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SYSTEMATIC REVIEW

# Efficacy and safety of therapeutic means for postoperative ileus: an umbrella review of meta-analyses

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## Abstract

**Background & aims** Postoperative ileus is treated using a large number of methods with variable efficacy. This study further clarifies the advantages and disadvantages of existing treatments through umbrella evaluation.

**Method** This study conducted a systematic search of databases to select and include meta-analyses discussing the treatment of postoperative ileus. We recalculated the estimated values, 95% confidence intervals, heterogeneity estimates, small study effects, excessive significance tests, and publication biases for each included study using both random and fixed effect models.

**Results** A total of 24 meta-analyses, including 27 treatment protocols, were reviewed in this study. Among them, chewing gum, coffee, ERAS(Enhanced Recovery After Surgery) protocols, acupuncture, opioid receptor antagonists, Da-Cheng-Qi-Tang, early enteral nutrition, and Zusanli point injection therapy have been shown to significantly improve postoperative ileus (Class II). Opioid receptor antagonists, early enteral nutrition, ERAS, and chewing gum have also been found to significantly reduce the postoperative hospital stay (Class II).

**Conclusion** Eight treatment options can effectively reduce postoperative ileus, while the effectiveness and safety of other treatment options for postoperative ileus require further confirmation through high-quality research.

**Keywords** Postoperative ileus (POI) · Intervention · Umbrella review · Meta-analysis

## Introduction

Postoperative ileus (POI) refers to a temporary gastrointestinal motility disorder that occurs after surgery and is characterized by abdominal distention, abdominal pain, nausea, vomiting, delayed passage of gas, delayed bowel movement, and delayed initiation of oral intake. This is a common functional gastrointestinal (GI) complication after abdominal surgery, which can impair postoperative recovery and prolong hospital stay [1–3]. Therefore, in health care, the prevention and management of postoperative ileus (POI) are of paramount importance. Moreover, POI has emerged as a significant economic and resource allocation burden on the entire health care system, with annual treatment costs in the United States reaching as high as $1.46 billion [4]. Therefore, it is critical to improve POI in patients after abdominal surgery in clinical practice, thereby alleviating patient discomfort, shortening hospitalization time, reducing complications, and reducing health care costs.

Postoperative ileus (POI) is the result of multifactorial interactions [5, 6]. Studies have shown that the development

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**Systematic Review Registration** Our study protocol was registered with PROSPERO (registration number: CRD42024580340) (https://www.crd.york.ac.uk/PROSPERO/).

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of POI is closely related to patients'nutritional status [7], neuropathologic factors [5, 8] and immunologic factors [9]. Furthermore, the prevention and management of POI have long been challenging for health care professionals [5, 6]. In our earlier randomized controlled study involving patients undergoing major abdominal surgery, implementing strategies to enhance neural function and nutritional status was shown to significantly reduce the occurrence of postoperative ileus [10, 11]. Additionally, several meta-analyses [12–35] have explored various preventative and therapeutic measures for POI, including chewing gum, coffee, opioid receptor antagonists, acupuncture, and early enteral nutrition. However, the efficacy and safety of these treatment approaches vary, which complicates their adoption in clinical practice.

Therefore, this study aims to conduct a comprehensive umbrella review to further evaluate and analyze meta-analyses related to the treatment of postoperative ileus (POI). We will assess the methodological quality of the included studies, delineate the safety and efficacy of various treatment protocols, and examine the level of evidence supporting these interventions, along with any potential sources of bias.

## Method

### Protocol and registration

This review was prospectively registered in the PROSPERO database. This systematic review was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [36] and Assessing the Methodological Quality of Systematic Reviews (AMSTAR) standards [37].

### Search strategy

We conducted a systematic and comprehensive literature search across several databases, including PubMed, Embase, Web of Science, and Ovid, focusing on studies published prior to January 2024 that investigated various factors related to postoperative ileus (POI). This research adhered to the guidelines provided by the SIGN [37] and utilized keywords such as"postoperative ileus,""POI,""umbrella review,"and"meta-analysis"for literature retrieval. Additionally, we performed supplementary searches of reference lists from relevant studies to ensure data completeness. We excluded conference abstracts, editorials, letters, and non-English publications. Manual searches of the references from the included studies were also conducted. Two authors independently screened the titles, abstracts, and full texts, while a third author acted as an arbitrator to resolve any discrepancies.

### Eligibility criteria

The inclusion criteria for this study were as follows: (1) the study population consisted of individuals undergoing abdominal surgery; (2) the interventions targeted various approaches for postoperative ileus (POI), including early enteral nutrition, chewing gum, acupuncture, and others; (3) the control group was defined as either a blank control, placebo, or standard clinical treatment; (4) clinical outcome measures included the incidence of postoperative ileus, time to first flatus, time to first defecation, time to first bowel movement, time to first bowel sounds, time to first feeding, time to first liquid diet, time to first solid diet, length of hospital stay, incidence of postoperative nausea and vomiting, and complication rates; (5) the studies were meta-analyses aimed at exploring the treatment of POI; (6) the meta-analyses formally presented risk estimates between various factors and outcome measures, including risk ratios, odds ratios, weighted mean differences, and standardized mean differences with 95% confidence intervals. (7) stand-alone randomized controlled trials or clinical studies that were not part of a secondary analysis. In instances where multiple meta-analyses examined the relationship between the same exposure or intervention factors and outcomes, if the publication date differed by more than 24 months, we selected the most recently published study, typically encompassing the largest number of cases and studies. If the publication dates were within 24 months, we prioritized studies with the highest number of randomized controlled trials or cohort studies included, as these often presented higher AMSTAR ratings. Ultimately, meta-analyses incorporating randomized controlled trials were regarded as the most favorable choice.

The exclusion criteria were as follows: (1) studies involving children, adolescents, or pregnant women; (2) meta-analyses or systematic reviews comparing the efficacy of two distinct treatments for postoperative ileus; (3) meta-analysis that did not formally display the associations between any factors and the outcomes of interest; (4) meta-analyses that did not formally present risk estimates; (5) Non-English articles.

The entirety of the included literature was meticulously reviewed through a dual independent cross-evaluation process conducted by two authors. Any discrepancies were discussed and resolved with the involvement of a third party to ensure accuracy and consistency in the assessment.

### Data extraction

Through a thorough review of the full texts, we extracted the following information: the name of the first author, the title, publication year, the main studies and sample sizes included, study design, details of the intervention or exposure, and the methods of group comparisons (high dose vs. low dose, any dose vs. no dose, additional treatment vs. no additional treatment, long-term exposure vs. short-term exposure), as well as the risk estimates with 95% confidence intervals, significance P values, assessments of heterogeneity, and the evaluation of publication bias. We also extracted the raw data for the summary risk estimates. All data extraction was independently performed by two authors, while a third author resolved any discrepancies encountered during the data extraction process and verified its accuracy.

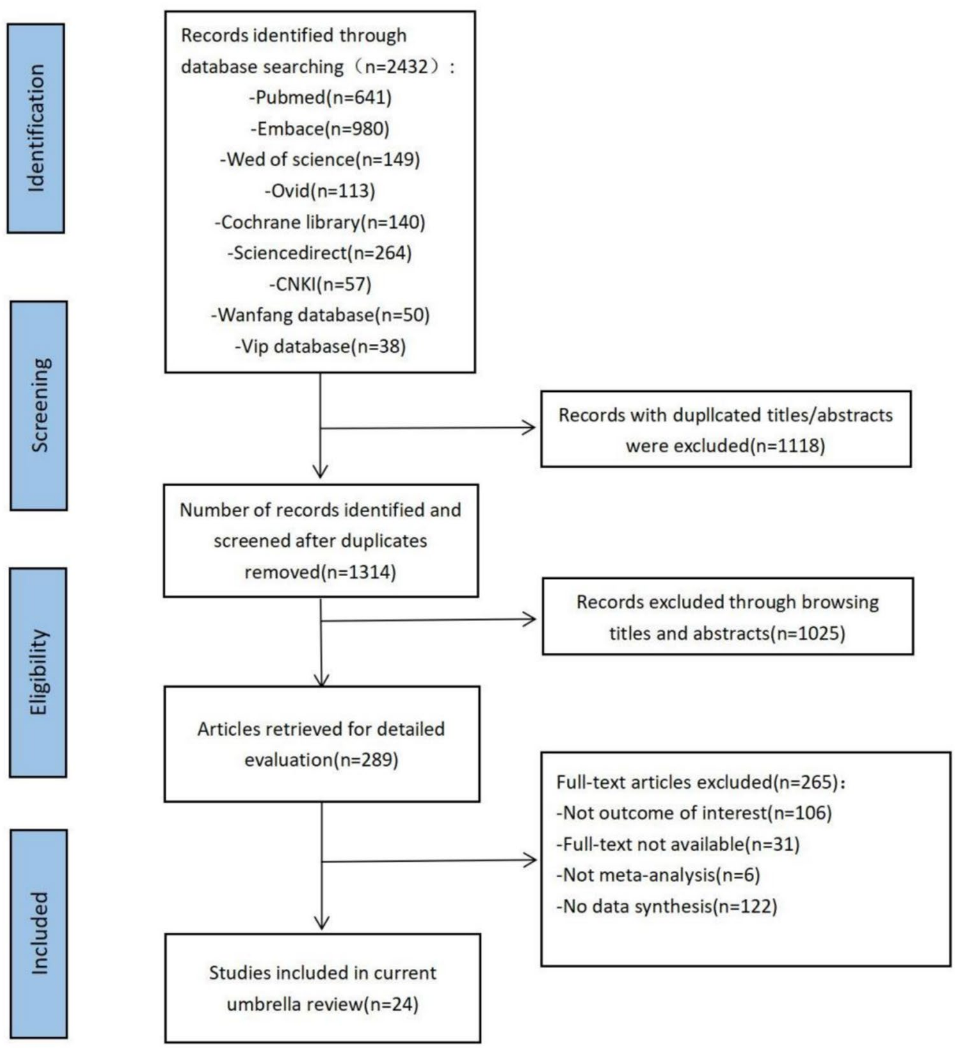
## Data analysis

The impact of all included treatment regimens [12–35] on clinical outcomes were reanalyzed separately, not only to ensure that risk estimates were calculated to measure the relationships between different interventions and outcomes but also to ensure that all presented data were calculated using a uniform methodology.

## Estimation of summary effects, heterogeneity, and 95% prediction intervals

Data were extracted from the included meta-analyses, and summary associations and 95% confidence intervals were reanalyzed [38]. The $I^2$ statistic was also used to assess heterogeneity [38, 39]. Finally, the effect estimates of the eligible effect model were summarized in the main analysis based on statistical heterogeneity. A 95% prediction interval was introduced to identify the uncertainty of the individual statistic [40, 41].

**Fig. 1** Flowchart of the study



## Assessment of publication bias, small study effects, and excess significance bias

For every reanalysis, the publication bias and small study effect were calculated [42–44]. A simple proportion of statistical significance test (PSST) and a direct test of excess statistical significance (TESS) were introduced to calculate the expected proportion of statistically significant findings in the absence of selective reporting or publication bias based on each study's standard error (SE) and meta-analysis estimates of the mean and variance of the true-effect distribution [45–47].

## Grading of the evidence

Significant evidence in the data was categorized into four levels of subgroups: strongly suggestive evidence, highly suggestive evidence, suggestive evidence, and weak evidence, as previously detailed [38, 40, 48, 49]. (1) Criteria for strongly suggestive evidence were as follows: i. Cases $\geq 1000$; ii. Significant P value (from the random effects model) $\leq 10^{-6}$; iii. No significant findings in the largest study (P $\leq 0.05$); iv. Absence of high heterogeneity ($I^2 < 50\%$); v. 95% prediction interval does not include zero; and vi. No excessive significance bias or small study effects. (2) Criteria for highly suggestive evidence must simultaneously meet the following: i. More than 1000 cases included in the meta-analysis; ii. Significant P value from the random effects model $\leq 10^{-6}$; and iii. No significant findings in the largest study. (3) Criteria for suggestive evidence must simultaneously meet the following: i. Patients $\geq 1000$; and ii. Significant P value from the random effects model $\leq 10^{-3}$. (4) Criteria for weak evidence only has to meet the following: i. Significant P value from the random effects model $< 0.05$.

Based on the aforementioned evidence grading standards, evidence was classified into five categories: Class I (strongly suggestive evidence), Class II (highly suggestive evidence), Class III (suggestive evidence), Class IV (weak evidence), and Class V (nonsignificant).

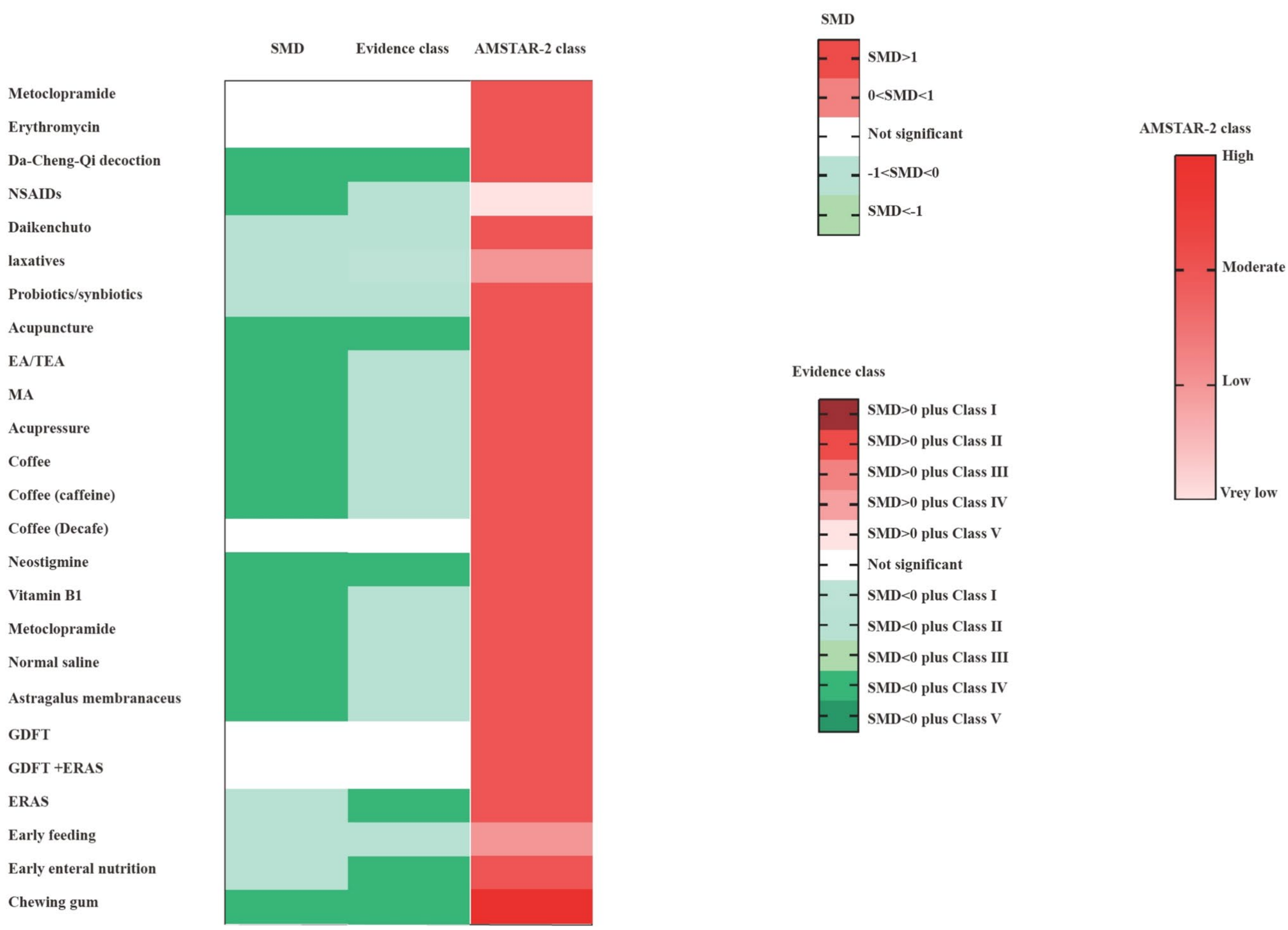



**Fig. 2** Postoperative time to first flatus

**Table 1** Postoperative time to first flatus

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | $Tau^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Total** | **RCT** | **OE** | **Fixed effects** | **Random effects** | **Largest study** | | | Fixed | Random | Largest | | **$I^2$(%)** | **$I^2$-P value** | | | | | |
| Drug | | | | | | | | | | | | | | | | | | | | |
| Metoclopramide | NR/876 | 4 | 4 | 0 | **−0.00(−0.03 to 0.03)** | −0.00(−0.03 to 0.03) | 0.00(−0.03 to 0.03) | Fixed | 0 | 0.945 | 0.945 | 1.000 | 2.196 to 2.367 | 0 | 0.657 | 0.265 | Yes | No | V | Moderate |
| Erythromycin | NR/232 | 3 | 3 | 0 | **−0.24(−0.54 to 0.06)** | −0.24(−0.54 to 0.06) | −0.30(−0.71 to 0.11) | Fixed | 0 | 0.114 | 0.114 | 0.150 | 1.571 to 3.309 | 0 | 0.516 | 0.863 | Yes | Yes | V | Moderate |
| Da-Cheng-Qi decoction | NR/1040 | 11 | 11 | 0 | −3.91(−4.31 to −3.51) | **−2.12(−3.07 to −1.17)** | −1.34(−1.76 to −0.92) | Random | 373.6489 | < 0.01 | < 0.01 | < 0.01 | −17.934 to 29.760 | 99.4 | < 0.01 | 0.028 | Yes | Yes | II | Moderate |
| NSAIDs | NR/431 | 4 | 4 | 0 | −7.53(−11.62 to −3.45) | **−9.44(−17.23 to −1.65)** | 0.00(−6.30 to 6.30) | Random | 43.3924 | < 0.01 | 0.018 | 1.000 | −6.514 to 3.498 $\times10^8$ | 70.0 | 0.018 | 0.063 | Yes | Yes | IV | Very low |
| Daikenchuto | NR/471 | 6 | 6 | 0 | −0.67(−0.78 to −0.56) | **−0.43(−0.77 to −0.09)** | −0.80(−0.93 to −0.67) | Random | 0.1016 | < 0.01 | 0.014 | < 0.01 | 0.936 to 5.554 | 72.8 | < 0.01 | 0.156 | Yes | Yes | IV | Moderate |
| laxatives | NR/328 | 3 | 3 | 0 | −0.17(−0.31 to −0.02) | **−0.17(−0.60 to −0.26)** | −0.37(−0.58 to −0.16) | Random | 0.025 | < 0.01 | < 0.01 | < 0.01 | 1.174 to 4.427 | 87.8 | < 0.01 | 0.996 | Yes | Yes | V | Low |
| Probiotics/synbiotics | NR/617 | 8 | 8 | 0 | −0.33(−0.42 to −0.25) | **−0.53(−0.75 to −0.30)** | −0.24(−0.35 to −0.13) | Random | 0.0555 | < 0.01 | < 0.01 | < 0.01 | 1.200 to 4.331 | 73.2 | < 0.01 | 0.020 | Yes | Yes | IV | Moderate |
| Acupuncture | NR/1162 | 16 | 16 | 0 | −1.04(−1.17 to −0.91) | **−1.15(−1.56 to −0.75)** | −10.00(−11.89 to −8.11) | Random | 55.2268 | < 0.01 | < 0.01 | < 0.01 | −6.582 to 3.666 $\times10^8$ | 91.5 | < 0.01 | 0.423 | Yes | No | II | Moderate |
| EA/TEA | NR/965 | 15 | 15 | 0 | −8.29(−9.28 to −7.31) | **−11.60(−16.19 to −7.02)** | −2.31(−3.86 to −0.76) | Random | 69.3003 | < 0.01 | < 0.01 | < 0.01 | −7.563 to 3.616 $\times10^9$ | 93.7 | < 0.01 | 0.156 | Yes | No | IV | Moderate |
| MA | NR/292 | 4 | 4 | 0 | −19.98(−22.67 to −17.29) | **−14.45(−26.12 to −2.78)** | −28.56(−32.45 to −24.67) | Random | 131.3286 | < 0.01 | 0.015 | < 0.01 | −10.138 to 15.256 | 94.0 | < 0.01 | 0.015 | Yes | Yes | IV | Moderate |
| Acupressure | NR/114 | 2 | 2 | 0 | **−19.27(−29.36 to −9.17)** | −19.27(−29.36 to −9.17) | −19.92(−32.57 to −7.27) | Fixed | 0 | < 0.01 | < 0.01 | < 0.01 | 1.527 to 6.906 $\times10^5$ | 0 | 0.867 | NA | Yes | NA | IV | Moderate |
| Coffee | NR/1151 | 12 | 12 | 0 | −4.18(−4.96 to −3.40) | **−4.27(−8.28 to −0.26)** | −8.21(−9.86 to −6.56) | Random | 45.0709 | < 0.01 | 0.037 | < 0.01 | −0.225 to 6.686 $\times10^7$ | 95.7 | < 0.01 | 0.947 | Yes | Yes | IV | Moderate |
| Coffee (caffeine) | NR/846 | 10 | 10 | 0 | −3.79(−4.61 to −2.96) | **−4.43(−8.80 to −0.06)** | −8.21(−9.86 to −6.56) | Random | 44.2731 | < 0.01 | 0.047 | < 0.01 | −0.221 to 6.683 $\times10^7$ | 95.8 | < 0.01 | 0.825 | Yes | Yes | IV | Moderate |
| Coffee (Decafe) | NR/140 | 2 | 2 | 0 | 2.61(−1.96 to 7.18) | **−0.13(−12.82 to 12.56)** | 5.80(0.54 to 11.06) | Random | 69.8500 | 0.263 | 0.984 | 0.031 | −9.715 to 15.044 | 82.7 | 0.016 | NA | Yes | NA | V | Moderate |
| ST36 injection acupoint | | | | | | | | | | | | | | | | | | | | |
| Neostigmine | NR/1095 | 15 | 15 | 0 | −1.90(−2.06 to −1.75) | **−2.84(−3.62 to −2.05)** | −22.80(−23.57 to −22.04) | Random | 82.8208 | < 0.01 | < 0.01 | < 0.01 | −7.881 to 2.453 $\times10^{10}$ | 97.6 | < 0.01 | 0.881 | Yes | Yes | II | Moderate |

**Table 1** (continued)

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | Tau$^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Total** | **RCT** | **OE** | **Fixed effects** | **Random effects** | **Largest study** | | | Fixed | Random | Largest | | **I$^2$(%)** | **I$^2$-P value** | | | | | |
| Vitamin B1 | NR/596 | 5 | 5 | 0 | −14.93(−15.76 to −14.11) | **−11.22(−17.01 to −5.43)** | −20.07(−21.25 to −18.89) | Random | 42.2942 | < 0.01 | < 0.01 | < 0.01 | −2.278 to 9.085 $\times 10^7$ | 97.6 | < 0.01 | < 0.01 | Yes | Yes | IV | Moderate |
| Metoclopramide | NR/260 | 3 | 3 | 0 | −14.56(−16.40 to −12.72) | **−15.65(−24.77 to −6.53)** | −18.00(−20.32 to −15.68) | Random | 57.2766 | < 0.01 | < 0.01 | < 0.01 | −1.961 to 6.467 $\times 10^9$ | 94.1 | < 0.01 | 0.967 | Yes | Yes | IV | Moderate |
| Normal saline | NR/68 | 1 | 1 | 0 | **−12.00(−14.43 to −9.57)** | −12.00(−14.43 to −9.57) | −12.00(−14.43 to −9.57) | NA | NA | < 0.01 | < 0.01 | < 0.01 | 0.109 to 47.545 | NA | NA | NA | Yes | NA | IV | Moderate |
| Astragalus membranaceus | NR/80 | 1 | 1 | 0 | **−8.91(−13.66 to −4.16)** | −8.91(−13.66 to −4.16) | −8.91(−13.66 to −4.16) | NA | NA | < 0.01 | < 0.01 | < 0.01 | 0.006 to 861.931 | NA | NA | NA | Yes | NA | IV | Moderate |
| Other | | | | | | | | | | | | | | | | | | | | |
| GDFT | NR/302 | 2 | 2 | 0 | **−0.16(−0.50 to 0.18)** | −0.18(−0.66 to 0.30) | 0.04(−0.40 to 0.48) | Fixed | 0.0577 | 0.352 | 0.454 | 0.860 | 1.103 to 4.714 | 48.1 | 0.165 | NA | Yes | NA | V | Moderate |
| GDFT + ERAS | NR/37 | 4 | 4 | 0 | −0.59(−0.82 to −0.35) | **−0.47(−1.38 to 0.44)** | −0.75(−1.07 to −0.43) | Random | 0.7142 | < 0.01 | 0.312 | < 0.01 | 0.215 to 24.191 | 90.8 | < 0.01 | 0.848 | Yes | Yes | V | Moderate |
| ERAS | NR/1072 | 13 | 13 | 0 | −0.34(−0.37 to −0.30) | **−0.66(−0.86 to −0.46)** | −0.31(−0.34 to −0.28) | Random | 0.0928 | < 0.01 | < 0.01 | < 0.01 | 1.038 to 5.009 | 82.5 | < 0.01 | < 0.01 | Yes | Yes | II | Moderate |
| Early feeding | NR/486 | 3 | 3 | 0 | **−0.64(−0.81 to −0.46)** | −0.64(−0.84 to −0.44) | −0.60(−0.84 to −0.37) | Fixed | 0.0074 | < 0.01 | < 0.01 | < 0.01 | 1.688 to 3.080 | 22.5 | 0.275 | 0.672 | Yes | No | IV | Low |
| Early enteral nutrition | NR/2827 | 19 | 19 | 0 | −0.65(−0.69 to −0.62) | **−0.69(−0.89 to −0.49)** | −0.60(−0.64 to −0.56) | Random | 0.1618 | < 0.01 | < 0.01 | < 0.01 | 0.825 to 6.298 | 94.8 | < 0.01 | 0.941 | Yes | No | II | Moderate |
| Chewing gum | NR/2096 | 25 | 25 | 0 | −10.25 (−10.98 to −9.51) | **−12.14(−15.71 to −8.56)** | −4.10(−7.05 to −1.15) | Random | 54.6092 | < 0.01 | < 0.01 | < 0.01 | −6.183 to 2.860 $\times 10^8$ | 92.8 | < 0.01 | 0.509 | Yes | No | II | High |

### Assessment of the methodological quality of the included studies

Two reviewers evaluated the methodological quality of the included articles using A Measurement Tool to Assess Systematic Reviews (AMSTAR 2), an effective and reliable instrument for assessing the quality of systematic reviews and meta-analyses [50]. This tool consists of 16 items that score aspects such as search quality, reporting, and transparency of analysis and meta-analysis. It generates four final ratings: high, moderate, low, and critically low.

Based on the associations extracted from the included meta-analyses, forest plots were constructed to illustrate the risk estimates. Statistical data were collected and analyzed using EndNote version 20.4, Stata version 17.0, and GraphPad Prism version 9.0.

## Results

Ultimately, our literature search yielded 2,432 unique studies (Fig. 1). Following a thorough and meticulous review of the full texts, a total of 24 articles were included in the final analysis.

### Time to first flatus postoperatively

As illustrated in Fig. 2 and Table 1, six interventions demonstrated significant efficacy in reducing the first postoperative exhaust time compared to placebo or conventional therapy: Da-Cheng-Qi-Tang [12] (SMD −2.12; 95% CI −3.07 to −1.17), acupuncture [13] (SMD −1.15; 95% CI −1.56 to −0.75), neostigmine injection at zusanli [14] (SMD −2.84; 95% CI −3.62 to −2.05), enhanced Recovery After Surgery (ERAS) protocols [15] (SMD −0.66; 95% CI −0.86 to −0.46), early enteral nutrition [16] (SMD −0.69; 95% CI −0.89 to −0.49) and chewing gum [17] (SMD −4.10; 95% CI −7.05 to −1.15). All six interventions were classified as Level II evidence, indicating strong recommendation for clinical application.

Several other modalities showed potential benefits but were supported by lower-quality evidence: non-steroidal anti-inflammatory drugs [18], daikenchuto [19], laxatives [20], probiotics or synthetic agents [21], electroacupuncture or transcutaneous electrical stimulation [22], acupressure [23], manual acupuncture [23], coffee [24], caffeinated coffee [24], early oral feeding [25], and zusanli point injections (normal saline, astragalus, vitamin B1, or metoclopramide) [14].

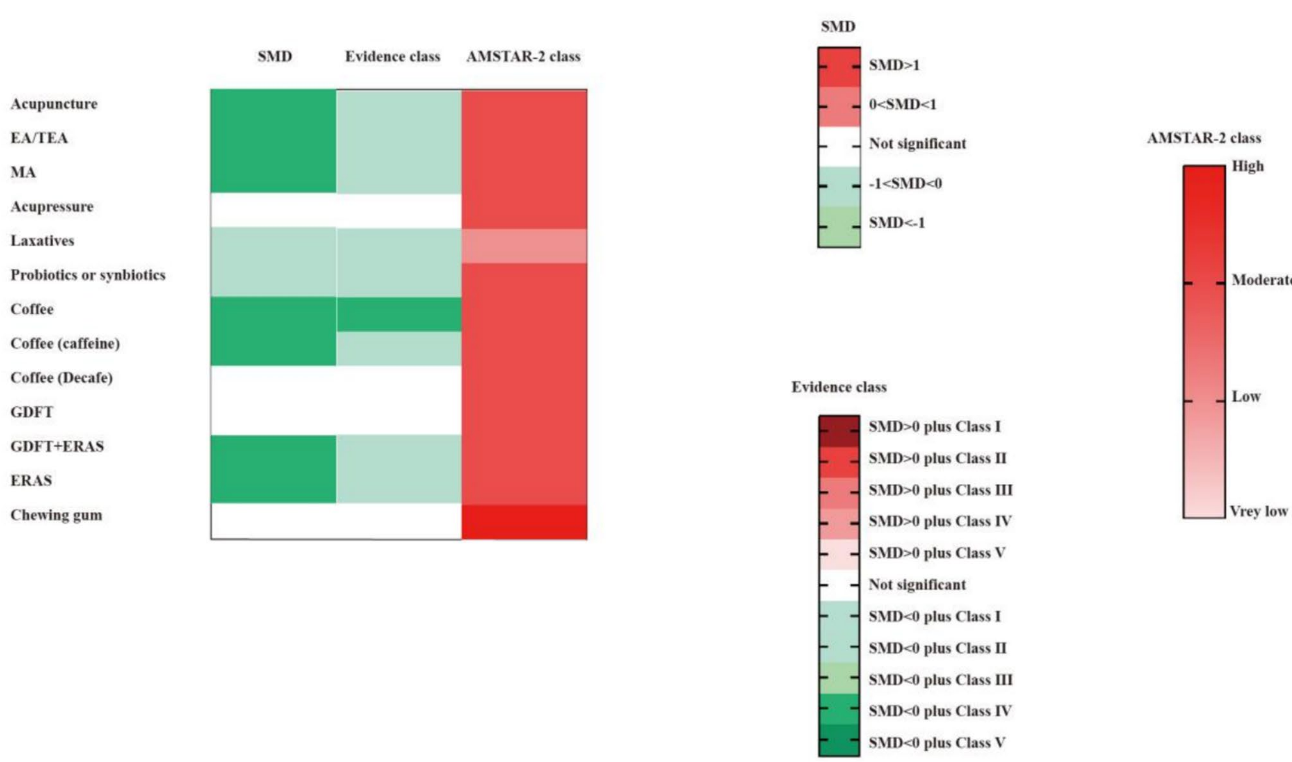



**Fig. 3** Postoperative time to first defecation

**Table 2** Postoperative time to first defecation

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | Tau$^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Total** | **RCT** | **OE** | **Fixed effects** | **Random effects** | **Largest study** | | | **Fixed** | **Random** | **Largest** | | **I$^2$(%)** | **I$^2$-P value** | | | | | |
| Acupuncture | **NR/980** | **13** | **13** | **0** | −15.65(−16.72 to −14.59) | **−17.07(−22.59 to −11.54)** | −22.56(−24.36 to −20.76) | Random | 75.6347 | < 0.01 | < 0.01 | < 0.01 | −5.730 to 1.217 $\times 10^{10}$ | 94.1 | < 0.01 | 0.915 | Yes | Yes | IV | Moderate |
| EA/TEA | **NR/842** | **13** | **13** | **0** | −10.04(−11.42 to −8.66) | **−12.94(−18.82 to −7.06)** | −14.71(−16.93 to −12.49) | Random | 72.0989 | < 0.01 | < 0.01 | < 0.01 | −4.030 to 8.707 $\times 10^{9}$ | 89.8 | < 0.01 | 0.505 | Yes | Yes | IV | Moderate |
| MA | **NR/292** | **4** | **4** | **0** | −21.29(−22.98 to −19.59) | **−13.64(−22.68 to −4.60)** | −22.56(−24.36 to −20.76) | Random | 69.5602 | < 0.01 | 0.003 | < 0.01 | −9.649 to 3.530 $\times 10^{10}$ | 81.9 | < 0.01 | 0.057 | Yes | Yes | IV | Moderate |
| Acupressure | **NR/114** | **2** | **2** | **0** | **−7.75(−18.15 to 2.65)** | −7.75(−18.15 to 2.65) | −6.08(−18.35 to 6.19) | Fixed | 0 | 0.144 | 0.144 | 0.331 | −0.846 to 1.009 $\times 10^{6}$ | 0 | 0.616 | NA | Yes | NA | V | Moderate |
| Drug | | | | | | | | | | | | | | | | | | | | |
| Laxatives | **NR/416** | **5** | **5** | **0** | −0.94(−1.07 to −0.80) | **−0.76(−1.34 to −0.19)** | −1.16(−1.36 to −0.96) | Random | 0.3088 | < 0.01 | < 0.01 | < 0.01 | 0.489 to 10.627 | 93 | < 0.01 | 0.484 | Yes | Yes | IV | Low |
| Probiotics or synbiotics | **NR/571** | **7** | **7** | **0** | −0.59(−0.73 to −0.44) | **−0.78(−1.27 to −0.28)** | −0.35(−0.53 to −0.17) | Random | 0.3681 | < 0.01 | < 0.01 | < 0.01 | 0.455 to 11.424 | 86.2 | < 0.01 | 0.338 | Yes | No | IV | Moderate |
| Coffee | **NR/1209** | **13** | **13** | **0** | −4.79(−5.60 to −3.99) | **−10.06(−14.54 to −5.58)** | −1.38(−2.38 to −0.37) | Random | 53.0334 | < 0.01 | < 0.01 | < 0.01 | −6.277 to 3.017 $\times 10^{8}$ | 93.7 | < 0.01 | 0.038 | Yes | Yes | II | Moderate |
| Coffee (caffeine) | **NR/829** | **10** | **10** | **0** | −12.04(−13.75 to −10.33) | **−11.39(−15.43 to −7.35)** | −15.27(−18.27 to −12.27) | Random | 25.1350 | < 0.01 | < 0.01 | < 0.01 | −2.108 to 1.336 $\times 10^{6}$ | 74.5 | < 0.01 | 0.705 | Yes | Yes | IV | Moderate |
| Coffee (Decafe) | **NR/215** | **3** | **3** | **0** | −1.44(−2.41 to −0.47) | **−3.44(−8.64 to 1.76)** | −1.38(−2.38 to −0.37) | Random | 13.7194 | < 0.01 | 0.194 | < 0.01 | −1.762 to 1.605 $\times 10^{5}$ | 79.7 | < 0.01 | 0.450 | Yes | No | V | Moderate |
| Other | | | | | | | | | | | | | | | | | | | | |
| GDFT | **NR/199** | **3** | **3** | **0** | −0.44(−0.85 to −0.03) | **−0.66(−1.53 to 0.21)** | 0.00(−0.54 to 0.54) | Random | 0.4334 | 0.035 | 0.135 | 1 | 0.326 to 15.950 | 74.1 | 0.021 | 0.169 | Yes | No | V | Moderate |
| GDFT + ERAS | **NR/536** | **5** | **5** | **0** | −0.68(−0.94 to −0.42) | **−1.09(−2.03 to −0.15)** | −0.44(−0.74 to −0.14) | Random | 0.8206 | < 0.01 | 0.023 | < 0.01 | 0.185 to 28.131 | 82.5 | < 0.01 | 0.435 | Yes | No | IV | Moderate |
| ERAS | **NR/539** | **5** | **5** | **0** | −1.05(−1.27 to −0.83) | **−1.10(−1.74 to −0.47)** | −0.50(−0.88 to −0.12) | Random | 0.4425 | < 0.01 | < 0.01 | < 0.01 | 0.373 to 13.948 | 87.3 | < 0.01 | 0.735 | Yes | No | IV | Moderate |
| Chewing gum | **NR/141** | **4** | **4** | **0** | −0.44(−1.03 to 0.15) | **−0.96(−2.75 to 0.83)** | −0.70(−1.65 to 0.25) | Random | 2.8834 | 0.141 | 0.293 | 0.150 | 0.020 to 2.561 $\times 10^{2}$ | 88.3 | < 0.01 | 0.228 | Yes | Yes | V | High |

Notably, no statistically significant effects were observed for: metoclopramide [16], erythromycin [16], decaffeinated coffee [24], goal-directed fluid therapy (GDFT) [26], combined GDFT and ERAS protocols [26].

## Time to first defecation postoperatively

As shown in Fig. 3 and Table 2, coffee [24] (SMD −10.06; 95% CI −14.54 to −5.58) demonstrated significant efficacy in accelerating the first postoperative bowel movement compared to placebo or conventional therapy, with its evidence graded as Level II—strongly recommended for clinical practice.

The following interventions showed potential benefits but were supported by lower-quality evidence: acupuncture [13], electroacupuncture or transcutaneous electrical stimulation [22], manual acupuncture [23], laxatives [20], probiotics or synthetic agents [21], caffeinated coffee [24], combined GDFT and ERAS protocols [26] and ERAS protocols [15].

There is no statistically significant difference in acupressure [23], decaffeinated coffee [24], goal-directed fluid therapy (GDFT) [26], and chewing gum [27].

## The incidence of postoperative ileus

As summarized in Fig. 4 and Table 3, opioid receptor antagonists [28] (RR 0.73; 95% CI 0.70–0.76) demonstrated significant prophylactic efficacy against postoperative ileus compared with placebo or conventional treatments, achieving Level II evidence classification indicating strong clinical recommendation.

Several interventions showed moderate preventive potential but were supported by limited evidence: non-steroidal anti-inflammatory drugs (NSAIDs) [17], alvimopan [29], probiotics or synthetic agents [21], coffee [24] and caffeinated coffee [24].

However, no statistically significant differences were found in reducing the incidence of postoperative intestinal paralysis among other factors.

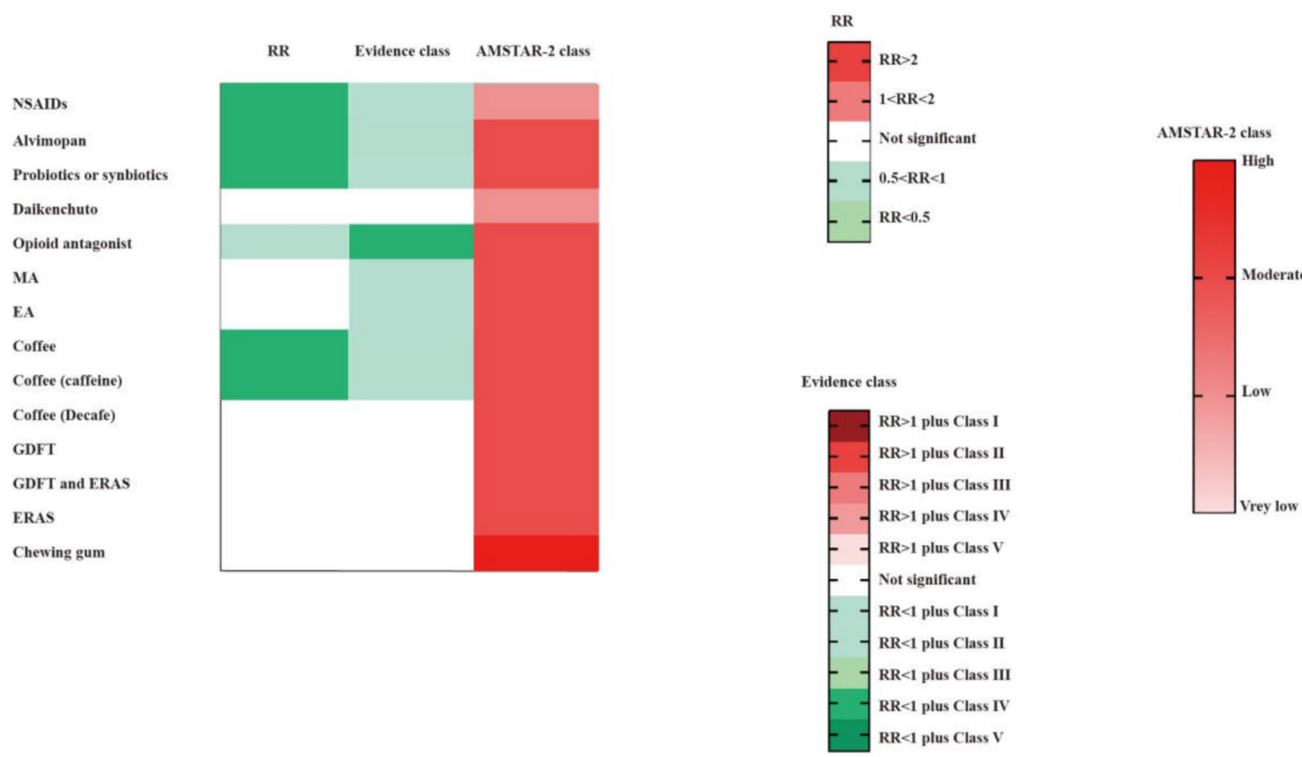



**Fig. 4** The incidence of postoperative ileus

**Table 3** The incidence of postoperative ileus

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary risk ratio estimate(RR, 95% CI) | | | Selected effect model | Tau$^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Total** | **RCT** | **OE** | **Fixed effects** | **Random effects** | **Largest study** | | | **Fixed** | **Random** | **Largest** | | **I$^2$(%)** | **I$^2$-P value** | | | | | |
| Drug | | | | | | | | | | | | | | | | | | | | |
| NSAIDs | 19/281 | 2 | 2 | 0 | ***0.38(0.15 to 0.96)*** | 0.39(0.15 to 1.00) | 0.42(0.15 to 1.13) | Fixed | 0 | 0.042 | 0.050 | 0.085 | 1.369 to 3.797 | 0 | 0.642 | NA | No | NA | V | Low |
| Alvimopan | 38/531 | 4 | 4 | 0 | ***0.27(0.13 to 0.57)*** | 0.29(0.11 to 0.80) | 0.10(0.02 to 0.45) | Fixed | 0.2971 | 0.001 | 0.016 | < 0.01 | 0.578 to 8.987 | 29.2 | 0.237 | 0.946 | No | Yes | IV | Moderate |
| Probiotics or synbiotics | 37/559 | 4 | 4 | 0 | ***0.48(0.23 to 0.97)*** | 0.53(0.25 to 1.13) | 0.11(0.01 to 0.92) | Fixed | 0 | 0.041 | 0.099 | 0.042 | 1.439 to 3.612 | 0 | 0.396 | 0.254 | No | Yes | V | Moderate |
| Daikenchuto | 49/939 | 7 | 7 | 0 | ***0.60(0.33 to 1.07)*** | 0.63(0.34 to 1.15) | 0.20(0.02 to 1.77) | Fixed | 0 | 0.082 | 0.134 | 0.149 | 1.439 to 3.612 | 0 | 0.596 | 0.275 | Yes | Yes | V | Low |
| Opioid antagonist | 9471/78971 | 25 | 25 | 0 | ***0.73(0.70 to 0.76)*** | 0.69(0.63 to 0.75) | 1.32(1.23 to 1.41) | Fixed | 0.0109 | < 0.01 | < 0.01 | < 0.01 | 1.747 to 2.975 | 40.2 | 0.021 | < 0.01 | Yes | Yes | II | Moderate |
| Acupuncture | | | | | | | | | | | | | | | | | | | | |
| MA | 4/78 | 1 | 1 | 0 | ***0.35(0.04 to 3.52)*** | 0.35(0.04 to 3.52) | 0.35(0.04 to 3.52) | NA | NA | 0.373 | 0.373 | 0.373 | 0.259 to 20.069 | NA | NA | NA | Yes | NA | V | Moderate |
| EA | 59/241 | 3 | 3 | 0 | ***1.12(0.60 to 2.07)*** | 1.13(0.55 to 2.33) | 0.93(0.45 to 1.95) | Fixed | 0.0583 | 0.724 | 0.737 | 0.854 | 0.764 to 6.800 | 10.7 | 0.326 | 0.364 | Yes | Yes | V | Moderate |
| Coffee | 103/913 | 9 | 9 | 0 | ***0.41(0.26 to 0.64)*** | 0.42(0.26 to 0.67) | 0.27(0.11 to 0.63) | Fixed | 0.0031 | < 0.01 | < 0.01 | < 0.01 | 1.731 to 3.003 | 0.7 | 0.424 | 0.098 | Yes | Yes | IV | Moderate |
| Coffee (caffeine) | 73/688 | 8 | 8 | 0 | ***0.45(0.26 to 0.76)*** | 0.50(0.26 to 0.96) | 0.27(0.11 to 0.63) | Fixed | 0.1099 | < 0.01 | 0.037 | < 0.01 | 0.955 to 5.440 | 14.0 | 0.323 | 0.150 | Yes | Yes | IV | Moderate |
| Coffee (Decafe) | 2/60 | 1 | 1 | 0 | ***1.00(0.06 to 16.74)*** | 1.00(0.06 to 16.74) | 1.00(0.06 to 16.74) | NA | NA | 1.000 | 1.000 | 1.000 | 1.780 to 7.667 $\times 10^4$ | NA | NA | NA | Yes | NA | V | Moderate |
| Other | | | | | | | | | | | | | | | | | | | | |
| GDFT | 5/142 | 1 | 1 | 0 | ***1.54(0.25 to 9.52)*** | 1.54(0.25 to 9.52) | 1.54(0.25 to 9.52) | NA | NA | 0.640 | 0.640 | 0.640 | 0.005 to 1.125 $\times 10^3$ | NA | NA | NA | Yes | NA | V | Moderate |
| GDFT and ERAS | 76/565 | 6 | 6 | 0 | ***1.58(0.95 to 2.62)*** | 1.58(0.74 to 3.38) | 0.70(0.25 to 1.99) | Fixed | 0.3670 | 0.077 | 0.238 | 0.502 | 0.371 to 13.999 | 42.8 | 0.120 | 0.691 | Yes | Yes | V | Moderate |
| ERAS | 27/1313 | 13 | 13 | 0 | ***1.52(0.74 to 3.16)*** | 1.57(0.70 to 3.53) | 3.33(0.88 to 12.68) | Fixed | 0 | 0.257 | 0.276 | 0.077 | 0.502 to 10.353 | 0 | 0.622 | 0.008 | Yes | Yes | V | Moderate |
| Chewing gum | 10/83 | 2 | 2 | 0 | ***0.29(0.07 to 1.26)*** | 0.29(0.07 to 1.26) | 0.29(0.06 to 1.48) | Fixed | 0 | 0.099 | 0.099 | 0.136 | 1.080 to 4.812 | 0 | 0.977 | NA | No | NA | V | High |

### Time to first bowel movement postoperatively

As demonstrated in Fig. 5 and Table 4, two interventions showed significant efficacy in accelerating the time to first postoperative bowel movement compared to placebo or conventional therapy: chewing gum [17] (SMD −17.32; 95% CI −23.41 to −11.22) and early enteral nutrition [16] (SMD −0.66; 95% CI −0.82 to −0.50). Both interventions were classified as Level II evidence with strong clinical recommendation.

Perioperative intravenous injection of lidocaine [30], metoclopramide [16], non-steroidal anti-inflammatory drugs [18], and early feeding [25] have an effect on shortening the first bowel movement time after surgery, but the evidence grading is relatively low.

Daikenchuto [19] and erythromycin [16] did not find evidence of statistically significant differences.

### Time to first bowel sounds postoperatively

As delineated in Fig. 6 and Table 5, the following interventions demonstrated modest efficacy in reducing the time to first postoperative bowel sounds compared to placebo or conventional therapy, albeit with limited evidence quality: acupuncture [13], electroacupuncture or transcutaneous electrical stimulation [22], manual acupuncture [23], coffee [24] and caffeinated coffee [24] and chewing gum [17].

Notably, decaffeinated coffee [24] showed no statistically significant evidence for accelerating bowel sound recovery.

### Time to first oral intake postoperatively

According to Fig. 7 and Table 6, it was found that compared with placebo or conventional treatment, electroacupuncture or transcutaneous electrical stimulation [22] has a certain effect on shortening the first postoperative feeding time, but the evidence grading is relatively low. Laxatives [20] and chewing gum [17] did not find evidence of statistically significant differences.

In the subgroup analysis of the first postoperative feeding time, we found that, ERAS protocols [31], non-steroidal anti-inflammatory drugs [18], probiotics or synthetic agents [21], coffee [24], and caffeinated coffee [24] have a certain effect on shortening the first solid diet time after surgery, but the evidence grading is relatively low. However, daikenchuto [32] did not find evidence of statistically significant differences.

Probiotics or synthetic agents [21] and ERAS protocols [31] have a certain effect on shortening the first liquid diet time after surgery, but the evidence grading is relatively low.

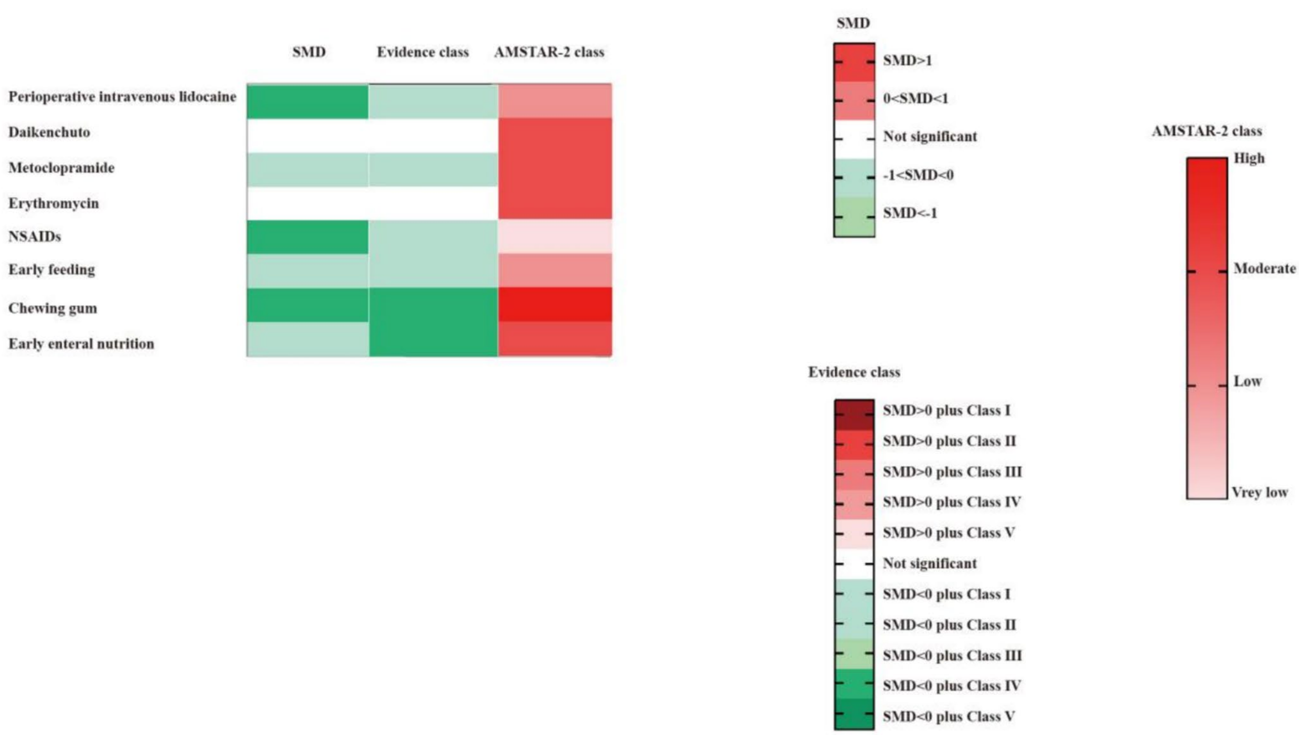



**Fig. 5** Postoperative time to first bowel movement

**Table 4** Postoperative time to first bowel movement

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference(SMD 95% CI) | | | Selected effect model | $Tau^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | RCT | OE | Fixed effects | Random effects | Largest study | | | Fixed | Random | Largest | | $I^2$(%) | $I^2$-P value | | | | | |
| Drug | | | | | | | | | | | | | | | | | | | | |
| Perioperative intravenous lidocaine | **NR/325** | **7** | **7** | **0** | **−6.53(−7.82 to −5.24)** | **−13.04(−21.55 to −4.52)** | **−5.90(−7.22 to −4.58)** | **Random** | **83.6614** | **< 0.01** | **< 0.01** | **< 0.01** | **−7.165 to 12.355** | **77.5** | **< 0.01** | **0.164** | **Yes** | **No** | IV | Low |
| Daikenchuto | **NR/787** | **6** | **6** | **0** | **−0.38(−0.49 to −0.27)** | **−0.29(−0.59 to 0.01)** | **−0.40(−0.53 to −0.27)** | **Random** | **0.0701** | **< 0.01** | **0.057** | **< 0.01** | **1.078 to 4.823** | **60.7** | **0.026** | **0.323** | **Yes** | **Yes** | V | Moderate |
| Metoclopramide | **NR/821** | **3** | **3** | **0** | **−0.10(−0.13 to −0.07)** | **−0.10(−0.13 to −0.07)** | **−0.10(−0.13 to −0.07)** | **Fixed** | **0** | **< 0.01** | **< 0.01** | **< 0.01** | **2.196 to 2.367** | **0** | **0.935** | **0.938** | **Yes** | **Yes** | IV | Moderate |
| Erythromycin | NR/211 | 2 | 2 | 0 | **−0.05(−0.45 to 0.34)** | −0.05(−0.45 to 0.34) | −0.20(−0.75 to 0.35) | Fixed | 0 | 0.799 | 0.799 | 0.480 | 1.394 to 3.729 | 0 | 0.455 | NA | Yes | NA | V | Moderate |
| NSAIDs | **NR/515** | **5** | **5** | **0** | **−12.09(−17.16 to −7.02)** | **−12.09(−17.16 to −7.02)** | **−12.00(−21.95 to −2.05)** | **Fixed** | **0** | **< 0.01** | **< 0.01** | **0.018** | **0.004 to $1.289\times10^3$** | **0** | **0.636** | **0.956** | **Yes** | **No** | IV | Vrey low |
| Other | | | | | | | | | | | | | | | | | | | | |
| Early feeding | **NR/735** | **4** | **4** | **0** | **−0.76(−0.93 to −0.58)** | **−0.63(−1.03 to −0.24)** | **−0.70(−0.98 to −0.42)** | **Random** | **0.1185** | **< 0.01** | **< 0.01** | **< 0.01** | **0.859 to 6.055** | **77.3** | **< 0.01** | **0.205** | **Yes** | **Yes** | IV | Low |
| Chewing gum | **NR/1680** | **21** | **21** | **0** | **−19.78(−20.67 to −18.88)** | **−17.32(−23.41 to −11.22)** | **−26.20(−27.46 to −24.94)** | **Random** | **139.5694** | **< 0.01** | **< 0.01** | **< 0.01** | **−10.712 to 15.272** | **95.8** | **< 0.01** | **0.438** | **Yes** | **Yes** | II | High |
| Early enteral nutrition | NR/3468 | 20 | 20 | 0 | −0.45(−0.47 to −0.42) | **−0.66(−0.82 to −0.50)** | −0.30(−0.33 to −0.27) | Random | 0.0898 | **< 0.01** | **< 0.01** | **< 0.01** | 1.066 to 4.877 | 95.4 | **< 0.01** | 0.137 | Yes | No | II | Moderate |

## Length of hospital stay postoperatively

According to Fig. 8 and Table 7, several factors significantly impacted the reduction in postoperative hospital stay compared with that of placebo or standard treatment. Opioid receptor antagonists [28] (SMD −1.08; 95% CI −1.47 to −0.69), early enteral nutrition [16] (SMD −1.41; 95% CI −1.80 to −1.03), ERAS protocols [15] (SMD −2.53; 95% CI −3.42 to −1.65), and chewing gum [17] (SMD −1.10; 95% CI −1.71 to −0.50) all demonstrated significant effects, with high-quality evidence classified as Class II.

Additionally, acupuncture [13], electroacupuncture or transcutaneous electrical stimulation [22], probiotics or synthetic agents [21], daikenchuto [19], coffee [24], early feeding [25] and combined GDFT and ERAS protocols [26] also appeared to have some effect in reducing the postoperative hospital stay; however, the evidence quality for these interventions was classified as weak.

Furthermore, we observed that manual acupuncture [23], perioperative intravenous injection of lidocaine [33], erythromycin [16], laxatives [20], caffeinated coffee [24], decaffeinated coffee [24] and goal-directed fluid therapy (GDFT) [26] did not yield evidence of statistically significant differences in shortening the duration of postoperative hospital stay.

## Incidence of postoperative nausea and vomiting

According to Fig. 9 and Table 8, compared with placebo or standard treatment, Non-steroidal anti-inflammatory drugs [34] have a certain effect on reducing the incidence of postoperative nausea and vomiting, but the evidence grading is relatively low. However, no statistically significant differences were found in the perioperative intravenous injection of lidocaine [33].

Acupressure [35] has a certain effect on reducing the incidence of postoperative nausea, but the evidence grading is relatively low. However, no statistically significant differences were found when chewing gum [27].

Acupressure [35] has a certain effect on reducing the incidence of postoperative vomiting, but the evidence grading is relatively low. However, no statistically significant differences were found when chewing gum [27].

## Postoperative complication rates

According to Fig. 10 and Table 9, compared with placebo or standard treatment,for the reduction of the overall incidence of postoperative complications, ERAS protocols [31] and coffee [24] has a certain effect, but the evidence is poorly graded. Regarding the total incidence of postoperative

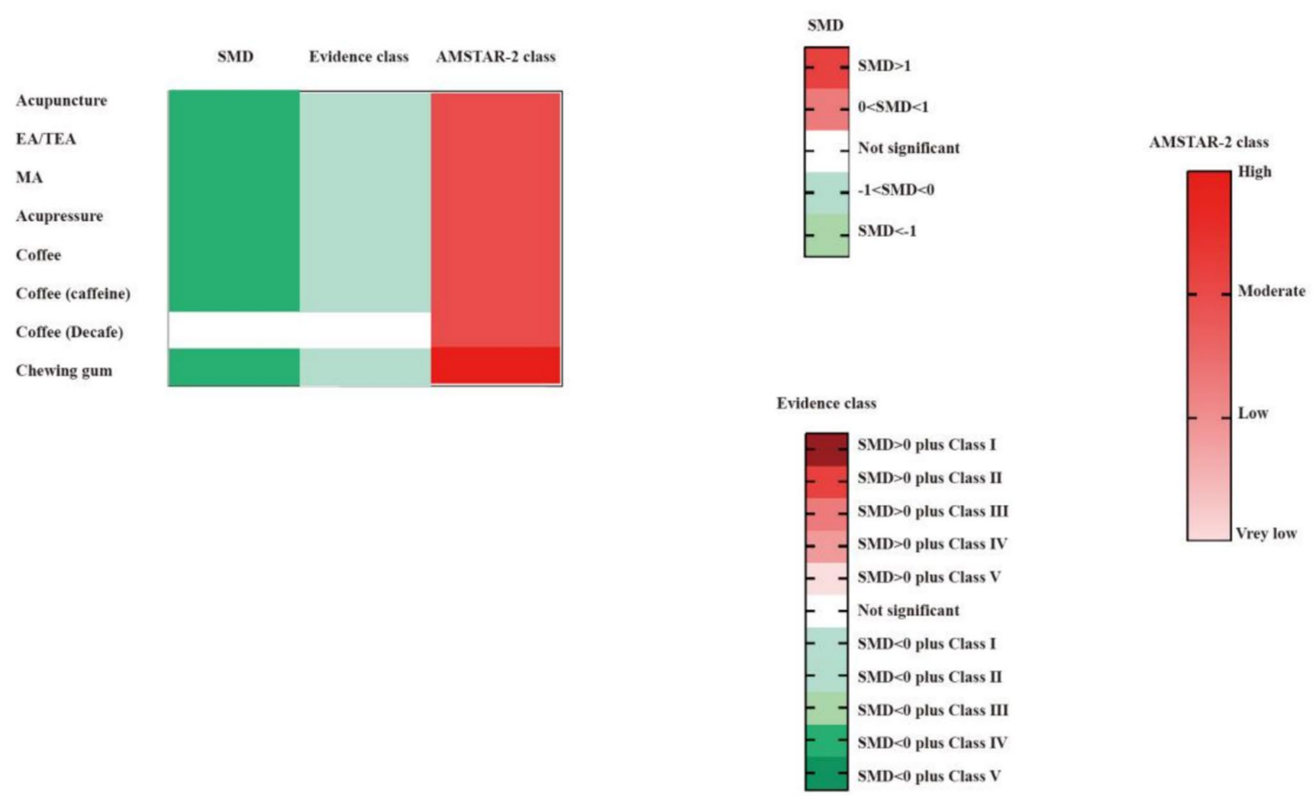



**Fig. 6** Postoperative time to first bowel sounds

**Table 5** Postoperative time to first bowel sounds

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | $Tau^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | RCT | OE | Fixed effects | Random effects | Largest study | | | Fixed | Random | Largest | | $I^2$(%) | $I^2$-P value | | | | | |
| Acupuncture | **NR/800** | **11** | **11** | **0** | **−6.78(−7.21 to −6.34)** | **−6.82(−8.60 to −5.04)** | 0.00(−4.04 to 4.04) | Random | 7.3762 | < 0.01 | < 0.01 | 1.000 | 0.002 to 2.541 $\times 10^3$ | 90.1 | < 0.01 | **0.915** | Yes | No | IV | Moderate |
| EA/TEA | **NR/560** | **9** | **9** | **0** | **−9.25(−10.21 to −8.30)** | **−7.26(−10.27 to −4.24)** | −11.15(−12.51 to −9.79) | Random | 15.0017 | < 0.01 | < 0.01 | < 0.01 | 3.380 to 6.203 $\times 10^4$ | 84.6 | < 0.01 | **0.168** | Yes | Yes | IV | Moderate |
| MA | **NR/154** | **2** | **2** | **0** | **−7.28(−7.84 to −6.72)** | **−9.19(−13.99 to −4.39)** | −7.20(−7.77 to −6.63) | Random | 9.8663 | < 0.01 | < 0.01 | < 0.01 | 0.000 to 3.943 $\times 10^4$ | 78.9 | 0.029 | **NA** | Yes | NA | IV | Moderate |
| Acupressure | **NR/193** | **3** | **3** | **0** | **−7.27(−7.83 to −6.71)** | **−8.45(−11.88 to −5.01)** | −7.20(−7.77 to −6.63) | Random | 5.4840 | < 0.01 | < 0.01 | < 0.01 | 0.002 to 2.955 $\times 10^3$ | 58.9 | 0.088 | **0.616** | Yes | No | IV | Moderate |
| Coffee | **NR/683** | **6** | **6** | **0** | **−1.33(−1.77 to −0.89)** | **−4.31(−7.10 to −1.52)** | −0.32(−0.86 to 0.22) | Random | 9.1450 | < 0.01 | < 0.01 | 0.243 | 0.001 to 8.200 $\times 10^3$ | 94.7 | < 0.01 | **0.142** | Yes | No | IV | Moderate |
| Coffee (caffeine) | **NR/413** | **4** | **4** | **0** | **−0.79(−1.26 to −0.31)** | **−4.24(−7.43 to −1.05)** | −0.32(−0.86 to 0.22) | Random | 9.3952 | < 0.01 | < 0.01 | 0.243 | 4.624 $\times 10^{-4}$ to 1.124 $\times 10^4$ | 94.9 | < 0.01 | **0.085** | Yes | Yes | IV | Moderate |
| Coffee (Decafe) | **NR/75** | **1** | **1** | **0** | **−1.25(−38.99 to 36.48)** | **−1.25(−38.99 to 36.48)** | **−1.25(−38.99 to 36.48)** | NA | NA | 0.948 | 0.948 | 0.948 | −13.511 to 26.941 | NA | NA | **NA** | Yes | NA | V | Moderate |
| Other | | | | | | | | | | | | | | | | | | | | |
| Chewing gum | **NR/505** | **4** | **4** | **0** | **−6.38(−6.68 to −6.08)** | **−6.02(−7.42 to −4.63)** | −6.40(−6.70 to −6.10) | Fixed | 0.7062 | < 0.01 | < 0.01 | < 0.01 | 0.281 to 18.474 | 26.0 | 0.256 | **0.265** | Yes | Yes | IV | High |

complications, coffee [24] and decaffeinated coffee [24] similarly did not show evidence of statistically significant differences.

ERAS protocols [31] has a certain effect on reducing postoperative lung infections, but the evidence grading is low. However, chewing gum [27] did not yield evidence of statistically significant differences in reduce the incidence of postoperative lung infections.

Additionally, neither ERAS protocols [15] nor nonsteroidal anti-inflammatory drugs [34] demonstrated evidence of statistically significant differences in reducing the incidence of postoperative surgical site infections.

ERAS protocols [15] and selective nonsteroidal anti-inflammatory drugs (NSAIDs) [34], did not yield evidence of statistically significant differences in reduce the incidence of postoperative anastomotic leaks. However, nonsteroidal anti-inflammatory drugs [34] and nonselective nonsteroidal anti-inflammatory drugs [34] have a certain effect on increasing the incidence of postoperative anastomotic leakage, and the evidence grading is Class II.

Finally, nonsteroidal anti-inflammatory drugs [34] did not yield evidence of statistically significant differences in reduce the incidence of postoperative cardiovascular events.

## Discussion

### Findings

To the best of our knowledge, this is the first umbrella review assessing the efficacy and safety of treatment methods for postoperative ileus through a meta-analysis of randomized controlled trials. In this umbrella review, we provide a comprehensive overview of the existing evidence and evaluate the methodological quality of the included meta-analyses, along with the overall quality of the evidence associated with these treatments. A total of 24 published meta-analyses were included, encompassing 27 treatment modalities, primarily consisting of medications, acupuncture, chewing gum, coffee, ERAS protocols, and other relevant interventions.

The implementation of these treatment factors during the perioperative period may significantly reduce the time to first flatus, time to first defecation, time to first bowel movement, time to first bowel sounds, time to first oral intake, length of hospital stay, incidence of postoperative nausea and vomiting, incidence of postoperative ileus, and overall incidence of postoperative complications. This study provides clear evidence comparing the efficacy and safety of various treatment methods for postoperative

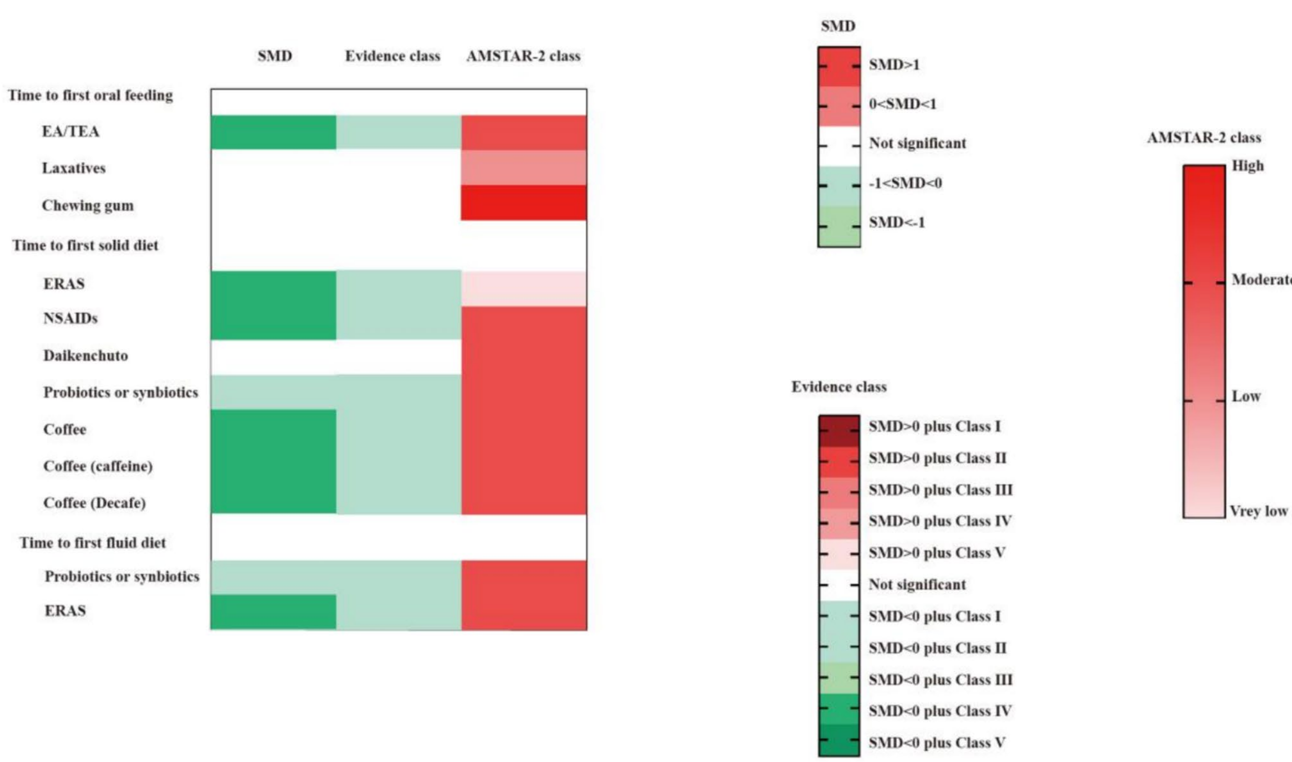



**Fig. 7** Time to first feeding postoperatively

**Table 6** Time to first feeding postoperatively

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | Tau$^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | RCT | OE | **Fixed effects** | **Random effects** | **Largest study** | | | **Fixed** | **Random** | **Largest** | | $I^2$(%) | **$I^2$-P value** | | | | | |
| Time to first oral feeding | | | | | | | | | | | | | | | | | | | | |
| Acupuncture | | | | | | | | | | | | | | | | | | | | |
| EA/TEA | **NR/439** | **6** | **6** | **0** | **−18.77(−23.86 to −13.68)** | **−15.76(−23.91 to −7.61)** | −23.80(−30.65 to −16.96) | Fixed | 45.7001 | < 0.01 | < 0.01 | < 0.01 | −3.513 to 1.158 $\times 10^8$ | 46.8 | 0.094 | **0.117** | Yes | Yes | IV | Moderate |
| Drug | | | | | | | | | | | | | | | | | | | | |
| Laxatives | **NR/288** | **3** | **3** | **0** | **−0.01(−0.12 to 0.10)** | **−0.01(−0.12 to 0.10)** | 0.00(−0.11 to 0.11) | Fixed | 0 | 0.865 | 0.865 | 1.000 | 1.983 to 2.621 | 0 | 0.677 | **0.380** | Yes | No | V | Low |
| Other | | | | | | | | | | | | | | | | | | | | |
| Chewing gum | **NR/103** | **2** | **2** | **0** | **−15.94(−31.42 to −0.46)** | **−14.74(−47.67 to 18.18)** | −31.20(−52.15 to −10.25) | Random | 438.6615 | 0.044 | 0.380 | < 0.01 | −22.807 to 36.394 | 77.7 | 0.034 | **NA** | Yes | NA | V | High |
| Time to first solid diet | | | | | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | | | | | |
| ERAS | **NR/842** | **4** | **4** | **0** | **−2.40(−2.62 to −2.19)** | **−2.38(−2.96 to −1.79)** | −2.40(−2.64 to −2.16) | Random | 0.2291 | < 0.01 | < 0.01 | < 0.01 | 0.573 to9.075 | 68.7 | 0.022 | **0.924** | Yes | Yes | IV | Vrey low |
| Drug | | | | | | | | | | | | | | | | | | | | |
| NSAIDs | **NR/289** | **2** | **2** | **0** | **−11.95(−18.66 to −5.24)** | **−11.95(−18.66 to −5.24)** | −12.00(−21.26 to −2.74) | Fixed | 0.0000 | < 0.01 | < 0.01 | 0.011 | 5.201 $\times 10^{-4}$ to 9.995 $\times 10^3$ | 0 | 0.988 | **NA** | Yes | NA | IV | Moderate |
| Daiken-chuto | **NR/258** | **2** | **2** | **0** | **−5.08(−12.61 to 2.45)** | **3.64(−24.45 to 31.74)** | −6.45(−14.15 to 1.25) | Random | 291.9025 | 0.186 | 0.799 | < 0.01 | −19.749 to 25.223 | 63.0 | 0.100 | **NA** | Yes | NA | V | Moderate |
| Probiotics or synbiotics | **NR/437** | **5** | **5** | **0** | **−0.25(−0.39 to −0.12)** | **−0.25(−0.39 to −0.12)** | −0.30(−0.48 to −0.12) | Fixed | 0.0000 | < 0.01 | < 0.01 | < 0.01 | 1.925 to 2.701 | 0 | 0.942 | **0.469** | Yes | Yes | IV | Moderate |
| Coffee | **NR/835** | **8** | **8** | **0** | **−1.94(−2.50 to −1.39)** | **−10.11(−14.26 to −5.95)** | 0.26(−0.46 to 0.98) | Random | 21.8447 | < 0.01 | < 0.01 | 0.478 | 1.891 to 6.588 $\times 10^5$ | 95.2 | < 0.01 | **0.044** | Yes | Yes | IV | Moderate |
| Coffee (caffeine) | **NR/610** | **7** | **7** | **0** | **−1.51(−2.08 to −0.94)** | **−8.46(−12.65 to −4.27)** | 0.26(−0.46 to 0.98) | Random | 16.3033 | < 0.01 | < 0.01 | 0.478 | 1.861 to 1.656 $\times 10^5$ | 93.9 | < 0.01 | **0.116** | Yes | No | IV | Moderate |
| Coffee (Decafe) | **NR/60** | **1** | **1** | **0** | **−22.80(−35.97 to −9.63)** | **−22.80(−35.97 to −9.63)** | **−22.80(−35.97 to −9.63)** | NA | NA | < 0.01 | < 0.01 | < 0.01 | −6.623 to 3.201 $\times 10^7$ | NA | NA | **NA** | Yes | NA | IV | Moderate |

**Table 6** (continued)

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) Total | RCT | OE | Summary mean difference (SMD, 95% CI) Fixed effects | Random effects | Largest study | Selected effect model | $Tau^2$ | P value Fixed | Random | Largest | 95% PI | Heterogeneity $I^2$(%) | $I^2$-P value | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time to first fluid diet | | | | | | | | | | | | | | | | | | | | |
| Drug | | | | | | | | | | | | | | | | | | | | |
| Probiotics or synbiotics | **NR/294** | **3** | **3** | **0** | **−0.29(−0.47 to −0.11)** | **−0.29(−0.47 to −0.11)** | −0.30(−0.52 to −0.08) | Fixed | 0.0000 | < 0.01 | < 0.01 | < 0.01 | 1.822 to 2.854 | 0 | 0.832 | **0.953** | Yes | Yes | IV | Moderate |
| Other | | | | | | | | | | | | | | | | | | | | |
| ERAS | **NR/735** | **2** | **2** | **0** | **−2.30(−2.37 to −2.23)** | **−2.33(−2.54 to −2.11)** | −2.30(−2.37 to −2.23) | Fixed | 0.0107 | < 0.01 | < 0.01 | < 0.01 | 1.743 to 2.982 | 12.1 | 0.286 | **NA** | Yes | NA | IV | Moderate |

ileus, offering effective strategies for clinicians in the prevention and management of this condition.

Moreover, the methodological quality of the included meta-analyses varied significantly. Among the outcome measures, the time to first flatus and time to first bowel movement are critical in assessing gastrointestinal dysfunction and postoperative ileus. These indicators are often regarded as markers of the resolution of postoperative ileus and are important metrics for evaluating the efficacy of interventions [24].

This study revealed that chewing gum, ERAS protocols, acupuncture, early enteral nutrition, Da-Cheng-Qi-Tang, neostigmine injection at the acupuncture point Zusanli, coffee, and opioid receptor antagonists all significantly alleviated postoperative ileus. Notably, ERAS protocols, chewing gum, early enteral nutrition, and opioid receptor antagonists (each classified as Class II) not only relieved postoperative ileus but also reduced hospital stay duration, making them viable treatment options for patients with postoperative ileus. Additionally, this study revealed that coffee significantly reduced the time to first defecation postoperatively.

## Possible mechanisms

The pathophysiology of postoperative ileus remains unclear and is likely related to the interplay of various factors [51]. Among these factors, excessive surgical stimulation of the sympathetic nervous system, which leads to gastrointestinal motility inhibition, may be the most significant factor [52]. Additionally, the secretion of substance P and nitric oxide by the enteric nervous system can prolong the duration of postoperative ileus. Surgical intervention triggers an inflammatory cascade, releasing a substantial amount of inflammatory mediators such as interleukin-6, interleukin-1, monocyte chemoattractant protein-1, and cell adhesion molecule-1. These inflammatory mediators can directly damage the intestinal musculature, further impeding the recovery of gastrointestinal function [51, 52].

Opioids are clinically used for pain management during different types of perioperative care; however, these medications significantly impact gastrointestinal motility by activating μ-opioid receptors on intestinal interstitial cells, which can lead to the inhibition of acetylcholine (ACh) release from enteric neurons and a reduction in gastrointestinal transit [53]. Therefore, administering opioid receptor antagonists (such as alvimopan and methylnaltrexone) postoperatively is a promising therapeutic strategy to mitigate the effects of opioids on gastrointestinal function.

In this study, opioid receptor antagonists effectively reduced the incidence of postoperative ileus and shortened the hospital stay (class II). Although there were no reports regarding adverse events in the included meta-analyses, previous multicenter randomized controlled trials indicated that alvimopan had a similar incidence of adverse events to placebo [54]. Furthermore, in a meta-analysis focusing on opioid antagonist treatment for opioid-induced constipation, opioid antagonists increased the overall incidence of adverse events compared with that of placebo, without increasing the risk of serious adverse events [55].

In summary, opioid receptor antagonists are effective in improving postoperative ileus without causing serious adverse events, making them a relatively safe option.

This study revealed that chewing gum significantly shortened the time to first flatus, time to first bowel movement, and length of hospital stay postoperatively. The mechanism by which chewing gum exerts its effects is not yet fully understood; it is believed to mimic the mechanisms of food intake, thereby significantly stimulating the stomach, duodenum, and rectum [56]; promoting secretory activities in the stomach, pancreas, and duodenum [57, 58]; and enhancing the release of neuropeptides [56]. The physiological mechanism involves activation of the cephalic−vagal axis, which stimulates intestinal myoelectric activity to counteract the activation of gastrointestinal opioid receptors [59].

Additionally, chewing gum may stimulate salivary secretion, leading to the production of adequate amounts of nitric oxide, which can combat pathogens within the oral cavity and intestines [60]. Furthermore, chewing gum may provide a better option for mitigating the potential risks associated with early postoperative enteral or oral feeding. By mimicking the effects of nonnutritive feeding, chewing gum primarily promotes recovery of the neuroendocrine system, and most researchers generally believe that it does not increase the incidence of adverse events.

This study revealed that coffee significantly shortened the time to first defecation postoperatively. The mechanisms by which coffee affects postoperative ileus (POI) are not yet fully understood; however, factors such as caffeine and the phenolic antioxidant compounds predominantly found in chlorogenic acid [61] may play crucial roles. Caffeine is known to exert positive effects on inflammation by facilitating the release of $Ca^{2+}$ from the sarcoplasmic reticulum, inhibiting cyclic guanosine monophosphate (cGMP) degradation, and activating cation channels sensitive to cyanide, thereby promoting the synthesis of nitric oxide in endothelial cells and enhancing caffeine-induced endothelium-dependent vasodilation [62–64]. This vasodilation may subsequently aid in the recovery of gastrointestinal function postoperatively [65, 66].

Given that coffee is a low-stimulus beverage with minimal residue, it is generally regarded as safe by most researchers. Additionally, this study revealed that the consumption of coffee did not increase the incidence of adverse events.

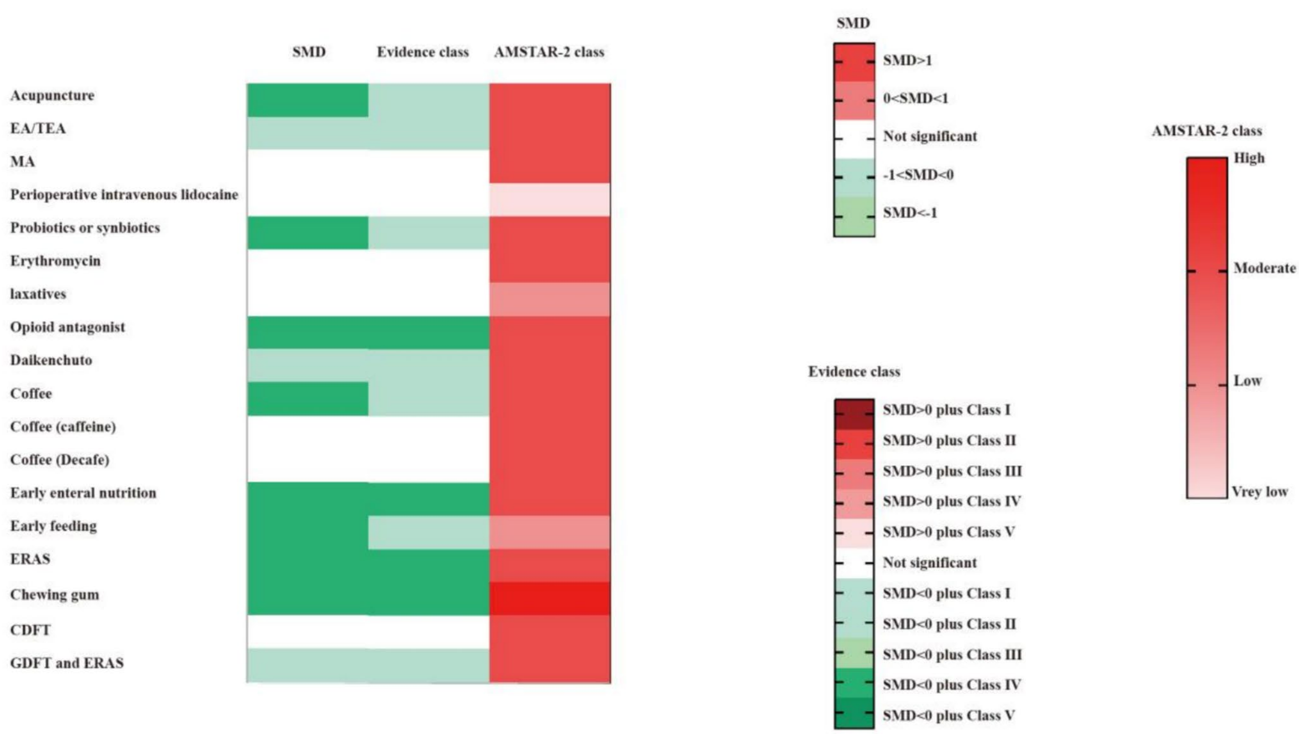



**Fig. 8** Length of hospital stay postoperative

**Table 7** Length of hospital stay postoperative

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | $Tau^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | RCT | OE | Fixed effects | Random effects | Largest study | | | Fixed | Random | Largest | | $I^2$(%) | $I^2$-P value | | | | | |
| Acupuncture | **NR/605** | **8** | 8 | 0 | −1.87(−2.13 to −1.61) | **−1.68(−2.55 to −0.80)** | −2.00(−2.33 to −1.67) | Random | 1.2276 | < 0.01 | < 0.01 | < 0.01 | 0.122 to 42.544 | 86 | < 0.01 | **0.663** | Yes | Yes | IV | Moderate |
| EA/TEA | **NR/510** | **8** | 8 | 0 | **−0.77(−1.09 to −0.45)** | **−1.19(−1.78 to −0.60)** | −0.42(−0.83 to −0.02) | Fixed | 0.2585 | < 0.01 | < 0.01 | 0.042 | 0.616 to 8.436 | 44 | 0.085 | **0.003** | Yes | Yes | IV | Moderate |
| MA | **NR/78** | **1** | 1 | 0 | **0.65(−1.25 to 2.55)** | 0.65(−1.25 to 2.55) | 0.65(−1.25 to 2.55) | NA | NA | 0.501 | 0.501 | 0.501 | 0.212 to 24.512 | NA | NA | **NA** | Yes | NA | V | Moderate |
| Drug | | | | | | | | | | | | | | | | | | | | |
| Perioperative intravenous lidocaine | **NR/220** | **5** | 5 | 0 | −0.59(−0.94 to −0.25) | **−0.58(−1.34 to 0.18)** | −0.20(−0.70 to 0.30) | Random | 0.4993 | < 0.01 | 0.136 | 0.429 | 0.316 to 16.451 | 72.9 | < 0.01 | **0.778** | Yes | No | V | Very low |
| Probiotics or synbiotics | **NR/880** | **12** | 12 | 0 | −0.84(−1.12 to −0.57) | **−1.43(−2.29 to −0.58)** | −0.63(−0.95 to −0.31) | Random | 0.9963 | < 0.01 | < 0.01 | < 0.01 | 0.158 to 32.892 | 67.3 | < 0.01 | **0.099** | Yes | Yes | IV | Moderate |
| Erythromycin | **NR/232** | **3** | **3** | **0** | **0.29(−0.31 to 0.88)** | **0.29(−0.31 to 0.88)** | **−0.10(−0.92 to 0.72)** | **Fixed** | **0** | **0.346** | **0.346** | **0.811** | **1.087 to 4.782** | **0** | **0.385** | **0.997** | **Yes** | **No** | **V** | Moderate |
| laxatives | **NR/416** | **5** | **5** | **0** | **0.45(0.22 to 0.68)** | **−0.06(−1.75 to 1.63)** | **1.25(0.96 to 1.54)** | **Random** | **2.3706** | < 0.01 | **0.942** | < 0.01 | **0.030 to 171.969** | **95.2** | < 0.01 | **0.726** | **Yes** | **No** | **V** | Low |
| Opioid antagonist | **NR/82598** | **25** | **25** | **0** | **−0.96(−0.99 to −0.92)** | **−1.08(−1.47 to −0.69)** | **−0.60(−0.66 to −0.54)** | **Random** | **0.8996** | < 0.01 | < 0.01 | < 0.01 | **0.212 to 24.503** | **99.0** | < 0.01 | **0.467** | **Yes** | **No** | **II** | Moderate |
| Daikenchuto | **NR/205** | **4** | 4 | 0 | −1.33(−1.52 to −1.14) | **−0.96(−1.70 to −0.21)** | −1.40(−1.60 to −1.20) | Random | 0.2634 | < 0.01 | 0.012 | < 0.01 | 0.476 to 10.913 | 57.2 | 0.072 | **0.228** | Yes | Yes | IV | Moderate |
| Coffee | **NR/951** | **10** | **10** | 0 | −0.77(−0.85 to −0.68) | **−1.36(−2.49 to −0.24)** | −0.50(−0.62 to −0.38) | Random | 3.1047 | < 0.01 | 0.017 | < 0.01 | 0.024 to 213.330 | 99.1 | < 0.01 | **0.368** | Yes | No | IV | Moderate |
| Coffee (caffeine) | **NR/726** | **9** | 9 | 0 | −1.08(−1.21 to −0.96) | **−1.51(−3.12 to 0.11)** | −0.09(−0.27 to 0.09) | Random | 5.8909 | < 0.01 | 0.067 | 0.314 | 0.004 to 1.216 $\times 10^3$ | 99.2 | < 0.01 | **0.469** | Yes | No | V | Moderate |
| Coffee (Decafe) | **NR/60** | **1** | 1 | 0 | **0.00(−0.43 to 0.43)** | **0.00(−0.43 to 0.43)** | **0.00(−0.43 to 0.43)** | NA | NA | 1.000 | 1.000 | 1.000 | 1.332 to 3.903 | NA | NA | **NA** | Yes | NA | V | Moderate |
| Other | | | | | | | | | | | | | | | | | | | | |
| Early enteral nutrition | **NR/4045** | **28** | **28** | **0** | **−0.87(−0.92 to −0.82)** | **−1.41(−1.80 to −1.03)** | **−0.60(−0.66 to −0.54)** | **Random** | **0.6642** | < 0.01 | < 0.01 | < 0.01 | **0.293 to 17.769** | **96** | < 0.01 | **0.123** | **Yes** | **No** | **II** | Moderate |
| Early feeding | **NR/785** | **5** | 5 | 0 | −3.56(−3.70 to −3.43) | **−2.33(−4.10 to −0.56)** | −3.70(−3.84 to −3.56) | Random | 3.4925 | < 0.01 | 0.010 | < 0.01 | 0.014 to 367.962 | 95.3 | < 0.01 | **0.217** | Yes | Yes | IV | Low |
| ERAS | **NR/1716** | **18** | 18 | 0 | −2.55(−2.70 to −2.40) | **−2.53(−3.42 to −1.65)** | −1.30(−1.61 to −0.99) | Random | 3.4184 | < 0.01 | < 0.01 | < 0.01 | 0.022 to 241.732 | 96.8 | < 0.01 | **0.976** | Yes | No | II | Moderate |
| Chewing gum | **NR/1714** | **20** | **20** | 0 | −0.94(−1.19 to −0.68) | **−1.10(−1.71 to −0.50)** | 0.20(−0.32 to 0.72) | Random | 0.9075 | < 0.01 | < 0.01 | 0.447 | 0.196 to 26.511 | 71.3 | < 0.01 | **0.643** | Yes | No | II | High |
| CDFT | **NR/566** | **7** | **7** | **0** | **−0.61(−1.27 to 0.05)** | **−0.73(−1.68 to 0.23)** | **−0.50(−1.46 to 0.46)** | **Fixed** | **0.5003** | **0.071** | **0.136** | **0.309** | **0.335 to 15.532** | **38.2** | **0.152** | **0.276** | **Yes** | **No** | **V** | Moderate |

**Table 7** (continued)

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary mean difference (SMD, 95% CI) | | | Selected effect model | $Tau^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | RCT | OE | Fixed effects | Random effects | Largest study | | | Fixed | Random | Largest | | $I^2$(%) | $I^2$-P value | | | | | |
| GDFT and ERAS | **NR/60** | **1** | **1** | **0** | **−0.63(−0.94 to −0.33)** | **−0.63(−0.94 to −0.33)** | −0.63(−0.94 to −0.33) | NA | **NA** | < 0.01 | < 0.01 | < 0.01 | **1.557 to 3.338** | **NA** | **NA** | **NA** | **Yes** | **NA** | **IV** | Moderate |

This study revealed that acupuncture significantly shortened the time to first flatus postoperatively. Some research suggests that the preservation of the functionality of interstitial cells of Cajal and the activation of the vagus nerve through acupuncture may be potential mechanisms underlying this effect [67, 68]. Furthermore, the injection of medications at acupuncture points may enhance and sustain the effects of simple acupuncture. In traditional Chinese medicine, the ST36 point is considered an effective location for treating various gastrointestinal disorders, although further research is needed to elucidate the specific mechanisms of action.

Due to the minimal tissue damage associated with acupuncture itself, some studies have indicated that patients may experience localized pain during or after the procedure [69] and, in rare cases, may face serious adverse events such as needle breakage, visceral injury, or bleeding [70]. However, acupuncture is generally regarded as a relatively safe treatment modality. In this study, it was found that acupuncture is safe in the context of postoperative ileus (POI) and does not increase the incidence of adverse events.

Traditionally, postoperative oral feeding following gastrointestinal surgery has been delayed to protect against anastomoses and prevent postoperative anastomotic leaks and other complications. Although early oral feeding in Enhanced Recovery After Surgery (ERAS) protocols may increase the risk of vomiting and abdominal distension [71], current research indicates that early oral feeding is not only safe but also beneficial for the recovery of intestinal function [72–74]. While certain components of the ERAS protocol, such as nutritional support and carbohydrate loading, may not be feasible in critically ill patients with hemodynamic instability, most elements of the ERAS protocol are considered applicable and appropriate even in emergency situations. Comprehensive preoperative consultations can help mitigate postoperative stress, pain, and anxiety [75], which may not be completely realizable in emergency contexts; however, information regarding surgical details, potential perioperative complications, the need for ostomies, and anticipated hospital stays can still be communicated to patients and their families prior to surgery.

On the other hand, while achieving fully optimized medical conditions may not be possible in emergency settings, objective intravenous fluid administration and antibiotic coverage are crucial and feasible in major emergency abdominal surgeries [76]. This study revealed that early oral enteral nutrition and ERAS protocols significantly shortened the time to first flatus postoperatively, with early oral enteral nutrition also significantly reducing the time to first bowel movement and length of hospital stay without causing serious adverse events, thereby demonstrating relative safety.

This study revealed that Da-Cheng-Qi-Tang (DCQD) significantly shortened the time to first flatus postoperatively.

Pharmacological studies and animal experiments have demonstrated that the active components in DCQD can prevent intestinal adhesions by reducing the concentration of fibrinogen in the peritoneal exudate following major abdominal surgery and increasing the concentration of fibrin degradation products [77]. Notably, the active constituent rhubarb can enhance small intestinal motility through mechanisms such as promoting the secretion of motilin, decreasing somatostatin levels, and inhibiting the activity of sodium–potassium exchange ATPase in the small intestinal mucosa [78]. However, the included meta-analyses did not report any adverse events related to the use of Da-Cheng-Qi-Tang.

## Advantages and limitations of this study

Advantages: (1) This is the first umbrella review analyzing the efficacy and safety of treatment methods for postoperative ileus. (2) Compared with other studies synthesizing information on postoperative ileus, we employed rigorous evidence evaluation criteria to assess bias and methodological limitations, thereby providing a systematic and comprehensive assessment.

Limitations: (1) Firstly, our analysis results are based on previously published meta-analyses, not our research data; Secondly, in clinical treatment, due to the implementation of multiple treatment methods, there may be overlapping treatment methods, leading to excessive exaggeration of intervention results; Finally, the intervention subjects included in the meta-analysis of this study were only patients undergoing abdominal surgery, which may be influenced by different abdominal surgeries (such as gynecological surgery, gastrointestinal surgery, etc.) and surgical methods (such as laparoscopic surgery, robotic surgery, etc.), indicating that classification should be emphasized in future research; (2) Many RCTs and meta-analyses have methodological flaws, as blinding may not be applicable to all types of interventions, such as acupuncture and chewing gum; (3) Some studies lack registration of research protocols, particularly in the field of postoperative ileus, which impacts the quality rating, as highlighted in key criterion 2 of the AMSTAR2 assessment; (4) The limited number of studies or sample sizes included in some meta-analyses affects the statistical power and external validity of the findings; (5) Several treatment protocols, such as opioid receptor antagonists and Da-Cheng-Qi-Tang, have not undergone safety assessments; (6) The variability in certain treatment protocols, such as acupuncture techniques (including needle placement, treatment duration, and frequency) and ERAS components (which differ in terms of covered items and timing of interventions),

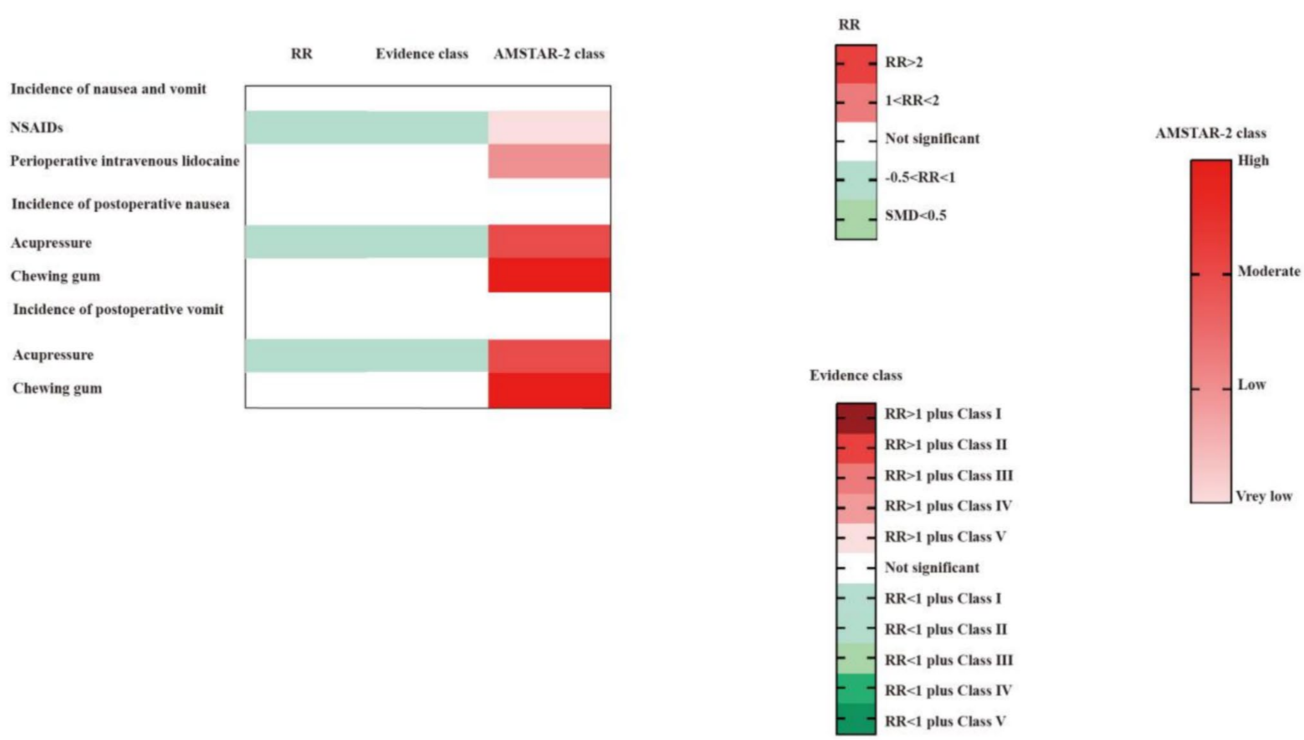



**Fig. 9** Incidence of postoperative nausea and vomiting

**Table 8** Incidence of postoperative nausea and vomiting

| Exposure or intervention | Events or cases/total(n.) | Studies(n.) | | | Summary risk ratio estimate(RR, 95% CI) | | | Selected effect model | Tau$^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | RCT | OE | Fixed effects | Random effects | Largest study | | | Fixed | Random | Largest | | I$^2$(%) | I$^2$-P value | | | | | |
| Incidence of nausea and vomit | | | | | | | | | | | | | | | | | | | | |
| NSAIDs | **122/489** | 4 | 4 | 0 | **0.63(0.42 to 0.94)** | 0.63(0.42 to 0.94) | 0.65(0.36 to 1.16) | Fixed | 0 | 0.025 | 0.025 | 0.145 | 1.642 to 3.165 | 0 | 0.955 | 0.948 | No | No | IV | Very low |
| Perioperative intravenous lidocaine | **71/170** | 5 | 5 | 0 | **0.59(0.33 to 1.06)** | 0.62(0.34 to 1.11) | 0.17(0.02 to 1.51) | Fixed | 0 | 0.076 | 0.105 | 0.111 | 1.449 to 3.587 | 0 | 0.806 | 0.034 | No | Yes | V | Low |
| Incidence of postoperative nausea | | | | | | | | | | | | | | | | | | | | |
| Acupressure | **355/858** | 6 | 6 | 0 | **0.70(0.54 to 0.90)** | 0.71(0.55 to 0.91) | 0.68(0.41 to 1.12) | Fixed | 0 | **< 0.01** | **< 0.01** | 0.132 | 1.821 to 2.855 | 0 | 0.462 | 0.019 | No | Yes | IV | Moderate |
| Chewing gum | **145/245** | 3 | 3 | 0 | **0.94(0.61 to 1.43)** | 0.95(0.62 to 1.45) | 1.07(0.67 to 1.71) | Fixed | 0 | 0.757 | 0.798 | 0.770 | 1.368 to 3.799 | 0 | 0.403 | 0.240 | No | No | V | High |
| Incidence of postoperative vomit | | | | | | | | | | | | | | | | | | | | |
| Acupressure | **220/858** | 6 | 6 | 0 | **0.64(0.47 to 0.88)** | 0.65(0.48 to 0.89) | 0.57(0.30 to 1.10) | Fixed | 0 | **< 0.01** | **< 0.01** | 0.092 | 1.771 to 2.935 | 0 | 0.502 | 0.019 | No | Yes | IV | Moderate |
| Chewing gum | **81/221** | 2 | 2 | 0 | 0.88(0.53 to 1.48) | **0.64(0.16 to 2.49)** | 0.25(0.05 to 1.27) | Random | 0.6705 | 0.639 | 0.516 | 0.095 | 0.191 to 27.168 | 63.8 | 0.097 | NA | No | NA | V | High |

leads to inconsistent conclusions regarding their impact on clinical outcomes related to postoperative ileus. High-quality trials with large sample sizes are needed to further validate these findings.

## Conclusion

Overall, although there are numerous treatment options for postoperative ileus, this study's quantitative analysis indicates that effective treatment approaches include chewing gum, coffee, ERAS protocols, acupuncture, opioid receptor antagonists, Da-Cheng-Qi-Tang, early enteral nutrition, and injections at the Zusanli point. The evidence supporting these treatment options for postoperative ileus is stronger and more reliable than that for other interventions assessed in this study. Notably, ERAS protocols, chewing gum, early enteral nutrition, and opioid receptor antagonists (each classified as Class II) not only alleviated postoperative ileus but also reduced hospital stay duration, making them viable treatment options for patients with postoperative ileus. Furthermore, coffee was identified as the treatment option that significantly reduced the time to first defecation postoperatively among all interventions.

The included meta-analyses evaluated the safety of chewing gum, coffee, acupuncture, and ERAS; however, the safety of opioid receptor antagonists and Da-Cheng-Qi-Tang requires further validation through high-quality research.

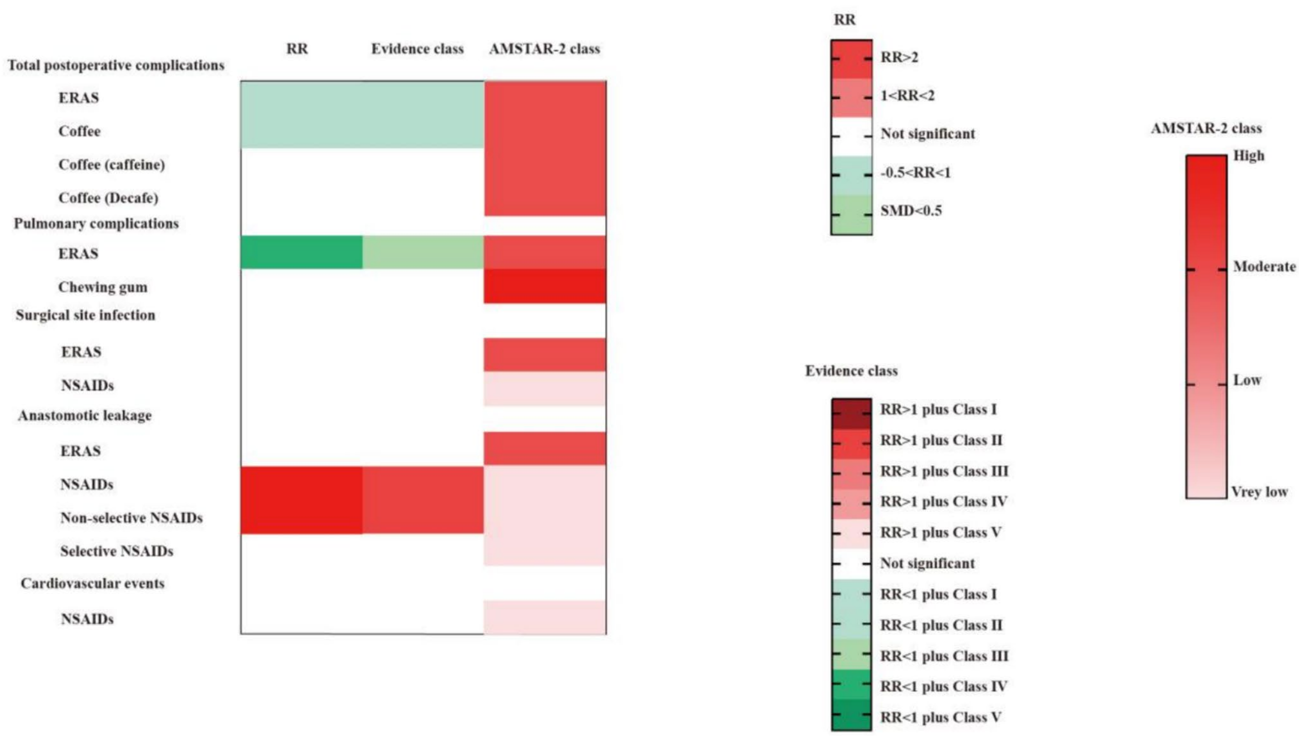



**Fig. 10** Postoperative complication rates

**Table 9** Postoperative complication rates

| Exposure or intervention | Events or cases/ total(n.) | Studies(n.) | | | Summary risk ratio estimate(RR, 95% CI) | | | Selected effect model | Tau$^2$ | P value | | | 95% PI | Heterogeneity | | Egger's P value | Excess significance | Small-study effect | Evidence class | AMSTAR-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Total** | **RCT** | **OE** | **Fixed effects** | **Random effects** | **Largest study** | | | **Fixed** | **Random** | **Largest** | | **$I^2$(%)** | **$I^2$-P value** | | | | | |
| Total postoperative complications | | | | | | | | | | | | | | | | | | | | |
| ERAS | 351/964 | 5 | 5 | 0 | **0.65(0.51 to 0.84)** | 0.59(0.40 to 0.87) | 0.75(0.56 to 1.01) | Fixed | 0.0547 | < 0.01 | < 0.01 | 0.054 | 1.205 to 4.314 | 25.6 | 0.251 | 0.308 | Yes | No | IV | Moderate |
| Coffee | 125/861 | 10 | 10 | 0 | **0.63(0.42 to 0.94)** | 0.67(0.38 to 1.19) | 0.27(0.11 to 0.63) | Fixed | 0.2151 | 0.024 | 0.171 | < 0.01 | 0.699 to 7.434 | 38.9 | 0.133 | 0.475 | Yes | Yes | IV | Moderate |
| Coffee (caffeine) | 123/831 | 10 | 10 | 0 | 0.62(0.41 to 0.93) | **0.65(0.37 to 1.14)** | 0.27(0.11 to 0.63) | Fixed | 0.1941 | 0.020 | 0.135 | < 0.01 | 0.739 to 7.039 | 36.1 | 0.153 | 0.616 | Yes | Yes | IV | Moderate |
| Coffee (Decafe) | 3/60 | 1 | 1 | 0 | 2.00(0.17 to 23.25) | **2.00(0.17 to 23.25)** | 2.00(0.17 to 23.25) | NA | NA | 0.580 | 0.580 | 0.580 | 1.240 to 4.290 $\times 10^6$ | NA | NA | NA | Yes | Yes | V | Moderate |
| Pulmonary complications | | | | | | | | | | | | | | | | | | | | |
| ERAS | 84/1496 | 15 | 15 | 0 | **0.46(0.29 to 0.73)** | 0.48(0.30 to 0.76) | 0.25(0.07 to 0.94) | Fixed | 0 | < 0.01 | < 0.01 | 0.039 | 1.325 to 3.922 | 0 | 0.997 | 0.368 | Yes | Yes | III | Moderate |
| Chewing gum | 12/443 | 2 | 2 | 0 | **0.99(0.31 to 3.14)** | 0.99(0.31 to 3.18) | 0.75(0.17 to 3.38) | Fixed | 0 | 0.983 | 0.981 | 0.704 | 0.306 to 16.995 | 0 | 0.567 | NA | Yes | Yes | V | High |
| Surgical site infection | | | | | | | | | | | | | | | | | | | | |
| ERAS | 38/1555 | 15 | 15 | 0 | **0.75(0.41 to 1.40)** | 0.78(0.40 to 1.51) | 0.40(0.08 to 2.14) | Fixed | 0 | 0.373 | 0.457 | 0.284 | 0.628 to 8.278 | 0 | 0.953 | 0.650 | Yes | Yes | V | Moderate |
| NSAIDs | 214/1973 | 6 | 6 | 0 | **0.79(0.53 to 1.18)** | 0.80(0.53 to 1.19) | 0.83(0.54 to 1.26) | Fixed | 0 | 0.249 | 0.265 | 0.384 | 1.454 to 3.576 | 0 | 0.747 | 0.403 | Yes | No | V | Very low |
| Anastomotic leakage | | | | | | | | | | | | | | | | | | | | |
| ERAS | 29/1414 | 13 | 13 | 0 | **0.75(0.37 to 1.51)** | 0.88(0.39 to 1.99) | 0.08(0.00 to 1.40) | Fixed | 0 | 0.422 | 0.763 | 0.763 | 0.953 to 5.452 | 0 | 0.450 | 0.580 | Yes | Yes | V | Moderate |
| NSAIDs | 157/2236 | 10 | 10 | 0 | **2.76(1.98 to 3.86)** | 3.29(1.83 to 5.89) | 1.74(1.09 to 2.76) | Fixed | 0.2629 | < 0.01 | < 0.01 | 0.020 | 0.445 to 11.689 | 41.4 | 0.092 | 0.483 | Yes | Yes | II | Very low |
| Non-selective NSAIDs | 112/1466 | 8 | 8 | 0 | **2.69(1.81 to 4.00)** | 2.97(1.62 to 5.45) | 1.89(1.13 to 3.16) | Fixed | 0.1626 | < 0.01 | < 0.01 | 0.016 | 0.455 to 11.418 | 25.9 | 0.231 | 0.545 | Yes | Yes | II | Very low |
| Selective NSAIDs | 76/1264 | 4 | 4 | 0 | 2.43(1.46 to 4.05) | **2.17(0.71 to 6.62)** | 1.16(0.50 to 2.70) | Random | 0.7213 | < 0.01 | 0.173 | 0.731 | 0.188 to 27.592 | 64.5 | 0.038 | 0.765 | Yes | Yes | V | Very low |
| Cardiovascular events | | | | | | | | | | | | | | | | | | | | |
| NSAIDs | 63/1784 | 3 | 3 | 0 | **0.52(0.23 to 1.14)** | 0.52(0.23 to 1.16) | 0.50(0.20 to 1.27) | Fixed | 0 | 0.102 | 0.110 | 0.144 | 1.169 to 4.447 | 0 | 0.907 | 0.911 | Yes | NA | V | Very low |

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