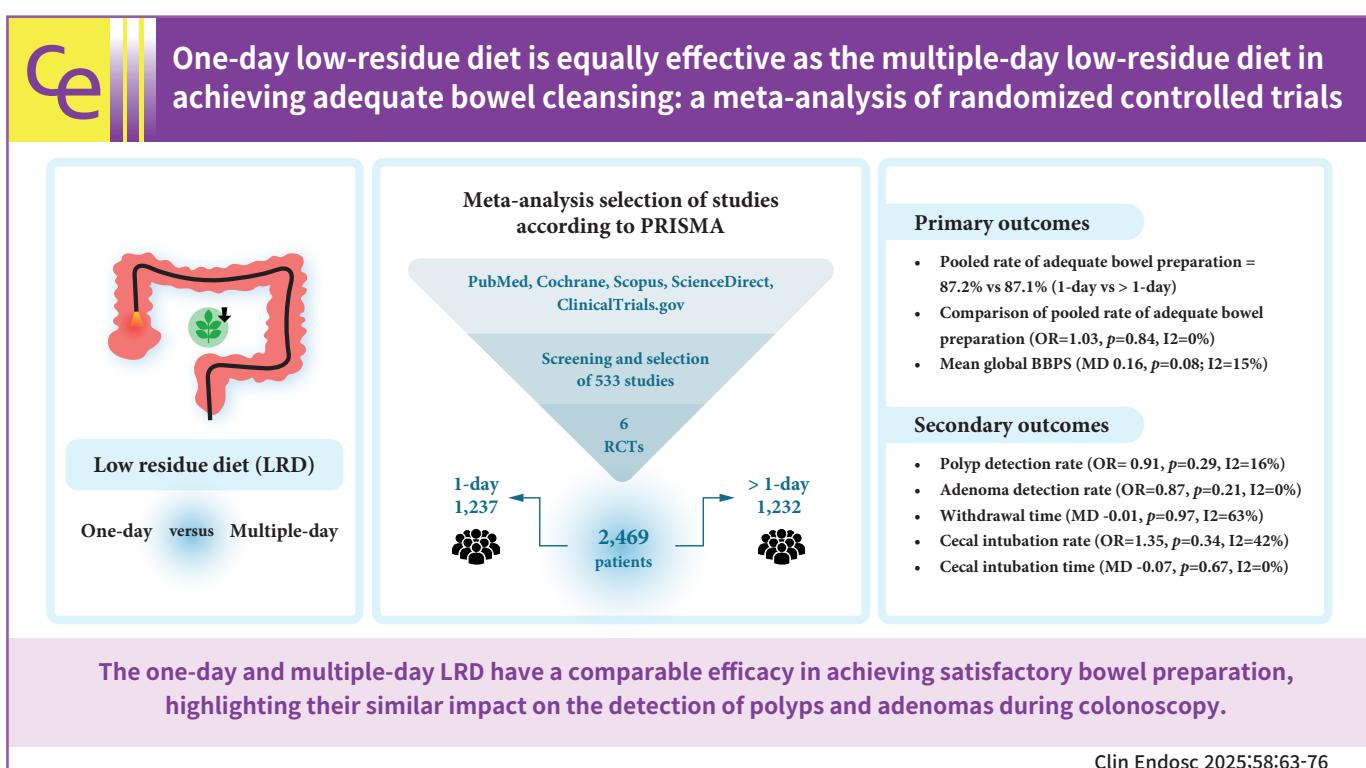




One-day low-residue diet is equally effective as the multiple-day low-residue diet in achieving adequate bowel cleansing: a meta-analysis of randomized controlled trials

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Background/Aims: Colonoscopy is widely used as a diagnostic and preventive procedure for colorectal diseases. The most recent guidelines advocate the use of a low-residue diet (LRD) for bowel preparation before colonoscopy. LRD duration varies considerably, with recommended 1-day and multiple-day regimens in clinical practice.

Methods: We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. We searched multiple databases for randomized controlled trials (RCTs) and analyzed the outcomes using a fixed-effects model.

Results: Six RCTs with 2,469 subjects were included in this study. The rates of adequate bowel preparation for 1-day and >1-day were 87.2% and 87.1%, respectively. No statistically significant differences were observed between the 1-day and >1-day LRD in adequate bowel preparation (odds ratio [OR], 1.03; 95% confidence interval [CI], 0.76–1.41; $p=0.84$; $I^2=0\%$), polyp detection rate (OR, 0.91; 95% CI, 0.76–1.09; $p=0.29$; $I^2=16\%$), adenoma detection rate (OR, 0.87; 95% CI, 0.71–1.08; $p=0.21$; $I^2=0\%$), and withdrawal time (mean difference, -0.01; 95% CI, -0.25 to 0.24; $p=0.97$; $I^2=63\%$).

Conclusions: The efficacy of 1-day and multiple-day LRD is comparable in achieving satisfactory bowel preparation, highlighting their similar impact on the detection of polyps and adenomas during colonoscopy.

Keywords: Bowel preparation; Colonoscopy; Colorectal adenoma; Colorectal cancer; Diet

INTRODUCTION

Colonoscopy is a widely utilized diagnostic and preventive procedure for colorectal diseases, including colorectal cancer, which is a leading cause of cancer-related morbidity and mortality worldwide.¹ Successful colonoscopy outcomes are contingent upon effective bowel preparation, a crucial pre-procedural step to achieve optimal visualization of the colonic mucosa.^{2,3} Suboptimal intestinal cleansing compromises the effectiveness of colonoscopy and diminishes the adenoma detection rate (ADR), prolongs the procedure time, and undermines patient compliance. Additionally, it increases the risk of adverse events and contributes to overall increased costs.^{4–6} The primary factors affecting the quality of colon cleansing include inadequate adherence to or limited tolerance of bowel preparation, ineffectiveness of the cleansing protocol encompassing both diet and cleansing solutions, the time gap between the last dose of bowel preparation and colonoscopy, and the method of administration (full- or split-dose regimens).^{3,7–9}

The low-residue diet (LRD), a dietary regimen restricting high-fiber food consumption, has demonstrated a higher level of tolerability than the traditionally recommended clear liquid diet (CLD).^{10–12} The most recent guidelines advocate using LRD with an evidence level at least equivalent to that of CLD.^{13,14} Although the guidelines from The European Society of Gastrointestinal Endoscopy (ESGE) assert a lack of evidence supporting LRD use for more than 24 hours,¹³ they acknowledge that certain endoscopists recommend an extended duration, such as 2 or 3 days, of an LRD before colonoscopy. However, the recommended duration for LRD is notably varied, as clinical practice

supports both 1-day and more than 1-day protocols.

The debate surrounding the optimal LRD duration for bowel preparation remains an area of active investigation, with implications for patient compliance and procedural efficacy.^{15–17} Given the potential impact on patient experience and adherence, this systematic review and meta-analysis aimed to synthesize and critically appraise the available randomized controlled trials (RCTs) comparing the efficacy of 1-day versus >1-day LRD in bowel preparation before colonoscopy. We intend to provide a robust evidence base for clinicians, researchers, and healthcare policymakers to inform decision-making and guideline development in colonoscopy preparation by systematically analyzing the existing literature.

METHODS

Data sources and search strategy

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to conduct this meta-analysis. The meta-analysis protocol was registered with PROSPERO on November 11th, 2023 (PROSPERO ID: CRD42023477314). Three authors (RDP, FA, and FAU) performed extensive searches across multiple databases, including PubMed, Cochrane Central Register of Controlled Trials, ScienceDirect, Scopus, and ClinicalTrials.gov, from the inception of the databases until October 2023, and May 2024 as the manuscript was reviewed. The search was restricted to English-language articles using both abbreviated and expanded keywords, which included terms such as “low residue diet” and “colonoscopy” (Supplementary Table 1). In addition to the

database searches, manual search of references in the included studies was conducted, eliminating duplicate citations. The titles and abstracts of the retrieved articles were independently assessed using the RDP and FA. Disagreements were resolved through discussions with the FAU. The full texts of the remaining articles were carefully examined. The screening results are presented in [Figure 1](#), which shows the PRISMA flowchart.

Eligibility criteria

Studies meeting the following criteria were included: (1) RCTs, (2) comparison of 1-day versus >1-day LRD, (3) adult patients (18 years or older) scheduled for colonoscopy for any indication, and (4) reporting of the outcome of interest and Boston bowel preparation scale (BBPS). We excluded studies with the following characteristics: (1) overlapping populations derived from overlapping institutions and recruitment periods, (2) lack of a control group, and (3) systematic reviews/meta-analyses, letters to editors/editorials, and conference abstracts.

Data extraction

All authors independently extracted the baseline characteristics and outcome data. Disagreements between the authors were resolved by consensus. The outcome of interest was adequate

bowel preparation, assessed using BBPS. This study used a BBPS score of ≥ 2 for each segment as the definition of adequate bowel preparation. The extracted data included various aspects, such as bowel preparation, indication for colonoscopy, polyp detection rate (PDR), ADR, withdrawal time, cecal intubation time and rate, and colonoscopy findings.

Risk of bias assessment

The Cochrane Risk-of-Bias 2 tool was used to assess the bias risk in the included studies.¹⁸ All authors independently conducted the risk of bias evaluation, resolving any disagreements through consensus after discussing the reasons for the discrepancies.

Data synthesis and statistical analysis

Dichotomous outcomes, such as adequate bowel preparation (BBPS score ≥ 2 for each segment), were compared using odds ratios (ORs) and 95% confidence intervals (CIs). The mean global BBPS scores were compared using the mean difference (MD) with a 95% CI. Heterogeneity was assessed using Cochran's Q test, I^2 statistics, and visual examination of forest plots. Heterogeneity was considered significant if the p -value was less than 0.10, I^2 statistics exceeded 25%, or if visual inspec-

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers, and other sources

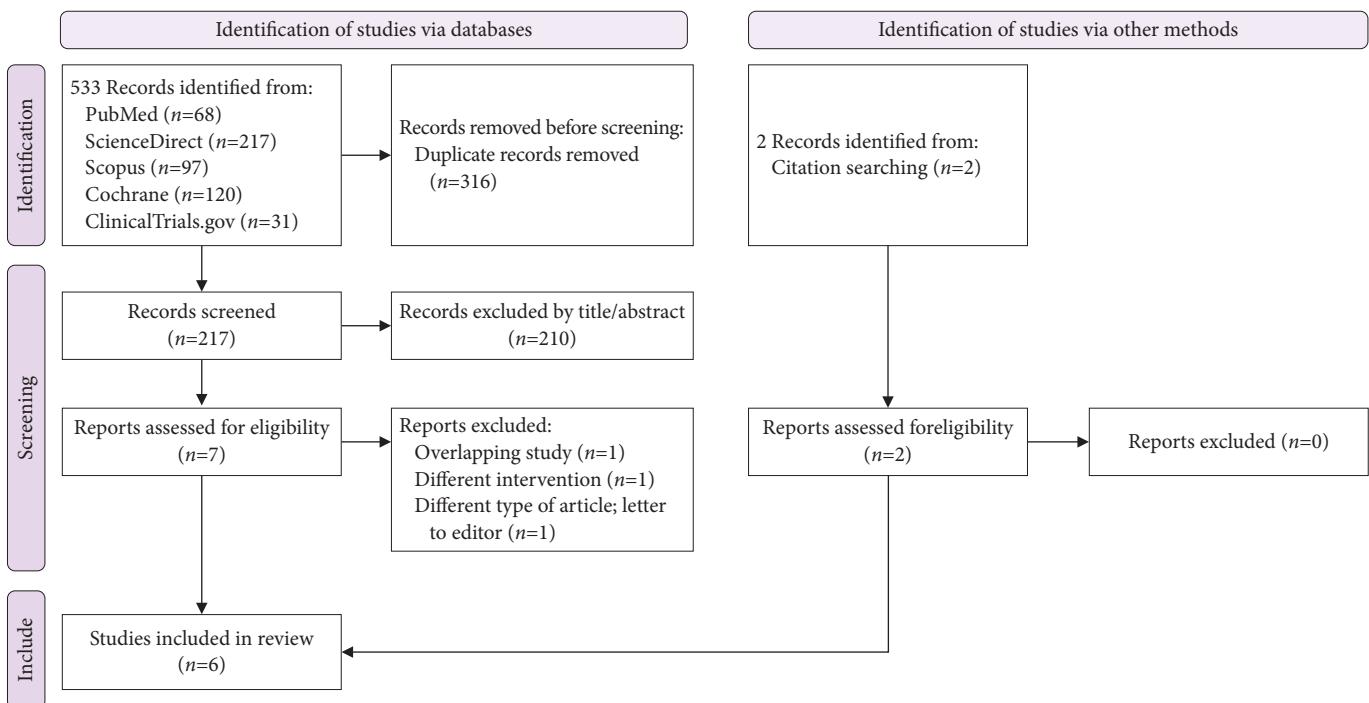


Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study screening and selection.

tion of the forest plot suggested heterogeneity in the effect size. However, the endpoint examined in this review demonstrated visual homogeneity, I^2 statistics <25%, and p -values greater than 0.10, indicating no significant heterogeneity. Therefore, we use a fixed-effects model in this study. Statistical analyses were performed using Review Manager 5.4 (The Cochrane Collaboration).

RESULTS

As illustrated in Figure 1, 316 of the 533 search results were duplicate records. A total of 210 articles were deemed unrelated based on title or abstract review and consequently excluded. The remaining seven articles underwent a thorough screening process. Two other articles were identified through a citation search. After applying the inclusion and exclusion criteria, six RCTs were included. The reasons for excluding certain studies were overlapping studies ($n=1$), different types of interventions ($n=1$), and different types of articles ($n=1$). The primary characteristics of the included studies are presented in Tables 1–3.^{19–24}

Of the 2,469 participants from the six RCTs^{19–23} included in this study, 1,238 (50.1%) were males. Among these participants, 1,237 (50.1%) were randomized to undergo a 1-day LRD, while the remaining 1,232 subjects had >1-day LRD (49.9%). Five studies compared 1-day and 3-day LRD, and one study compared 1-day and 2-day LRD. One study employed a noninferiority model. Table 1 provides the definition of adequate bowel preparation as specified in each study.

Mucosal visualization

The rates of adequate bowel preparation for 1 day and >1-day are 87.2% and 87.1%, respectively. The difference in the pooled rate of adequate bowel preparation at 1 day and >1 day yielded an OR of 1.03, $p=0.84$, $I^2=0\%$, indicating a statistically nonsignificant difference (Fig. 2A). The mean global BBPS between the two groups is not significant; MD 0.16 (95% CI, -0.02 to 0.34; $p=0.08$; $I^2=15\%$; Fig. 2B).

Secondary outcomes

No statistically significant differences were found between the groups in the PDR (OR, 0.91; 95% CI, 0.76–1.09; $p=0.29$; $I^2=16\%$; Fig. 3A); ADR (OR, 0.87; 95% CI, 0.71–1.08; $p=0.21$; $I^2=0\%$; Fig. 3B); withdrawal time (MD, -0.01; 95% CI, -0.25 to 0.24; $p=0.97$; $I^2=63\%$; Fig. 3C); cecal intubation rate (OR, 1.35; 95% CI, 0.73–2.50; $p=0.34$; $I^2=42\%$; Fig. 3D); and cecal intuba-

tion time (MD, -0.07; 95% CI, -0.38 to 0.24; $p=0.67$; $I^2=0\%$; Fig. 3E).

Risk of bias

Figure 4 presents an overview of the separate assessments conducted for each RCT included in the meta-analysis. Among these, three studies were categorized as having a low risk of bias, one study had some concerns, and two exhibited a high risk of bias. Two studies categorized as high risk of selection bias reported results from multiple eligible analyses of the data. The funnel plots did not show conclusive evidence of publication bias; however, the analysis was constrained by the limited number of studies (<10; Fig. 5).

DISCUSSION

Effective bowel cleansing is crucial in various aspects of colonoscopy. Inadequate bowel cleansing diminishes the quality of colonoscopy and has detrimental effects on the ADR, procedure duration, and patient compliance. Furthermore, it increases the risk of adverse events and contributes to overall procedural costs.^{4–6} A prospective study investigating repeated colonoscopies revealed that the likelihood of missing adenomas larger than 5 mm was three times higher in cases of inadequate intestinal preparation.²⁵

Certain scholars suggest a three-day LRD before colonoscopy because of the prolonged transit time observed in certain patients, while other scholars advocate for a one-day LRD. The ESGE guidelines recommends a one-day LRD for bowel preparation based on practical experience, albeit without robust evidence from evidence-based studies.¹³ A systematic review and meta-analysis encompassing six RCTs encompassing 2,469 patients comparing 1-day and >1-day LRD for individuals scheduled for colonoscopy revealed the following key findings: (1) differences between the two groups concerning adequate bowel preparation are not significant, as assessed by mucosal visualization using the BBPS, and (2) the rates of polyp and adenoma detection are not significantly different between the 1-day and >1-day LRD groups.

All included studies applied blinding to the gastroenterologists. The patients were instructed not to reveal their diet to the gastroenterologist team. Regarding adequate bowel preparation, four articles included in this study used categorical data and four articles used numerical data to assess BBPS in the 1-day vs. >1-day LRD group comparisons. Our findings suggest that

Table 1. Characteristics of studies

Study	Study population	Subjects		Age (yr)		Male		BMI (kg/m ²)		Definition of adequate bowel preparation	
		Total	>1-Day LRD	1-Day LRD	>1-Day LRD	1-Day LRD	>1-Day LRD	1-Day LRD	>1-Day LRD		
Gimeno-García et al. (2019) ¹⁹	Patients over 18 years old scheduled for morning outpatient colonoscopy. Exclusion: intestinal obstruction, severe hypertension, congestive heart failure, acute liver failure, end-stage renal disease, pregnancy, lactation, dementia, past inadequate bowel preparation and refusal to participate.	390	196	194	59.7±14.6	60.2±14.3	96 (49.0)	103 (53.1)	27.8±4.9	27.8±4.8	Defined as a BBPS score of ≥2 for each segment.
Jiao et al. (2019) ²⁰	Patients aged 18 to 80 undergoing colonoscopy for colorectal cancer screening or non-specific gastrointestinal symptoms. Exclusions: inability to cooperate, prior gastrointestinal surgery, severe heart, brain, kidney, liver diseases, intolerance to colonoscopy, contraindications like bowel obstruction, severe infection, toxic megacolon, consciousness disorder, unstable vital signs, failure to reach ileocecum (non-prep-related), pregnancy, lactation, stroke, dementia, anxiety or depressive psychosis and PEG allergy. Patients aged between 18 and 80 years who underwent colonoscopy were enrolled, including patients receiving colorectal cancer screening or patients with non-specific gastrointestinal symptoms. Exclusion criteria: patients who were/with (1) non-cooperative during examination (2) history of digestive tract surgery (3) severe heart, brain, kidney, liver, or other diseases unable to tolerate colonoscopy (3) contraindications such as digestive tract obstruction, perforation, severe intestinal infection, toxic megacolon, impaired consciousness, or unstable vital signs (4) unable to reach the caecum due to issues like malignant lumen narrowing (5) pregnant or lactating women (6) stroke or dementia (7) anxiety, depression, or allergy to PEG.	221	111	110	47.80±15.46	46.64±15.09	39 (35.14)	40 (36.36)	NA	NA	Assessed according to BBPS. A 4-point classification scale was utilized as previously reported. These total scores were mainly divided into 5 grades: excellent (8–9), good (6–7), medium (4–5), poor (2–3) and extremely poor (0–1).
Jiao et al. (2020) ²⁴		321	161	160	48.17±15.44	47.03±13.79	56 (34.78)	70 (43.75)	61.26±10.82	62.66±10.96	Evaluated with BBPS, the total score of the 3 segments was used to grade the overall bowel preparation quality in 5 grades: excellent (8–9 points), good (6–7 points), medium (4–5 points), poor (2–3 points), and extremely poor (0–1 point), of which “excellent”, “good” and “medium” were considered meeting bowel preparation requirements.

(Continued to the next page)

Table 1. Continued

Study	Study population	Subjects		Age (yr)		Male		BMI (kg/m^2)		Definition of adequate bowel preparation	
		Total	1-Day LRD	>1-Day LRD	1-Day LRD	>1-Day LRD	1-Day LRD	>1-Day LRD	1-Day LRD		
Taveira et al. (2019) ²¹	All morning total colonoscopy scheduled patients. Exclusion: sedated procedures, urgent cases, those not intending to reach the caecum, previous colectomy, patient refusal, and absolute contraindications to colonoscopy.	412	206	67±11.85	66±10.37	138 (67)	140 (68)	NA	NA	Defined as BBPS total score ≥ 6 or ≥ 2 for each segment.	
Machlab et al. (2021) ²²	Participants aged 50 to 69 in the CRC detection program, agreeing to colonoscopy after positive FIT results. Exclusions: contraindications to colonoscopy, refusal to participate, or inability to provide informed consent.	836	420	416	58.9±5.4	59.3±5.5	233 (55.7)	242 (58.2)	27.5±4.3	27.5±4.5	Defined as a BBPS score of ≥ 2 for each segment.
Scaglione et al. (2023) ²³	Consecutive outpatients undergoing total colonoscopy. Exclusion: age < 18 , previous proctocolonoscopy, colonoscopy without or contraindicated bowel preparation, contraindicated dietary regimen, refusal of informed consent, and inability to understand study instructions.	289	143	146	60.2±12.4	60.3±13.5	68 (47.6)	83 (56.8)	26.5±4.5	26±4.4	Defined as score ≥ 2 on the BBPS in each segment.

Values are presented as mean±standard deviation or number (%) unless otherwise indicated.
 BMI, body mass index; LRD, low-residue diet; BBPS, Boston bowel preparation scale; NA, not available; PEG, polyethylene glycol; CRC, colorectal cancer; FIT, fecal immunochemical test.

Table 2. Comparison of LRD preparations, bowel solutions, and colonoscopy indications

Study	LRD preparation		Type of bowel preparation solution	Indication for colonoscopy (n, %)	
	1-Day LRD	>1-Day LRD		1-Day LRD	>1-Day LRD
Gimeno-García et al. (2019) ¹⁹	A structured LRD the day before the examination for breakfast, lunch, and snacks and a CLD for dinner designed by an endocrinologist specialized in nutrition.	A structured LRD for 3 days before the examinations for all meals and a CLD for the last dinner before the examination designed by an endocrinologist specialized in nutrition.	2-L split-dose polyethylene glycol plus ascorbic acid.	Positive FOBT: 49 (25.0) Postpolypectomy surveillance :34 (17.3) Change of bowel habit: 25 (12.8) Anemia: 19 (9.7) Rectal bleeding: 24 (12.2) Inflammatory bowel disease: 14 (7.1) Abdominal pain: 14 (7.1)	Positive FOBT: 51 (26.3) Postpolypectomy surveillance lance: 38 (19.6) Change of bowel habit: 18 (9.3) Anemia: 22 (11.3) Rectal bleeding: 19 (9.8) Inflammatory bowel disease: 16 (8.2) Abdominal pain: 13 (6.7)
Jiao et al. (2019) ²⁰	LRD one day before colonoscopy, and then fasted for about 11 hours (10 PM to 9 AM on the day of the procedure).	LRD three day before colonoscopy, and then fasted for about 11 hours (10 PM to 9 AM on the day of the procedure).	3-L PEG electrolyte solution between 9 to 11 AM on the day of colonoscopy, followed by oral administration of 30 mL simethicone.	Constipation history: 20 (18.02) Digestive tract symptoms: 72 (7.97)	Constipation history: 24 (21.82) Digestive tract symptoms: 91 (82.73)
Jiao et al. (2020) ²⁴	Low-residue foods refer to foods that have a low fiber content, including rice porridge, noodles, taro, bread, tofu, Chinese steamed eggs, chicken, some peeled and cored fruits, and cooked vegetables (such as apples and carrots). Patients were told to avoid eating vegetables, fruits, and whole grains. Patients began the LRD 1 day before the colonoscopy and started fasting (food and water) at 10:00 PM the day before the examination.	Low-residue foods refer to foods that have a low fiber content, including rice porridge, noodles, taro, bread, tofu, Chinese steamed eggs, chicken, some peeled and cored fruits, and cooked vegetables (such as apples and carrots). Patients were told to avoid eating vegetables, fruits, and whole grains. Patients began the LRD 2 day before the colonoscopy and started fasting (food and water) at 10:00 PM the day before the examination.	3 L of PEG-ES from 9:00 AM to 11:00 AM on the day of the examination, followed by 30 mL of simethicone.	Gastrointestinal symptoms (abdominal pain, bloating, altered bowel habit, bloody stool, etc.)=112 (69.57)	Gastrointestinal symptoms (abdominal pain, bloating, altered bowel habit, bloody stool, etc.)=101 (63.13)

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Table 2. Continued

Study	LRD preparation		Type of bowel preparation solution	Indication for colonoscopy (n, %)	
	1-Day LRD	>1-Day LRD		1-Day LRD	>1-Day LRD
Taveira et al. (2019) ²¹	A 1-day LRD for all meals until dinner of the day before colonoscopy suggested by the Nutrition department.	A 3-day LRD for all meals until dinner of the day before colonoscopy suggested by the Nutrition department.	3-L PEG preparation on the late afternoon of the day prior to the examination and a 1-L PEG preparation in the morning of the day of the examination, ending 4 hours before the scheduled examination time.	Screening: 39 (18.9) Symptoms/diagnostic: 23 (11.2) Polypectomy: 40 (19.4) Postpolypectomy surveillance: 97 (47.1) Family history of colorectal cancer: 7 (3.4) CRC screening: 420 (100)	Screening: 40 (19.4) Symptoms/diagnostic: 14 (6.8) Polypectomy: 41 (19.9) Postpolypectomy surveillance: 102 (49.5) Family history of colorectal cancer: 9 (4.4) CRC screening: 416 (100)
Machlab et al. (2021) ²²	An endocrinologist specialized in nutrition devised dietary instructions for one day. Subjects were provided with a logbook and instructed to record their diet one day before colonoscopy.	An endocrinologist specialized in nutrition devised dietary instructions for three days. Subjects were provided with a logbook and instructed to record their diet one day before colonoscopy.	Low volume PEG plus ascorbic acid in split-dose regimens was prescribed. The first dose was administered in the evening before colonoscopy at 20:00 hours. The second dose was scheduled to finish 2 to 4 hours before the colonoscopy	PEG (4 L) PEG+bisacodyl (2 L) PEG+ascorbate (2 L), Sodium picosulfate+magnesium citrate	Positive FOBT: 63 (44.7) Abdominal pain: 31 (22) Bowel habit modification: 21 (14.9) Bleeding: 18 (12.8) Post-polypectomy surveillance: 9 (6.4) Anemia: 11 (7.8) Family history: 9 (6.4) Inflammatory bowel diseases: 5 (3.5) Weight loss: 5 (3.5)
Scaglione et al. (2023) ²³	Daily intake of less than 10 g of fiber for one day, contained in specific foods were formulated under the guidance of a nutritionist.	Daily intake of less than 10 g of fiber for three days, contained in specific foods were formulated under the guidance of a nutritionist.	PEG (4 L) PEG+bisacodyl (2 L) PEG+ascorbate (2 L), Sodium picosulfate+magnesium citrate	Positive FOBT: 66 (46.2) Abdominal pain: 27 (18.9) Bowel habit modification: 18 (12.6) Bleeding: 19 (13.3) Post-polypectomy surveillance: 11 (7.7) Anemia: 6 (4.2) Family history: 8 (5.6) Inflammatory bowel diseases: 8 (5.6) Weight loss: 4 (2.8)	

LRD, low-residue diet; CLD, clear liquid diet; FOBT, fecal occult blood test; PEG-ES, polyethylene glycol-electrolyte solution; CRC, colorectal cancer.

Table 3. Outcomes of 1-day vs. >1-day LRD on bowel preparation quality and detection rates in colonoscopy

Study	BBPS Score ≥2		Global segment BBPS score		PDR	ADR	Withdrawal time (min)	Cecal intubation rate	Cecal intubation time (min)
	1-Day LRD	>1-Day LRD	1-Day LRD	>1-Day LRD					
Gimeno-Garcia et al. (2019) ¹⁹	162 (82.7)	166 (85.6)	6.71±2.50	6.19±2.62	73 (39.0)	85 (45.9)	62 (33.2)	74 (40.0)	9.8±4.64
Jiao et al. (2019) ²⁰	NA	NA	6.54±1.45	6.55±1.45	21 (19)	19 (17.3)	NA	NA	9.77±2.45
Jiao et al. (2020) ²⁴	NA	NA	6.48±1.59	6.42±1.06	28 (17.39)	40 (25)	NA	NA	9.74±2.43
Taveira et al. (2019) ²¹	195 (94.7)	189 (91.7)	7.83±1.62	7.56±1.88	108 (52.4)	109 (52.9)	72 (34.9)	82 (39.8)	8.5±2.2
Machlab et al. (2021) ²²	411 (97.9)	403 (96.9)	NA	NA	327 (77.9)	313 (75.2)	304 (72.4)	302 (72.6)	13.0±7.40
Scaglione et al. (2023) ²³	101 (70.6)	105 (71.9)	NA	NA	39 (30.2)	50 (37.6)	NA	NA	14±6.67

Values are presented as number (%) or mean±standard deviation.

BBPS, Boston bowel preparation scale; LRD, low-residue diet; PDR, polyp detection rate; ADR, adenoma detection rate; NA, not available.

a more convenient 1-day LRD regimen may offer a practical alternative to the >1-day regimen without compromising bowel cleanliness. The nonsuperiority test conducted by Machlab et al.²² in their study revealed that the 1-day LRD group exhibited superior rates of excellent colon cleansing. An RCT comparing 1-day vs. 2-day LRD showed that both groups exhibited similar bowel preparation qualities and demonstrated comparable colonoscope insertion times, withdrawal times, PDRs, and patient tolerance scores (hanger comfort scores).²⁴

While it might seem logical that bowel cleansing would improve with an extended period of fiber abstinence, some authors have argued otherwise. They argued that LRD may decrease bowel motility and extend the time taken for substances to move through the intestines. This counterintuitive effect could be particularly pronounced in individuals dealing with constipation, leading to outcomes opposite to those desired in terms of effective bowel preparation.¹¹ The movement of material through the colon, known as colonic transit, is affected by dietary fiber. Specifically, insoluble fiber promotes faster colonic transit through mechanical and neuroendocrine mechanisms.^{26,27} Consequently, it is plausible to hypothesize that diminishing this influence could result in a reduction in colon transit.²¹ Although lacking a standardized definition; consensus among some authors defines LRD as a fiber intake of less than 10 g/day.^{26,28} Our analysis revealed comparable rates of polyp and adenoma detection between the 1-day and >1-day LRD groups, implying that the choice of dietary preparation duration may not significantly impact the efficacy of colonoscopy in detecting colonic abnormalities.

Regarding clinical implications, the observed lack of significant differences in bowel preparation and detection rates supports the consideration of a shorter, equally effective, 1-day LRD, potentially enhancing patient adherence and satisfaction. Patient preference and satisfaction have emerged as important considerations. Gimeno-García et al.¹⁹ highlighted that subjects showed a preference for 1-day LRD based on satisfaction and perceived difficulty. Jiao et al.'s study²⁰ corroborated this finding, noting that subjects favored 1-day LRD because of its shorter duration and easier compliance. Taveira et al.'s findings²¹ add depth to this aspect, suggesting a higher perceived difficulty in adhering to the 3-day diet, favoring the recommendation of a 1-day LRD. The importance of the bowel preparation solution and regimen likely outweighs that of the diet. A shorter diet is not only easier to adhere and more tolerable but also enhances adherence and motivation to the preparation solution and reg-

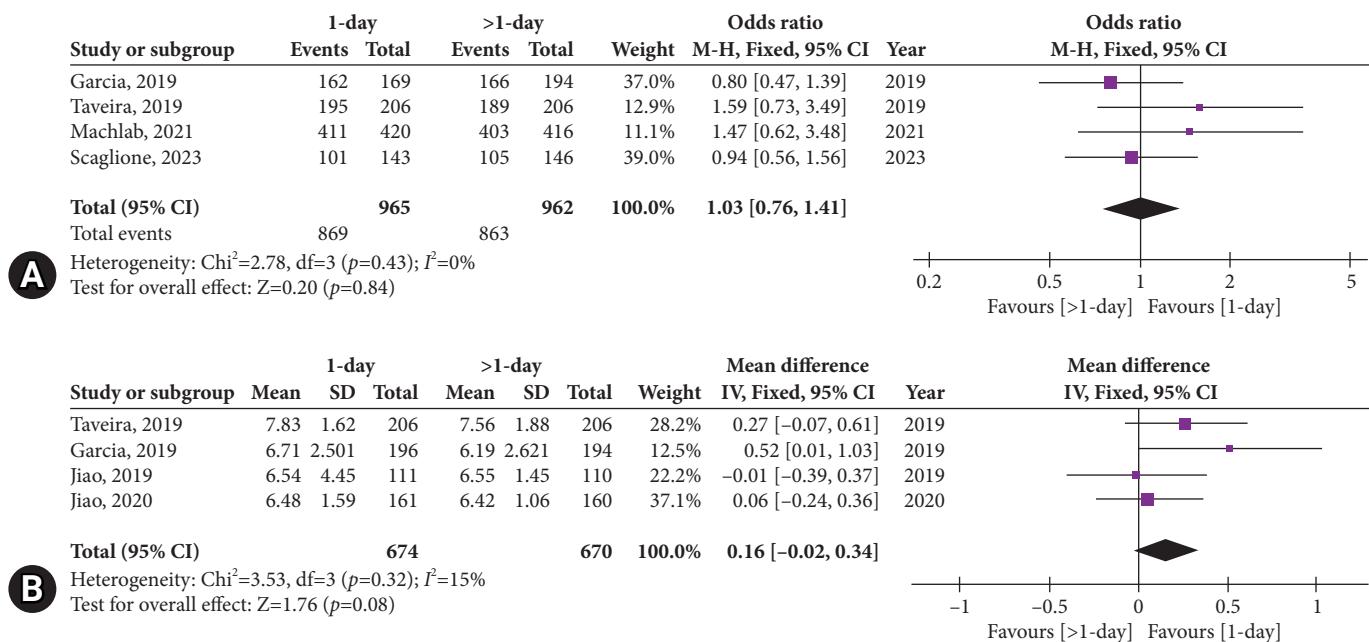


Fig. 2. (A) Comparison of adequate bowel preparation rate between 1-day and >1-day low-residue diet (LRD) group. (B) Comparison of mean Boston bowel preparation scale between 1-day and >1-day LRD group. M-H, Mantel–Haenszel; CI, confidence interval.

imen. This brief dietary period underscores the importance of the cleansing solution. Moreover, prolonged LRD may decrease intestinal motility and transit time, potentially exacerbating bowel cleansing issues.^{22,29} An observational study discovered that the diet consumed on the preceding day of colonoscopy notably impact BBPS scores. The study assessing the diet three days before the colonoscopy suggested that providing multi-day dietary instructions could be perplexing for patients and may not contribute significantly to the effectiveness of bowel preparation results.³⁰

This meta-analysis had several strengths. First, this study only included RCTs, which markedly elevated the evidence credibility. Second, the inclusion of RCTs from diverse countries that utilized consistent intestinal preparations within the same study fostered comparability. Simultaneously, different bowel preparations usage across various studies suggests that the findings of this study can be generalized to other bowel preparation methods. Lastly, the heterogeneity was absent in the assessment of bowel preparation adequacy and ADR outcomes, and heterogeneity was low for the PDR outcome.

Nevertheless, this study had inherent limitations. First, the LRD varied across studies, as each study implemented a distinct plan or protocol devised by the respective nutritionists. Second, there was a divergence in the arrangement of meals

among studies; while most permitted all three meals of the LRD, Garcia deviated by utilizing a CLD for dinner.¹⁹ Third, certain outcomes were constrained in terms of available data; for instance, only three studies assessed ADR, and two studies evaluated cecal intubation rate and time. However, it is important to highlight that these studies represent all existing research on this subject till now. Lastly, the impact of factors affecting bowel preparation quality, such as patients' underlying diseases, notably constipation, coupled with challenges in their correction, represents a limitation of this study.

In conclusion, this study revealed no substantial distinction in terms of adequate bowel preparation between the 1-day and >1-day LRD groups as evaluated through mucosal visualization using the BBPS. Additionally, the rates of polyp and adenoma detection did not significantly differ between the two dietary preparation durations. These findings collectively underscore the comparable efficacy of the 1-day and >1-day LRD protocols in achieving satisfactory bowel preparation and highlighting their similar impact on the detection of polyps and adenomas during colonoscopy.

Future research should delve into the cost-effectiveness and patient-reported outcomes associated with different durations of LRD during colonoscopy preparation. Owing to the diverse types and protocols of LRD, further research is necessary in

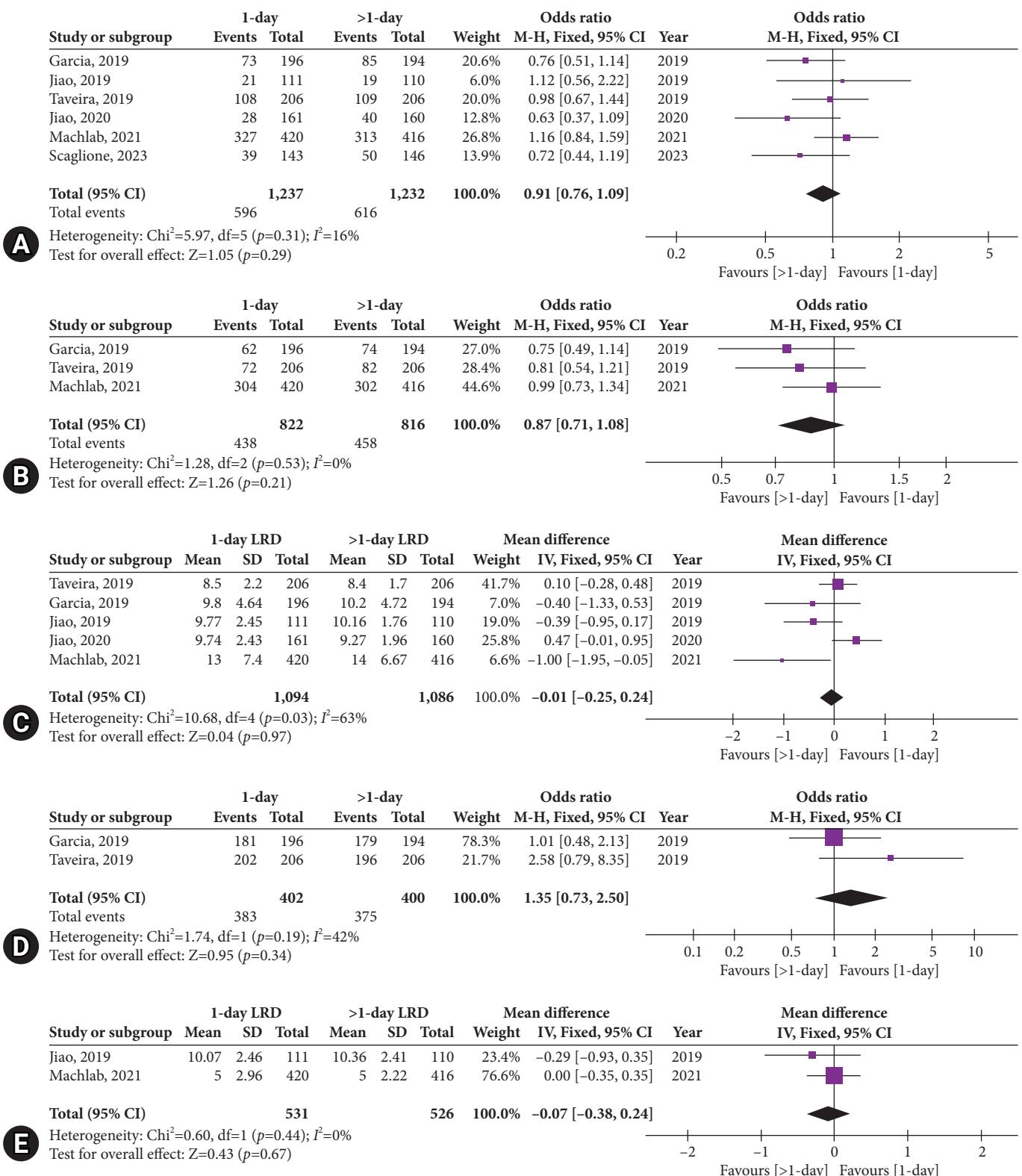


Fig. 3. Comparison between 1-day and 3-day low-residue diet (LRD) group in polyp detection rate (A), adenoma detection rate (B), withdrawal time (C), cecal intubation rate (D), and cecal intubation time (E). M-H, Mantel-Haenszel; CI, confidence interval.

Study	Risk of bias domains					
	D1	D2	D3	D4	D5	Overall
Garcia, 2019	+	+	+	+	×	×
Jiao, 2019	+	+	+	+	+	+
Taveira, 2019	+	+	+	+	×	×
Jiao, 2020	-	+	+	+	+	-
Machlab, 2021	+	+	+	+	+	+
Scaglione, 2023	+	+	+	+	+	+

Domains:
D1: Bias arising from the randomization process
D2: Bias due to deviations from intended intervention
D3: Bias due to missing outcome data
D4: Bias in measurement of the outcome
D5: Bias in selection of the reported result

Judgement
✖ High
- Some concerns
+ Low

Fig. 4. Risk of bias assessment of the included studies in the meta-analysis using Cochrane Risk-of-Bias 2 tool.

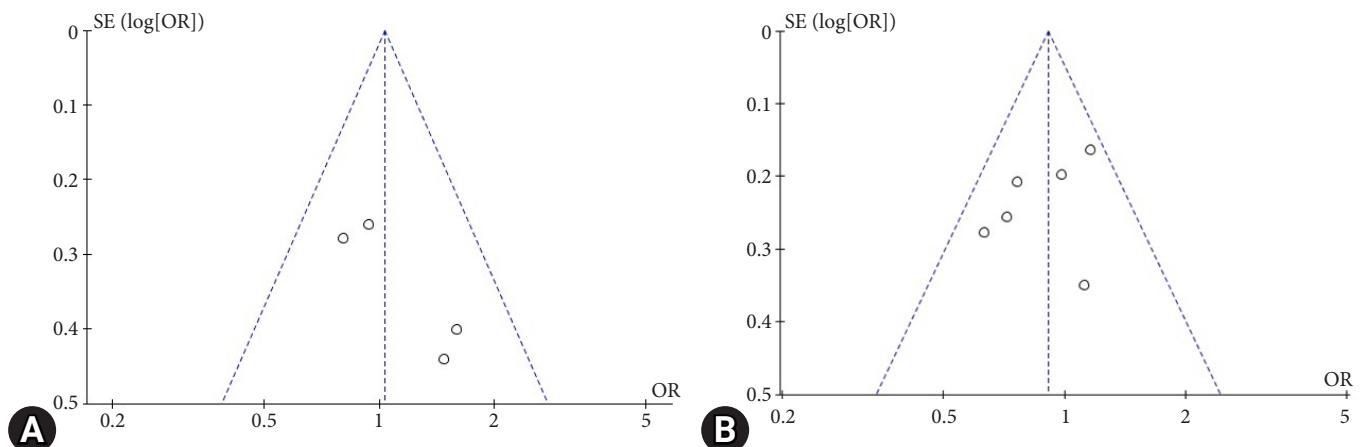


Fig. 5. (A) Funnel plot for Boston bowel preparation scale of the included studies. (B) Funnel plot for polyp detection rate of the included studies.

each country. Our study contributes to the growing body of evidence that informs clinical guidelines and suggests potential modifications to existing recommendations. As the field evolves, a comprehensive understanding of the nuances of dietary preparation duration will ultimately contribute to more tailored and patient-centric approaches for colonoscopy procedures.

Supplementary Material

Supplementary Table 1. Database search strategy.

Supplementary materials related to this article can be found online at <https://doi.org/10.5946/ce.2024.061>.

Ethical Statements

Not applicable.

Conflicts of Interest

The authors have no potential conflicts of interest.

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Author Contributions

Conceptualization: all authors; Methodology: all authors; Data curation: RDP, FA, FAU; Formal analysis: RDP, FA, FAU; Investigation: all authors; Methodology: all authors; Project administration: RDP; Resources: RDP; Software: RDP; Validation: all authors; Writing-original draft: RDP, FA, FAU; Writing-review & editing: all authors.

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REFERENCES

- Brenner H, Chang-Claude J, Jansen L, et al. Reduced risk of colorectal cancer up to 10 years after screening, surveillance, or diagnostic colonoscopy. *Gastroenterology* 2014;146:709–717.
- Kastenberg D, Bertiger G, Brogadir S. Bowel preparation quality scales for colonoscopy. *World J Gastroenterol* 2018;24:2833–2843.
- Gimeno-García AZ, Baute JL, Hernandez G, et al. Risk factors for inadequate bowel preparation: a validated predictive score. *Endoscopy* 2017;49:536–543.
- Rex DK, Imperiale TF, Latinovich DR, et al. Impact of bowel preparation on efficiency and cost of colonoscopy. *Am J Gastroenterol* 2002;97:1696–1700.
- Froehlich F, Wietlisbach V, Gonvers JJ, et al. Impact of colonic cleansing on quality and diagnostic yield of colonoscopy: the European Panel of Appropriateness of Gastrointestinal Endoscopy European multicenter study. *Gastrointest Endosc* 2005;61:378–384.
- Parra-Blanco A, Nicolas-Perez D, Gimeno-Garcia A, et al. The timing of bowel preparation before colonoscopy determines the quality of cleansing, and is a significant factor contributing to the detection of flat lesions: a randomized study. *World J Gastroenterol* 2006;12:6161–6166.
- Hassan C, Fuccio L, Bruno M, et al. A predictive model identifies patients most likely to have inadequate bowel preparation for colonoscopy. *Clin Gastroenterol Hepatol* 2012;10:501–506.
- Ness RM, Manam R, Hoen H, et al. Predictors of inadequate bowel preparation for colonoscopy. *Am J Gastroenterol* 2001;96:1797–1802.
- Rivero-Sánchez L, Pellisé M. Bowel preparation for colonoscopy: any significant progress on the horizon? *Gastroenterol Hepatol* 2015;38:287–300.
- Nguyen DL, Jamal MM, Nguyen ET, et al. Low-residue versus clear liquid diet before colonoscopy: a meta-analysis of randomized, controlled trials. *Gastrointest Endosc* 2016;83:499–507.
- Song GM, Tian X, Ma L, et al. Regime for bowel preparation in patients scheduled to colonoscopy: low-residue diet or clear liquid diet?: evidence from systematic review with power analysis. *Medicine (Baltimore)* 2016;95:e2432.
- Chen E, Chen L, Wang F, et al. Low-residue versus clear liquid diet before colonoscopy: an updated meta-analysis of randomized, controlled trials. *Medicine (Baltimore)* 2020;99:e23541.
- Hassan C, East J, Radaelli F, et al. Bowel preparation for colonoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Guideline - Update 2019. *Endoscopy* 2019;51:775–794.
- Johnson DA, Barkun AN, Cohen LB, et al. Optimizing adequacy of bowel cleansing for colonoscopy: recommendations from the US multi-society task force on colorectal cancer. *Gastroenterology* 2014;147:903–924.
- Walter J, Francis G, Matro R, et al. The impact of diet liberalization on bowel preparation for colonoscopy. *Endosc Int Open* 2017;5:E253–E260.
- Gómez-Reyes E, Tepox-Padrón A, Cano-Manrique G, et al. A low-residue diet before colonoscopy tends to improve tolerability by patients with no differences in preparation quality: a randomized trial. *Surg Endosc* 2020;34:3037–3042.
- ASGE Standards of Practice Committee, Saltzman JR, Cash BD, et al. Bowel preparation before colonoscopy. *Gastrointest Endosc* 2015;81:781–794.
- Sterne JA, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019;366:l4898.
- Gimeno-García AZ, de la Barreda Heuser R, Reygosa C, et al. Impact of a 1-day versus 3-day low-residue diet on bowel cleansing quality before colonoscopy: a randomized controlled trial. *Endoscopy* 2019;51:628–636.
- Jiao L, Wang J, Zhao W, et al. Comparing the influence of 1-day versus 3-day low-residue diet on bowel preparation for colonoscopy: a randomized controlled trial. *Res Sq* 2019 Oct 14 [Epub]. <https://doi.org/10.21203/rs.2.15706/v1>
- Taveira F, Areia M, Elvas L, et al. A 3-day low-fibre diet does not improve colonoscopy preparation results compared to a 1-day diet:

- A randomized, single-blind, controlled trial. *United European Gastroenterol J* 2019;7:1321–1329.
- 22. Machlab S, Martínez-Bauer E, López P, et al. Comparable quality of bowel preparation with single-day versus three-day low-residue diet: randomized controlled trial. *Dig Endosc* 2021;33:797–806.
 - 23. Scaglione G, Oliviero G, Labianca O, et al. One-day versus three-day low-residue diet and bowel preparation quality before colonoscopy: a multicenter, randomized, controlled trial. *Dig Dis* 2023;41:708–718.
 - 24. Jiao L, Wang J, Zhao W, et al. Comparison of the effect of 1-day and 2-day low residue diets on the quality of bowel preparation before colonoscopy. *Saudi J Gastroenterol* 2020;26:137–143.
 - 25. Clark BT, Protiva P, Nagar A, et al. Quantification of adequate bowel preparation for screening or surveillance colonoscopy in men. *Gastroenterology* 2016;150:396–405.
 - 26. Vanhauwaert E, Matthys C, Verdonck L, et al. Low-residue and low-fiber diets in gastrointestinal disease management. *Adv Nutr* 2015;6:820–827.
 - 27. Eswaran S, Muir J, Chey WD. Fiber and functional gastrointestinal disorders. *Am J Gastroenterol* 2013;108:718–727.
 - 28. Lijoi D, Ferrero S, Mistrangelo E, et al. Bowel preparation before laparoscopic gynaecological surgery in benign conditions using a 1-week low fibre diet: a surgeon blind, randomized and controlled trial. *Arch Gynecol Obstet* 2009;280:713–718.
 - 29. Burkitt DP, James PA. Low-residue diets and hiatus hernia. *Lancet* 1973;2:128–130.
 - 30. Leszczynski AM, MacArthur KL, Nelson KP, et al. The association among diet, dietary fiber, and bowel preparation at colonoscopy. *Gastrointest Endosc* 2018;88:685–694.