique.[8] Compared to conventional acupuncture or electroacupuncture, TEAS is easy to perform and has no associated risk of infection, contamination, bleeding, patients' psychological dread, or operator bias.[9] A recent meta-analysis revealed that TEAS could be a non-pharmacological treatment for postoperative gastrointestinal dysfunction in patients after gastrointestinal surgery.[10] To date, there have been no comprehensive reviews evaluating the effectiveness of TEAS in enhancing postoperative gastrointestinal function in patients after CRC surgery. This meta-analysis aimed to assess whether TEAS facilitates the recovery of gastrointestinal function after surgery for CRC.

2. Methods

Our findings were reported according to the Preferred Reporting of Systematic Reviews and Meta-Analyses Guidelines and the study protocol was registered in the PROSPERO database (No. CRD42022383798). No ethical approval was necessary prior to this study because it was a meta-analysis.

2.1. Search strategy

Seven databases, including PubMed, Excerpta Medica Database, Cochrane Library, China National Knowledge Infrastructure, Wanfang Database, VIP Database for Chinese Technical Periodicals, and China Biomedical Literature were searched from their inception to June 10th, 2025 in English or Chinese. Databases were searched by combining Medical Subject Headings and free-text terms. The Medical Subject Headings or key terms and their abbreviation or derivatives were utilized, taking PubMed searching strategy for example: ("colorectal neoplasms" OR "colonic neoplasms" OR "rectal neoplasms" OR "colon cancer" OR "colorectal cancer" OR "colorectal carcinoma" OR "carcinoma of colon" OR "rectal cancer" OR "rectal carcinoma" OR "cancer colon" OR "cancers colon" OR "colon cancers" OR "carcinoma of the rectum" OR "intestinal cancer") AND ("transcutaneous electrical acupoint stimulation" OR "TEAS"). The detailed search strategy used for PubMed is presented in Table S1, Supplemental Digital Content, https://links.lww.com/MD/P592. Relevant reference articles were manually searched to avoid potential omissions.

Table 1

Characteristic of the include studies.

First author, year	Cancer type	Type of surgery	Sample size (E/C)	Outcomes*
Fan, 2018[11]	Colorectal cancer	Laparoscopy	52 (26/26)	1, 5
Huang, 2018[12]	Colorectal cancer	Laparoscopy	67 (32/35)	1, 4, 5, 6
Huang, 2019[8]	Colorectal cancer	Laparoscopy	57 (29/28)	1, 4, 6
Wei, 2019[13]	Colorectal cancer	Laparoscopy	104 (52/52)	1, 2, 3
Huang, 2019[14]	Rectal cancer	Laparoscopy	92 (46/46)	1, 2, 3
Feng, 2020[15]	Colorectal cancer	Laparoscopy	60 (28/32)	1, 4, 5
Li, 2020[16]	Rectal cancer	Laparoscopy	169 (85/84)	1, 3, 4
Zhang, 2020[17]	Colorectal cancer	Open	90 (45/45)	1, 3, 4, 5
Cai, 2020[18]	Colorectal cancer	Laparoscopy	49 (24/25)	1, 5
Yue, 2021[19]	Colorectal cancer	Laparoscopy	80 (40/40)	1, 5
Li, 2021[20]	Colorectal cancer	Laparoscopy	65 (33/32)	1, 2, 4, 5
Wang, 2021[21]	Colorectal cancer	Laparoscopy	68 (34/34)	1, 2, 4
Gao, 2021[9]	Colorectal cancer	Not specified (open or Laparoscopy)	610 (303/307)	1, 2, 3, 4
Chen, 2021[22]	Colorectal cancer	Open	72 (36/36)	1, 2, 3, 4, 5
Xu, 2021[23]	Colorectal cancer	Laparoscopy	72 (36/36)	1, 2, 3, 5
Cai, 2021[24]	Rectal cancer	Laparoscopy	94 (47/47)	1
Cai, 2021[25]	Rectal cancer	Laparoscopy	96 (64/32)	1, 2, 3, 5
Fu, 2022[26]	Colorectal cancer	Laparoscopy	46 (25/21)	1, 5
Jia, 2022[27]	Colon cancer	Laparoscopy	90 (45/45)	1
Jiang, 2023[28]	Colorectal cancer	Laparoscopy	86 (42/44)	5
Li, 2023[29]	Colorectal cancer	Laparoscopy	95 (48/47)	1, 2
Gao, 2024[30]	Colorectal cancer	Laparoscopy	70 (35/35)	1, 2, 5
Li, 2024[31]	Colorectal cancer	Laparoscopy	60 (30/30)	1, 2, 5
Li, 2025[32]	Colorectal cancer	Laparoscopy	65 (33/32)	1, 2, 4

C = control group, E = experimental group.

*1: time to first flatus, 2: time to first defecation, 3: time to first bowel movement, 4: postoperative feeding time, 5: incidence of postoperative nausea and vomiting.

Table 2

Details of interventions.

First author, year	Time point	Frequency	Acupoints
Fan, 2018[11]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz, 3–8 mA	P6, L14, ST36, ST37, ST39
Huang, 2018[12]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz, intensity of tolerable level.	ST36
Huang, 2019[8]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/10 Hz, intensity of tolerable level	ST36
Wei, 2019[13]	The first day after surgery until the anus resumes defecation and bowel movement.	2 times a day, 30 min each time, 20 Hz, intensity of tolerable level	L14, LI11, ST36, ST44
Huang, 2019[14]	30 min before induction	8–12 mA, intensity of tolerable level	DU20, P6, ST36, SP6
Feng, 2020[15]	3 d before operation	3 mA, for the patient's comfort situation	P6, ST36
Li, 2020[16]	30 min before induction until the end of surgery, and 3 d after surgery	Dense-disperse frequency, 2/100 Hz, 6–8 mA	L14, P6, ST36, SP6
Zhang, 2020[17]	After extubation and 3 d after operation	Dense-disperse frequency, 2/100 Hz, 10–25 mA	ST36, ST37, SP6
Cai, 2020[18]	30 min before surgery as well as 2 d after surgery	Dense-disperse frequency, 2/15 Hz, 10–25 mA, intensity of tolerable level	ST36, P6
Yue, 2021[19]	30 min before induction until the end of surgery	Intensity of tolerable level	ST36, L14, P6
Li, 2021[20]	1 d before operation, 30 min before induction, 3 d after operation	Dense-disperse frequency, 2/10 Hz, intensity of tolerable level	P6, L14, ST36, ST37, ST39, SP6
Wang, 2021[21]	6 h postoperatively and 3 d after surgery	Dense-disperse frequency, 2/100 Hz, 10–15 mA	ST36, L14, P6
Gao, 2021[9]	3 d after surgery	2/15 Hz, 13–14 mA	ST36, ST37, SP6
Chen, 2021[22]	30 min before surgery until 30 min after surgery, and 2 d after surgery	Dense-disperse frequency, 2/100 Hz, 8–12 mA	ST36, P6
Xu, 2021[23]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz, 8–12 mA	ST36, ST37, DU20, L14, P6
Cai, 2021[24]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz, 8–12 mA	P6, L14, ST36
Cai, 2021[25]	30 min before induction in group A, 30 min before induction until the end of the surgery in group B	Dense-disperse frequency, 2/100 Hz, intensity of tolerable level.	ST36, P6
Fu, 2022[26]	30 min before induction	Dense-disperse frequency, 2/100 Hz, intensity of tolerable level.	ST36, SP6
Jia, 2022[27]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz, intensity of tolerable level.	ST36, L14, P6
Jiang, 2023[28]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz	ST36, P6, L14, SP6
Li, 2023[29]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz	ST36, P6, L14, SP6
Gao, 2024[30]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/100 Hz	ST36, P6, L14, LI11
Li, 2024[31]	3 d after operation	2/100 Hz	ST36, P6, L14, SP6
Li, 2025[32]	30 min before induction until the end of surgery	Dense-disperse frequency, 2/10 Hz	LI4, P6, ST36, ST37, ST39, SP6

Neiguan, P6; Hegu, L14; Zusanli, ST36; Shangjuxu, ST37; Xiajuxu, ST39; Sanyinjiao, SP6; Quchi, LI11; Neiting, ST44; Baihui, DU20.

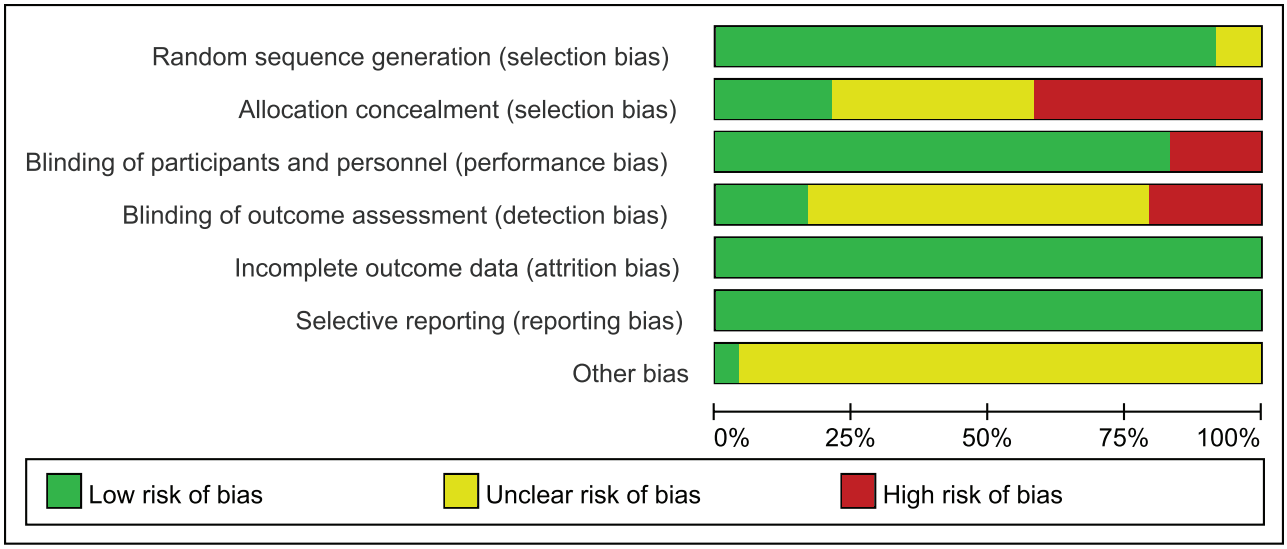

Figure 2. Risk of bias graph.

2.2. Eligibility criteria

The inclusion criteria were as follows: (I) Type of study: all of randomized controlled trials using TEAS to treat postoperative gastrointestinal dysfunction in colorectal cancer. (II) Participants: patients who were cytologically or pathologically confirmed cases of colorectal cancer according to any accepted diagnostic criteria, and had undergone surgical resection. (III) Intervention: the treatment group received TEAS without any restrictions on intervention intensity, frequency, or acupoints. (IV) Comparators: the comparators received conventional treatments except TEAS. (V) Type of outcome measures: we considered the time of first defecation after operation as the primary outcomes. Secondary outcomes included recovery time to flatus, time of bowel sound recovery, postoperative feeding time, and incidence of postoperative nausea and vomiting. The included articles must contain at least one of these outcome indicators.

The exclusion criteria were: (I) patients who did not meet the diagnostic criteria; (II) nonrandomized controlled trials; (III) insufficient data; and (IV) overlapping or duplicate data.

2.3. Data extraction

Two reviewers (YHC and NZ) independently reviewed all eligible studies and extracted data. Any emerging discrepancies were resolved through discussion with the coauthors. Baseline information extracted included first author, year of publication, number of patients, performance status, primary tumor site, and details of the intervention.

2.4. Quality assessment

Two investigators (XNX and NZ) evaluated the risk of bias in RCTs using the Cochrane Bias Risk Assessment Tool. Quality assessment was conducted from 7 perspectives: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessments, incomplete outcome data, selective reporting and other sources of bias.

2.5. Statistical analysis

The meta-analysis was performed using Review Manager5.4.1. I^2 statistics were used to assess heterogeneity between studies. The random-effects model was used when $I^2 \geq 50\%$ indicated the existence of heterogeneity. Otherwise, a fixed-effects model was applied. In this meta-analysis, the mean differences (MDs) (for continuous variables) and risk ratios (for dichotomous variables) with 95% confidence intervals (CIs) were calculated as the effect size of the included studies. Sensitivity analysis was conducted to evaluate the effect of the combined results on the outcomes with significant heterogeneity. Potential publication bias was assessed qualitatively with the funnel plot and quantitatively with Egger test for outcomes with 10 or more included studies.

3. Results

3.1. Literature search and study selection

A flow diagram of the literature selection process is shown in Figure 1. According to the retrieval strategy, 614 potentially relevant articles were initially identified. After excluding 159 duplicates, 455 records were screened by reading the titles and abstracts. Another 413 trials were culled from animal experiments, reviews and studies on unrelated topics. Finally, 24 randomized controlled trials were identified after reading the full texts.

3.2. Study description and quality assessment

The baseline characteristics are shown in Tables 1 and 2. The 24 studies involved 2409 participants, including 1218 patients received TEAS and 1191 patients received conventional therapies. The sample sizes varies from 40 to 610. All participants were diagnosed with colorectal cancer, with colon cancer in 1 study, and rectal cancer in 4 studies. Two articles applied open surgery, while others used laparoscopic surgery. Most studies used compound acupoints, except for 2 that applied a single acupoint.

Figures 2 and 3 present the detailed results of the bias assessment. Random sequence generation was regarded as adequate in most studies; however, allocation concealment and outcomes assessments were sometimes inadequate or unclear. Twenty RCTs were double-blinded by using rigorous study design, whereas the other 4 RCTs had high risks in blinding of participants and personnel. Four RCTs provided detailed methods for blinding of outcomes assessment. Most of the included studies had low risk bias of attrition and reporting.

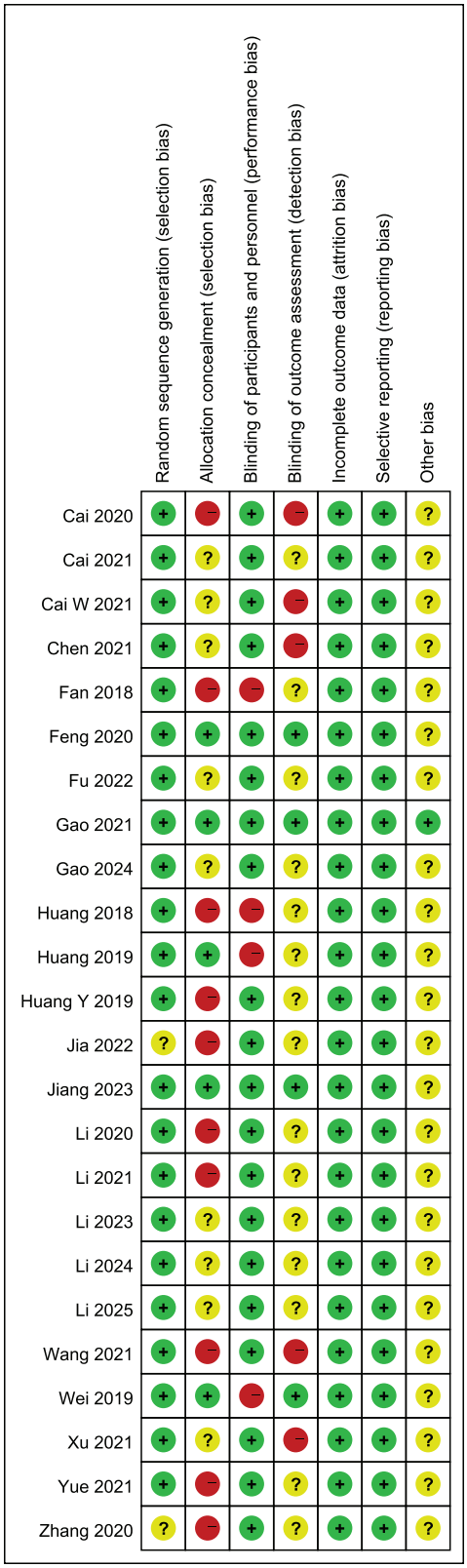

Figure 3. Risk of bias summary.

3.3. Primary outcomes

3.3.1. Time to first defecation. There were 12 articles[9,13,14,20–23,25,29–32] that reported the data of the time to first defecation between the 2 groups. Evidence synthesis detected a significantly shorter time in the TEAS group (MD = –15.74, 95% CI: –20.49 to–10.99, $P < .001$) (Fig. 4) with a significant heterogeneity ($I^2 = 88\%$, $P < .001$) (Fig. 4). Sensitivity analysis demonstrated that the new combined MDs remained stable after excluding any individual study (Fig. 5).

3.4. Secondary outcomes

3.4.1. Time to first flatus. Twenty-three studies[8,9,11–27,29–32] reported the time to first flatus, and the pooled analysis revealed that the TEAS group had a significantly shorter time to first postoperative flatus than the control group (MD = –13.39, 95% CI: –16.28 to –10.50, $P < .001$) (Fig. 6). The studies were tested for heterogeneity with $I^2 = 94\%$ and $P < .001$, suggesting that the heterogeneity between the studies was statistically significant. Sensitivity analysis revealed that the new combined MDs remained constant after excluding any individual study (Fig. 7).

3.4.2. Time to first bowel movement. Eight studies[9,13,14,16,17,22,23,25] were included in the analysis of time to first bowel movement. Pooled analysis indicated that the TEAS group had a significantly lower time. (MD: –11.12, 95% CI: –13.94 to –8.30, $P < .001$) (Fig. 8) with a statistically significant heterogeneity ($I^2 = 91\%$, $P < .001$) (Fig. 8). Sensitivity analyses revealed that the new combined MDs remained constant after excluding any individual study (Fig. 9).

3.4.3. Postoperative feeding time. Data of the postoperative feeding time were available in ten articles.[8,9,12,15–22,32] Pooled analysis revealed a significantly shorter time of postoperative feeding in the TEAS group (MD: –11.91, 95% CI: –17.62 to –6.21, $P < .001$) (Fig. 10) with a statistically significant heterogeneity ($I^2 = 86\%$, $P < .001$) (Fig. 10). Sensitivity analysis revealed that the new combined MDs remained constant after excluding any individual study (Fig. 11).

3.4.4. The incidence of postoperative nausea and vomiting. Fourteen studies[11,12,15,17–20,22,23,25,26,28,30,31] were analyzed for incidence of postoperative nausea and vomiting. Pooled results indicated that the TEAS group had a significantly lower rate of postoperative nausea and vomiting (risk ratios: 0.40, 95% CI: 0.31–0.52, $P < .001$) (Fig. 12). No significant heterogeneity was detected ($I^2 = 0\%$, $P = .98$) (Fig. 12).

3.5. Publication bias

Since more than 10 articles reported the time of first defecation, the time of first flatus and the incidence of postoperative nausea and vomiting, the funnel plots were created to detect publication bias. Funnel plots (Fig. 13, Figure S1, Supplemental Digital Content, https://links.lww.com/MD/P590, and Figure S2, Supplemental Digital Content, https://links.lww.com/MD/P591) showed that the funnel plot scatters were mainly concentrated at the top, and the distribution of scatters on both sides was symmetrical. No statistically significant publication bias was detected through Egger tests for the incidence of postoperative nausea and vomiting ($P = .332$). The results of Begg and Egger tests are shown in Table S2, Supplemental Digital Content, https://links.lww.com/MD/P592.

4. Discussion

As a non-pharmacological intervention, TEAS combines acupoint stimulation with modern electrical stimulation technology, which is simple, stable and safe, and is widely used in clinical practice.[33] As shown in our meta-analysis, TEAS significantly reduced the time to first flatus, time to first defecation, time to first bowel movement, time of postoperative feeding, incidence of postoperative nausea and vomiting, time of postoperative

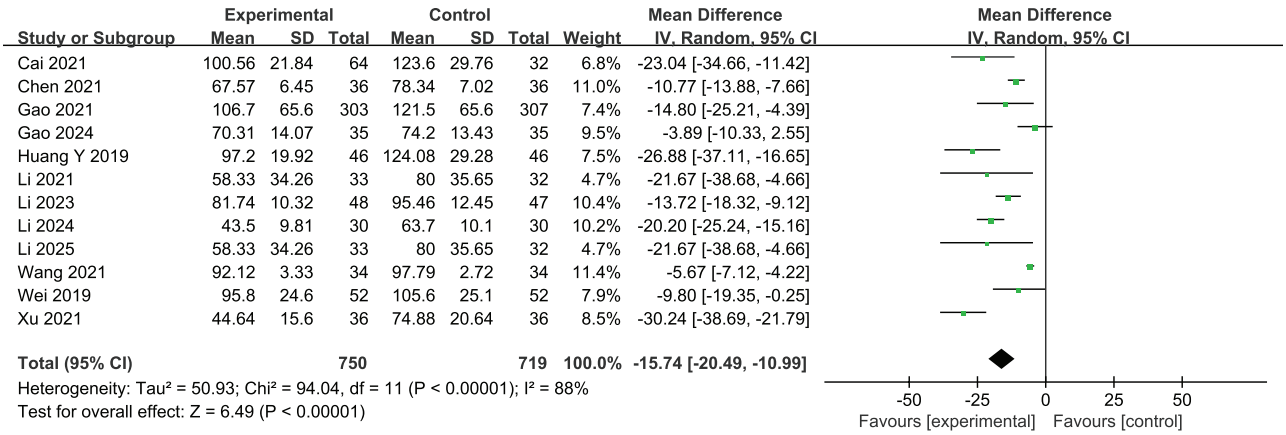

Figure 4. Forest plot of the time to first defecation.

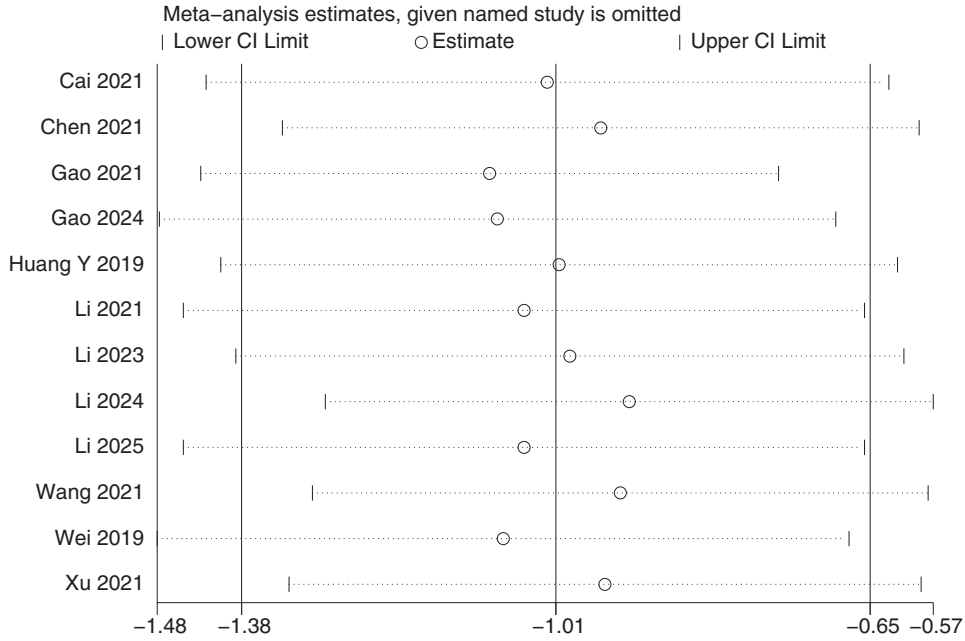

Figure 5. Sensitivity analysis of time to first defecation.

ambulation, and time of postoperative hospitalization. These results indicate that TEAS promotes the recovery of gastrointestinal function after surgery for colorectal cancer and is promising as an important part of perioperative management without drug-induced side effects.

The selected acupoints with higher frequency were Zusanli (ST36, 14 times), Neiguan (P6, 18 times), and Hegu (LI4, 13 times). Zusanli (ST36) is one of the most important acupoints in the Foot Yang Ming stomach meridian. Yang et al found that electroacupuncture at ST36 significantly enhanced bowel function recovery and could be safely administered in a postoperative setting to patients with colorectal cancer after resection.[34] Huang et al found that TEAS at ST36 could promote the recovery of postoperative gastrointestinal function, and the regulatory effects of TEAS may be associated with a neuroimmuno endocrine network involving nerve nuclei, neurotransmitters, and gastrointestinal hormones.[8] Neiguan (P6) is one of the acupoints of the Pericardium Meridian of Hand-Jueyin. Jin et al found that TEAS at P6 could dramatically reduce the occurrence and severity of postoperative nausea and vomiting.[35] Hegu (LI4) is an acupoint of the Hand Yang Ming stomach meridian. Hu et al found that TEAS at LI4 and ST36 improved abdominal pain and quality of life in patients with diarrhea-dominant irritable bowel syndrome.[36] In addition, the commonly applied parameter of TEAS was 2/100 Hz (dispersedense frequency) within the max-tolerance intensity of each patient. Most researchers preferred to use TEAS 30 minutes before induction to the end of the surgery, which may be due to its effect as an aid to anesthesia.[37]

This study had several limitations. First, there was a selection bias because most studies included in this review were conducted in Asia; therefore, the results should be carefully applied to Western populations. The number of included studies and participants was too small to achieve sufficient statistical power considering the massive population and multiple ethnic groups worldwide. Second, the majority of the studies were not blinded to the operators and assessors. Finally, although sensitivity analysis demonstrated that the new combined MDs remained stable after exclusion of any individual study, it should be noted that considerable heterogeneity existed between studies, including different tumor types, frequency of electrical stimulation, duration of intervention, acupoints selection of TEAS treatment, and sample size, which may affect the reliability of the results. Therefore, well-designed clinical trials with larger sample sizes from different ethnicities are required to overcome these limitations.

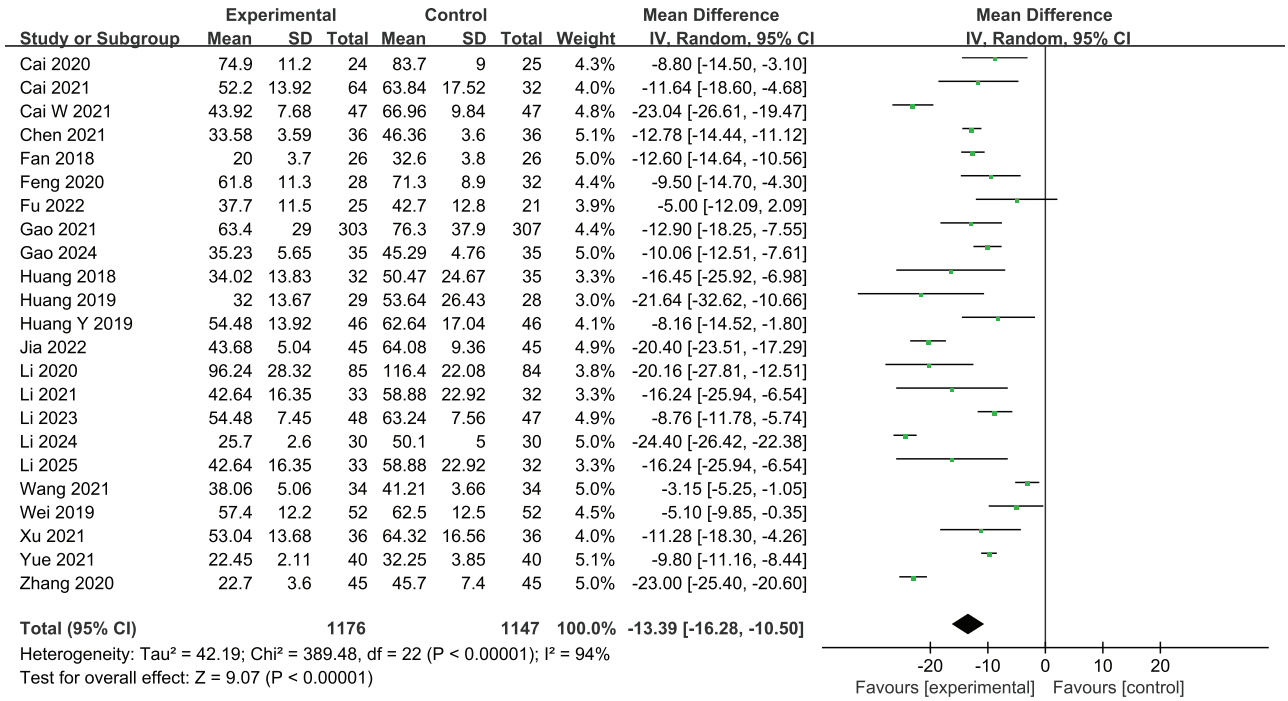

Figure 6. Forest plot of the time to first flatus.

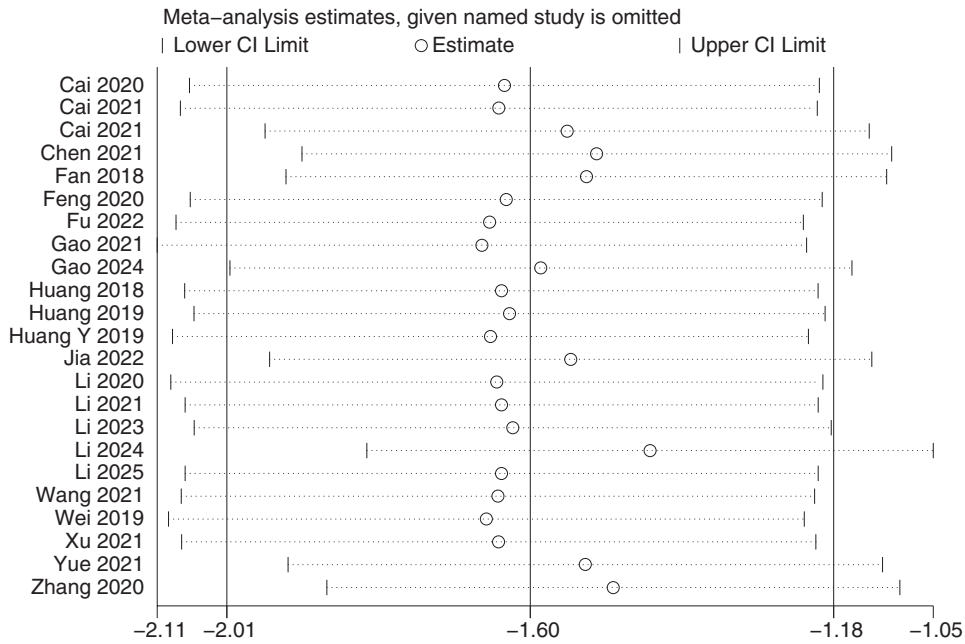

Figure 7. Sensitivity analysis of the time to first flatus.

5. Conclusion

TEAS can assist in the recovery of gastrointestinal function after surgery for colorectal cancer, which may provide guidance for the clinical rehabilitation of postoperative gastrointestinal function in CRC patients. Given the above limitations, caution should be exercised when interpreting our results. High-quality randomized controlled trials with larger sample sizes are warranted.

Acknowledgments

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Author contributions

Conceptualization: Yanan Li.
Data curation: Yiheng Chen, Nan Zhang.
Formal analysis: Xiaona Xu.
Methodology: Rui Zhang.
Software: Wenchao Li.
Supervision: Erping Xu.
Validation: Yanan Li.
Visualization: Yiheng Chen.
Writing – original draft: Yanan Li.
Writing – review & editing: Yanan Li, Erping Xu.

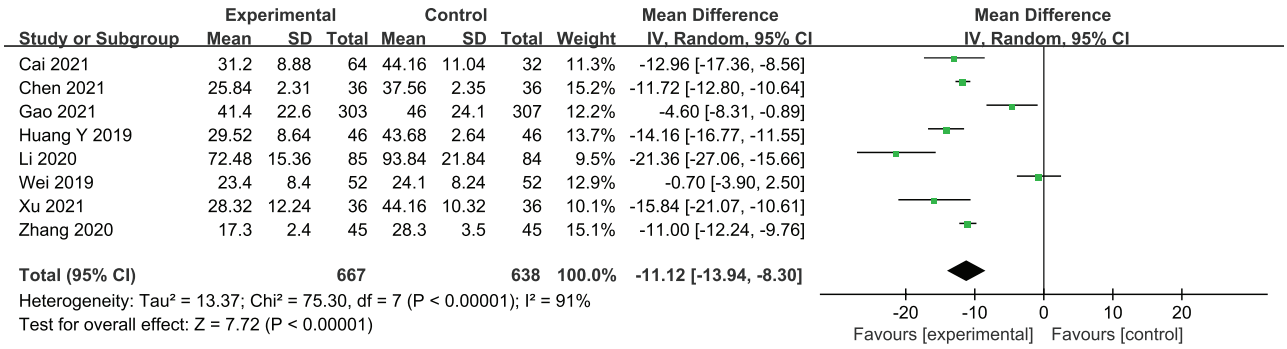

Figure 8. Forest plot of the time to first bowel movement.

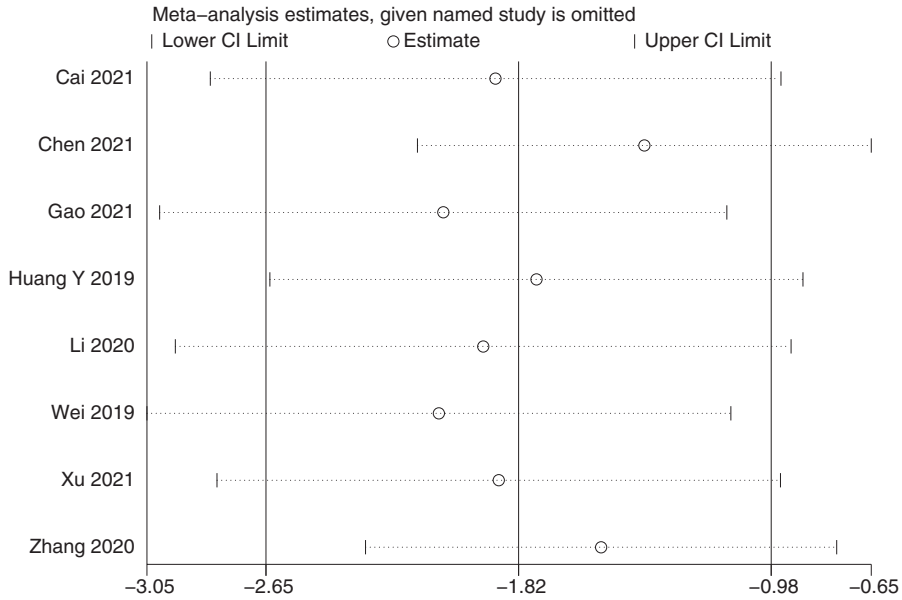

Figure 9. Sensitivity analysis of the time to first bowel movement.

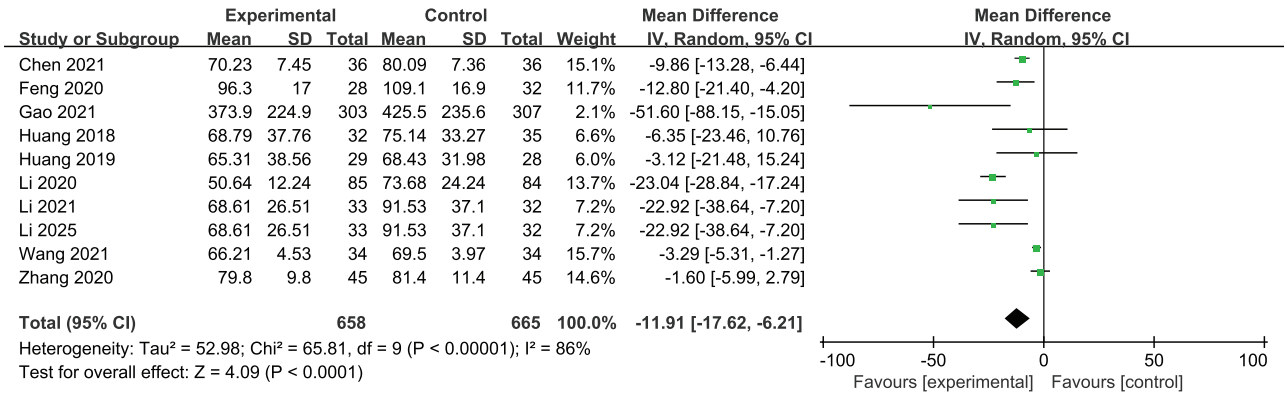

Figure 10. Forest plot of postoperative feeding time.

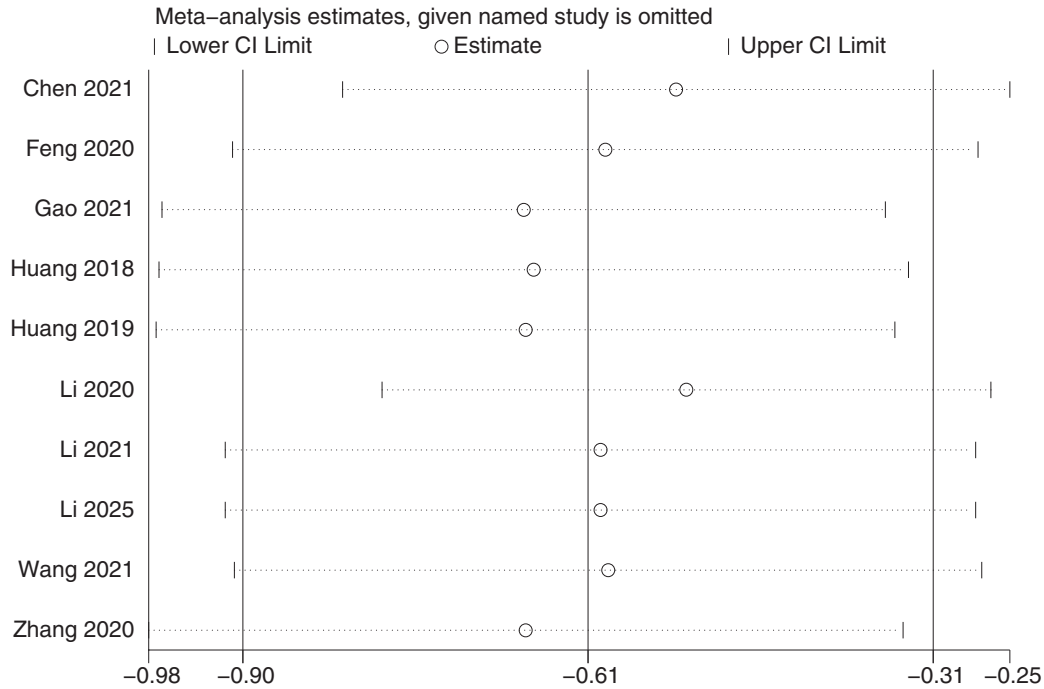

Figure 11. Sensitivity analysis of postoperative feeding time.

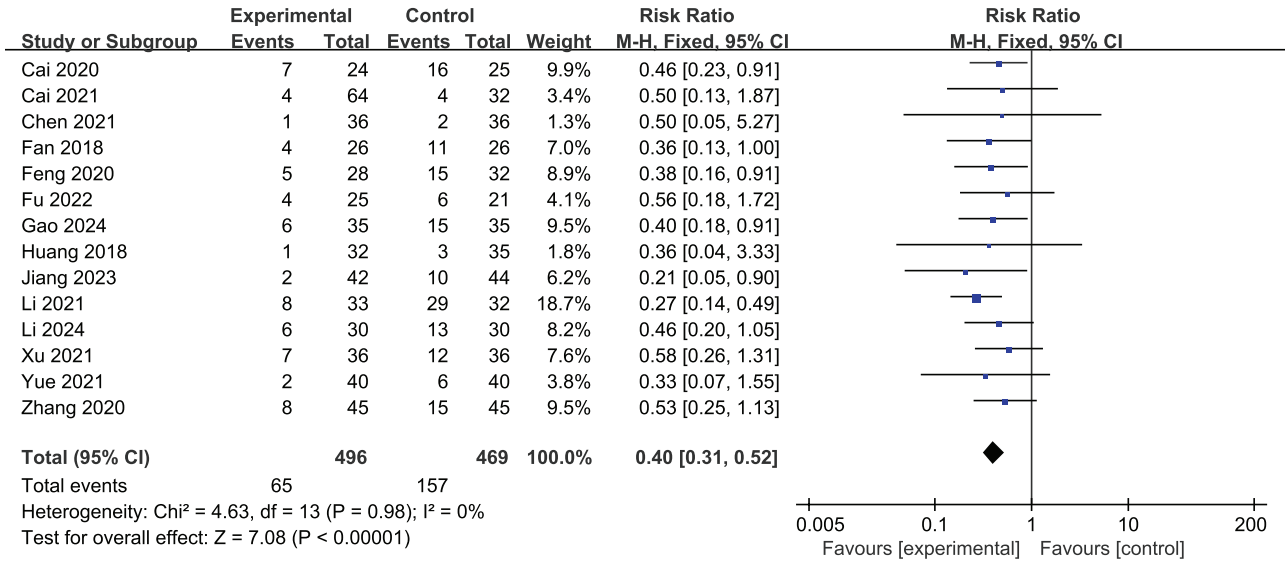

Figure 12. Forest plot of the incidence of postoperative nausea and vomiting.

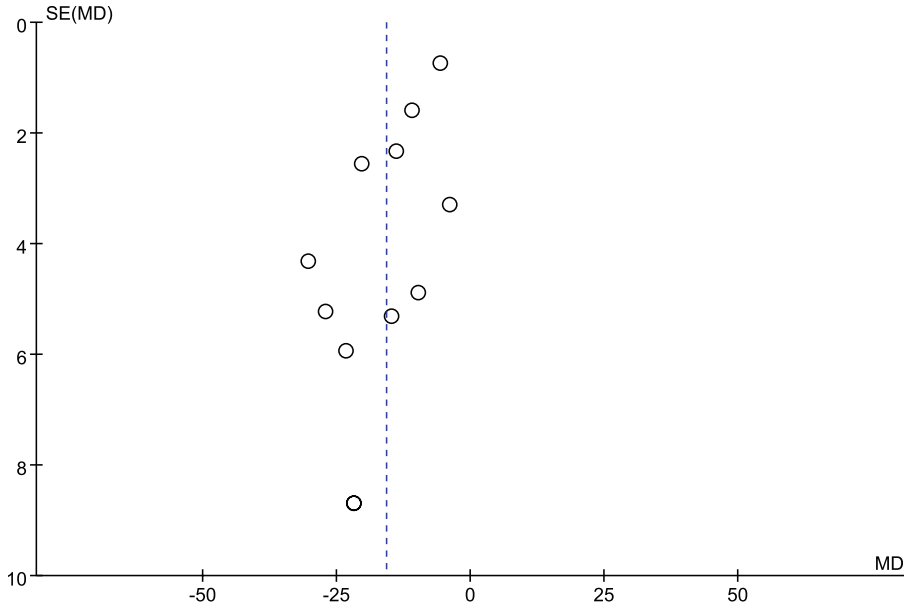

Figure 13. Funnel plot of the time to first defecation.

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