

Low-residue versus clear liquid diet before colonoscopy

An updated meta-analysis of randomized, controlled trials

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Abstract

Great value in the early identification and treatment of adenomatous polyps or early canceration using colonoscopy has been recognized. A clear colonoscopic vision brought by good intestinal preparation will become crucial. Several studies have completed using the low-residue diet (LRD) versus a clear liquid diet (CLD) the day before colonoscopy that presenting contradictory results. Therefore, a more comprehensive and updated meta-analysis is needed to summarize the findings on the effects of LRD and CLD on intestinal preparation and the quality of coloscopy.

The comprehensive search was performed in PubMed/MEDLINE, Scopus, Cochrane databases (February 2020). LRD vs CLD before colonoscopy were included in this study. Mantel-Haenszel or DerSimonian and Laird models with the relative risk (RR) to evaluate differences in intestinal preparation, tolerance, readiness to repeat preparation, detected of a polyp, and overall adverse reactions.

Total 16 studies (N=3413) were eligible. Patients with LRD compared with CLD indicated significantly better of tolerability (RR 0.92;95% CI,0.85–0.99; $P < .05$) and willingness to repeat intestinal preparation (RR 0.86; 95% CI 0.79–0.93; $P < .05$), but no differences with adequate intestinal preparations, detected polyp or overall adverse reactions (all $P > .05$).

Patients with LRD the day before colonoscopy show better tolerance and willingness to repeat intestinal preparation, and no difference with adequate intestinal preparations compared with CLD, but the recommended level of evidence is weak. However, in terms of the detection rate of intestinal adenomas, the LRD group is not weaker than the CLD group, for its evidence level is high, and can significantly reduce the hunger experience of patients.

Abbreviations: CLD = clear liquid diet, CRC = colorectal cancer, LRD = low-residue diet, RCT = randomized controlled trials, RR = relative risk, SMD = standardized mean difference.

Keywords: clear liquid diet, colonoscopy, low-residue diet, meta-analysis

1. Introduction

Colorectal cancer (CRC) is the second most common cancer among women and the third most common cancer among men.^[1]

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

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However, the morbidity and mortality of CRC in some developed countries, especially the United States and Japan, have been decreasing in recent years.^[2–4] In 2016, United States Preventive Services Task Force released new guidelines for CRC screening, which strongly recommends that general risk adults start screening at the age of 50.^[5] Therefore, this is partly due to the benefits of early screening by colonoscopy, which is of great value in the early identification and treatment of adenomatous polyps or early canceration.^[6] However, there is a certain rate of missed diagnosis in colonoscopy.^[7] One of the main factors resulting in the rate of missed diagnosis is the quality of intestinal preparation. Inadequate intestinal preparation can obviously limit the operator's field of vision and reduce the ability to identify lesions. Improper intestinal preparation is often an important cause of inadequate intestinal preparation, such as consuming a large amount of fluid, eating only clear fluid the day before the colonoscopy, and so on. These reasons may reduce the patient's compliance and lead to poor intestinal preparation.^[8]

A diet consisting of exclusively clear liquids is a clear liquid diet (CLD). Solid food on this diet is not allowed and any food including water, broth, which is considered as liquid is allowed.^[9] With a CLD diet before intestinal preparation, colonoscopy is obviously unlikely to contain food residue, but at the same time, it is difficult for patients to strike a perfect balance between diet orders and the intake of large doses of laxatives, which may affect the effectiveness of colonoscopy. Many prospective studies

evaluated the quality of intestinal preparation and colonoscopy results as well as overall adverse reactions to the use of a low-residue diet (LRD) and a CLD diet the day before the colonoscopy. A meta-analysis of randomized, controlled trials in 2016 showed that there was no difference in adequate intestinal preparation or adverse reactions compared with CLD, but there was a significant increase in tolerance and willingness to repeat preparation in patients with a LRD.^[10]

However, since the release of the meta-analysis, seven clinical trials have been published, and some of the conclusions in these clinical trials are still contradictory.^[11–17] In addition, effects of LRD and CLD on the percentage of adenomas detected under colonoscopy were not analyzed in this meta-analysis in 2016. Therefore, a more comprehensive and updated meta-analysis is needed to summarize the initial findings. The current meta-analysis is used to summarize the results of existing studies on the effects of LRD and CLD on intestinal preparation and the quality of colonoscopy.

2. Methods

2.1. Literature search strategy

Systematic and comprehensive literature review of the low-residue versus CLD before colonoscopy: randomized controlled trials were performed based on multiple databases which included PubMed/Medline, Scopus, Cochrane databases in February 2020. Search terms were described as “low-residue diet and colonoscopy,” “diet liberalization and colonoscopy” and “fiber-free diet and colonoscopy.” Detailed terms were listed below: diet [All Fields] AND Low-residue [All Fields] AND colonoscopy [All Fields], liberalization [All Fields] AND diet [All Fields] AND colonoscopy [All Fields], and fiber-free [All Fields] AND diet [All Fields] AND colonoscopy [All Fields]. Then, all references of retrieved articles are reviewed again to ensure that the relevant literature will not be missed. Incomplete data or indistinct data was got accessing to the corresponding author if necessary. Two authors (L.C and W.Z) reviewed all the titles and abstracts based on the literature inclusion criteria. Any divergences on study selection were resolved by a third author (E.G.C).

2.2. Data inclusion

This study included studies of LRD vs. CLD preparation in adult patients who needed intestinal preparation before colonoscopy. In each study, patients had to eat at least 1 low-residual meal the day before the colonoscopy, and both diet groups used the same intestinal preparation. The required data is independently extracted by 2 reviewers (L.C and W.Z) and passed by a third party (E.G.C) to resolve the disagreements in the extraction process.

2.3. Study quality assessment

The Cochrane Risk of Bias Tool was performed by 2 independent authors (F.W and W.Z) to assess the risk bias of included studies. The funnel plot was constructed to evaluate the publication bias.

2.4. Institutional review board

This manuscript is dispensed from Institutional Review Board Given for the results in this meta-analysis from published meta-analysis of randomized controlled trials.

2.5. Statistical analysis

We used a meta-analysis to compare the differences in intestinal preparation, tolerance, readiness to repeat preparation, detected of polyp and overall adverse reactions between adults who ingested LRD the day before the colonoscopy and those who ingested CLD. In this study, pooled estimates analyses were conducted in these five aspects. Better gut preparation is generally defined as a score of good or above on the Aronchick scale, greater than 6 on the Boston bowel preparation scale, or A or B on the Harefield Cleansing scale. The tolerance of the intestinal preparation was summarized and analyzed. The mantel-haenszel method with fixed effects was used in the outcome model without heterogeneity, and the DerSimonian and Laird method with random effects was used in the outcome model with heterogeneity, and the results were presented as relative risk. If there is statistically significant heterogeneity, a separate sensitivity analysis of the results will be carried out. Significant heterogeneity was identified as $P < .10$ or $I^2 > 50\%$. The standardized mean difference (SMD) can be selected as the effective variable for meta-analysis of measurement data. The statistical analysis of this study was conducted by the Stata 12.0 (Stata Corporation College Station, TX). The existence of publication bias was analysed by funnelingplot.

3. Results

3.1. Literature search

411 studies were initially identified after the literature search (Fig. 1). Of these articles, 24 studies were selected for further review. Of these chosen, 16 studies (N = 3413) were included in this meta-analysis, which met the inclusion criteria. Details of studying inclusion listed in the supplementary document, <http://links.lww.com/MD/F329>.

3.2. Characteristics and qualities of selected studies

Table 1 summarized the characteristics of selected 16 studies. The assessment of study quality was shown in Table 2 according to Cochrane risk of bias tool for controlled trials. In these randomized controlled trials (RCT) studies, the risk of bias was similar within higher score in the selection and outcome parts than in other parts of the study. No significant detection, attrition and reporting bias was found but majority of studies did not blind participants or personnel.

3.3. Adequate intestinal preparations

Of the 16 studies, 13 assessed the adequacy of intestinal preparation in 2 groups (LDR group and CLD group).^[11–23] The study of meta-analysis published in 2016 had discussed the lack of relevant records of Park et al, but we carefully analyzed the study by Siped et al and found that this study did not specify the number of intestinal preparations in the CLD group and the LRD group, but scored specific measurement data. Therefore, in this study, research involving measurement data will be re-analyzed and studied according to the scoring criteria, and then compared with the existing results.

Of the 13 studies, 73.7% (1000/1356) of the CLD group was well prepared for the intestine while the percentage of the LRD group was 73.2% (1034/1413). After pooled analysis, it was found that there was no significant statistical difference in the

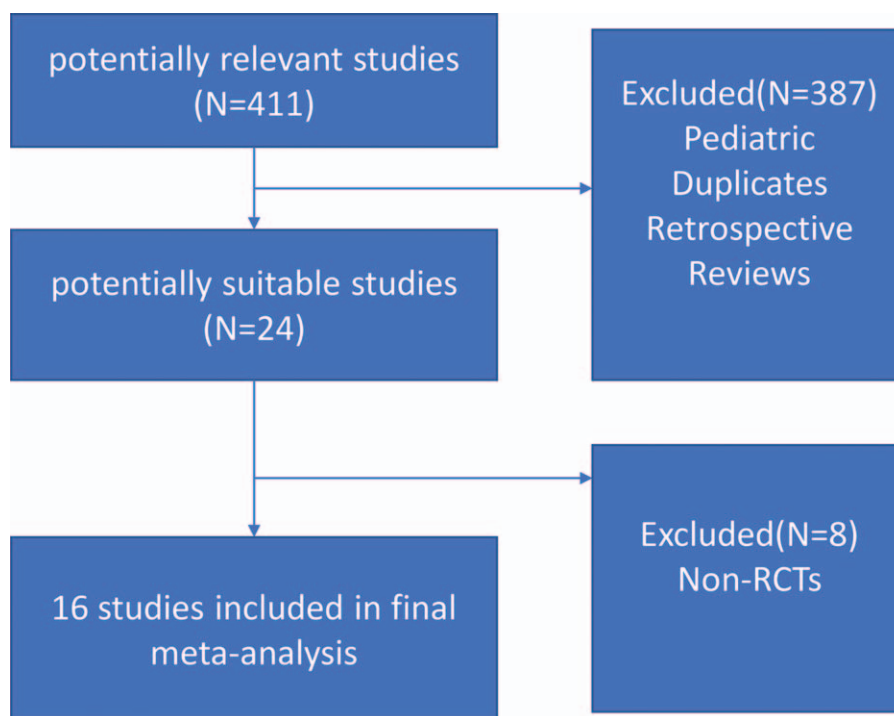


Figure 1. Flow chart of studies' enrollment.

adequacy of intestinal preparation between the 2 groups (RR, 0.99, 95% CI, 0.94–1.04; $P > .05$; $I^2 = 61.5\%$, $P = .002$). (Fig. 2)

According to the research on the measurement data involved in the articles, it was found that there were 3 studies using the Ottawa scale scoring criteria, in which the average score (\pm standard deviation) of the CLD group was 4.05 ± 2.65 and the average score (\pm standard deviation) of the LRD group was 4.09 ± 2.55 .^[12,20,24] The standardized mean difference (SMD) was 0.00 (95% CI: -0.15–0.16; $I^2 = 68.1\%$, $P = .044$), so it could not be considered that there was a difference in intestinal preparation between the 2 groups. (Fig. 3). In the 2 studies based on the Boston scale scoring criteria, the average score (\pm standard deviation) of the CLD group was 7.77 ± 1.61 , and the average score (\pm standard deviation) of the LRD group was 7.68 ± 1.55 .^[23,25] The SMD was 0.06 (95% CI: -0.16–0.27; $I^2 = 61.6\%$, $P = .107$). Similarly, it could not be considered that there was any difference in intestinal preparation between the 2 groups. After the pooled of the 2 sub-analysis, it was found that the SMD was 0.03 (95% CI: -0.16–0.22). It was still not considered that there was a difference in intestinal preparation between the 2 groups.

3.4. Tolerance of intestinal preparations of specified diet

Of the 16 studies, 9 (N=2096) recorded the tolerance of intestinal preparation in patients who received a specified diet.^[11,12,14,17,18,20,21,24,26] 81.3% of the patients in the CLD group showed good tolerance, while in the LRD group, 72% of the patients were tolerated. The pooled analysis indicated that the intestinal preparation tolerance rate of the CLD group was slightly lower than that of the LDR group (RR 0.92; 95% CI, 0.85–0.99; $P < .05$; $I^2 = 77.5\%$, $P < .001$) (Fig. 4). For attributes data used in these studies, the level of evidence for this result should be considered moderate.

3.5. Willingness to repeat intestinal preparation with a specified diet

Six of the 16 studies provided the report that the willingness of patients with repeated intestinal preparations in a specified diet.^[11,17,19,21,24,26] 88.6% (697/787) showed willingness to repeat intestinal preparation and diet in the LRD group, but only 74.9% (536/716) in the CLD group had the willingness. The pooled analysis of these 6 studies indicated that compared with CLD, patients with LRD were more likely to repeat the same intestinal preparation (RR 0.86; 95% CI 0.79–0.93; $P < .05$) (Fig. 5). No significant with heterogeneity was found (I^2 , 63.7%, $P = .017$). The level of evidence for this result is considered to be moderate.

3.6. Detected polyp with a specified diet

Half of these studies (N=1727) reported the data of polyp detected with a specified diet.^[12–14,16,17,21–23] 45.2% (389/859) showed polyp detected in the LRD group, and 44.3% (385/868) in the CLD group. The pooled analysis of these eight studies showed that the detect rate of polyp in LRD group was similar with in CLD group (RR 0.98; 95% CI 0.87–1.10; $P > .05$; I^2 , 28.1%, $P = .204$) (Fig. 6). The level of evidence for this result is deemed as high level.

3.7. Overall adverse reactions

First, we analyzed studies involving overall adverse reactions (including cramping, bloating, vomiting, headaches, nausea, dizziness, and so on) in this meta-analysis, and a total of 4 studies (N=980) assessed the overall adverse reactions associated with the 2 dietary strategies used in intestinal preparation.^[11,18,24,26] In these 4 studies, adverse reactions were measured using general

Table 1
Characteristics of selected studies.

Author	Study Type	Region	No. Of Patients	Demographics	Definition of Adequate Bowel Preparation	Diet During Bowel Preparation Phase	Type Bowel Preparation Solution
Park et al 2009	RCT	South Korea	214	Male: 120 (56.1%) Female: 94 (43.9%) Mean Age: 53.1–55.2 yr	Ottawa Scale No reported cut off for adequate preparation	Prepackaged low- residue diet all day vs Clear liquid diet all day	4L PEG with electrolytes on day of colonoscopy
Rapier et al 2006	RCT	USA	75	Male: 44 (58.7%) Female: 31 (41.3%) Mean Age: 61.0 yr	Aronchick Scale Adequate bowel preparation was excellent or good	Prepackaged low- residue diet all day vs Clear liquid diet all day	Magnesium citrate and bisacodyl (oral and rectal)
Scott et al 2004	RCT	USA	185	Male: 82 (44.3%) Female: 103 (55.7%) Mean Age: 56.9–57.0 yr	Aronchick Scale Adequate bowel preparation was excellent or good	Regular breakfast then low-residue diet lunch, then clear liquids rest of day vs Light breakfast then clear liquid rest of day	Sodium phosphates oral solutions split-dose
Sipe et al 2013	RCT	USA	196	Male: 93 (47.4%) Female: 103 (52.6%) Mean Age: 56.9–57.8 yr	Boston Bowel Preparation Scale No reported cut off for adequate preparation	Low-residue diet for breakfast, lunch, snack, then clear liquids rest of day vs Clear liquid diet all day	Oral sulfate solution split-dose
Soweid et al 2010	RCT	Lebanon	200	Male: 105 (52.5%) Female: 95 (47.5%) Mean Age: 55.5–56.6 yr	Aronchick Scale Adequate bowel preparation was excellent or good	Low-residue diet for breakfast, lunch, dinner vs Clear liquid diet all day	4L PEG with electrolytes the evening prior
Melicharkova et al 2013	RCT	Canada	213	Male: 109 (51.2%) Female: 104 (48.8%) Mean Age: 56.5–57.1 yr	Ottawa and Aronchick Scales Adequate bowel preparation were excellent or good	Low-residue diet for breakfast, then clear liquids the rest of day vs Clear liquid diet all day	Sodium picosulfate + magnesium citrate + bisacodyl evening prior for morning procedures and day of for afternoon procedures
Stolpman et al 2014	RCT	USA	201	Male: 114 (56.7%) Female: 87 (43.3%) Mean Age: 60 yr	Boston Bowel Preparation Scale Adequate bowel preparation was score ≥ 6	Low-residue diet for breakfast and lunch, then clear liquids rest of day vs Clear liquid diet all day	Oral sulfate solution split-dose
Butt et al 2016	RCT	Australia	226	Male: 117 (51.8%) Female: 109 (48.2%) Mean Age: 52 yr	Harefield Cleansing Scale Adequate bowel preparation was score of A or B	Low-residue diet all day (white diet) vs Clear liquid diet all day	2L PEG + ascorbic acid evening prior for morning procedures and split-dose for afternoon procedures
Walter et al 2017	RCT	USA	140	Male: 60 (42.9%) Female: 80 (57.1%) Mean Age: NA	Boston Bowel Preparation Scale Adequate bowel preparation was score ≥ 6	Low-residue diet for breakfast and lunch, then clear liquids rest of day vs Clear liquid diet all day	2L PEG + ascorbic acid split-dose
Delegge et al 2005	RCT	USA	506	Male: 184 (36.4%) Female: 322 (63.6%) Mean Age: 54.3 yr	Custom standard, Adequate bowel preparation was excellent or good	Prepackaged low-residue diet all day vs Clear liquid diet all day	sodium phosphates (2 \times 45-mL, split dose.) vs low volume dose of magnesium citrate and bisacodyl
Flemming et al 2015	RCT	Canada	214	Male: 86 (40.2%) Female: 128 (63.6%) Mean Age: 62–65 yr	Ottawa scale; Aronchick scale, Adequate bowel preparation was excellent or good	Low-residue diet for breakfast, then clear liquids rest of day vs Clear liquid diet all day	4L PEG-ELS solution, split-dosing or traditional dosing depend on colonoscopy time
Dwyer et al 2017	RCT	Australia	250	Male: 135 (54%) Female: 115 (46%) Mean Age: 54–54.5 yr	Ottawa scale, Adequate bowel preparation was score ≤ 6	White Diet vs Light breakfast, then clear fluids only	1L PEG or split-dose Picosalax + SPMC
Thukral et al 2017	RCT	USA	215	Male: 112 (52.3%) Female: 103 (47.7%) Mean Age: 55.8–57 yr	Boston Scale, Adequate bowel preparation was score > 5	Specific instructions on acceptable foods for breakfast, lunch, and evening snacks vs Clear liquid diet all day	Split dose magnesium citrate
Tikfu et al 2018	RCT	Malaysia	97	Male: 51 (53%) Female: 46 (47%) Age: 16–73 years old	The modified Aronchick bowel preparation quality scale.	Low-residue, lactose-free semi-elemental enteral formula vs Clear liquid diet	Sodium phosphate (PEG, 3 L in total instead if contraindicated)
Marco et al 2019	RCT	Spain	276	Male: 144 (52%) Female: 132 (48%) Mean Age: 59.9 yr	Boston bowel preparation scale	Low-fiber diet vs Clear liquid diet	4 L of polyethylene glycol in a split-dose regimen
Elisa et al 2019	RCT	Mexico	205	Male: 72 (35.1%) Female: 133 (64.9%) Mean Age: 55.6 yr	Boston bowel preparation scale	Low-residue diet vs Clear liquid diet	4-L preparation of single-dose PEG

RCT = randomized controlled trials.

Table 2
Cochrane risk of bias tool for controlled trials.

Author, year	Selection bias		Performance bias	Detection bias	Attrition bias	Reporting bias	Other bias
	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	
Scott et al 2004	+	+	-	+	+	+	+
Delegge et al 2005	+	+	-	+	-	-	-
Rapier et al 2006	+	+	-	+	N	+	+
Park et al 2009	+	+	-	+	+	+	+
Soweid et al 2010	+	+	-	+	N	-	-
Melicharkova et al 2013	+	+	-	+	+	+	+
Sipe et al 2013	+	-	-	+	-	-	+
Stolpman et al 2014	+	+	-	+	N	+	+
Flemming et al 2015	-	-	-	+	+	+	+
Butt et al 2016	+	+	-	+	+	+	-
Walter et al 2017	+	+	-	+	+	+	+
Dwyer et al 2017	+	+	-	+	+	+	+
Thukral et al 2017	+	+	-	+	+	N	+
likfu et al 2018	+	+	-	+	+	N	-
Marco et al 2019	+	+	-	+	-	+	+
Elisa et al 2019	+	+	-	+	+	-	+

+ = performed, - = not performed, N = not mentioned.

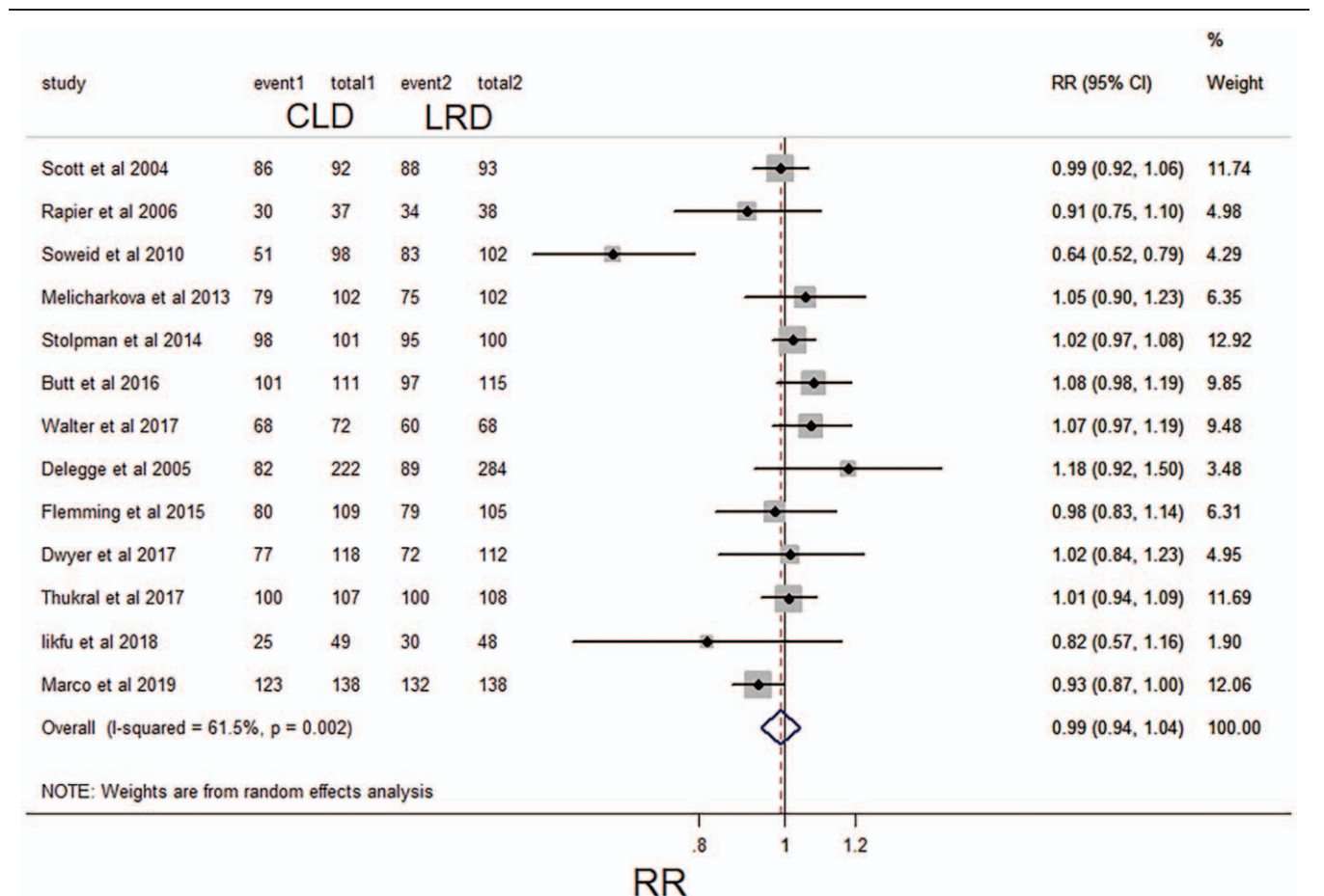


Figure 2. Forest plot comparing the frequency of adequate intestinal preparations between a low-residue diet and clear liquid diet before colonoscopy for categorical data. CI, confidence interval; RR, relative risk.

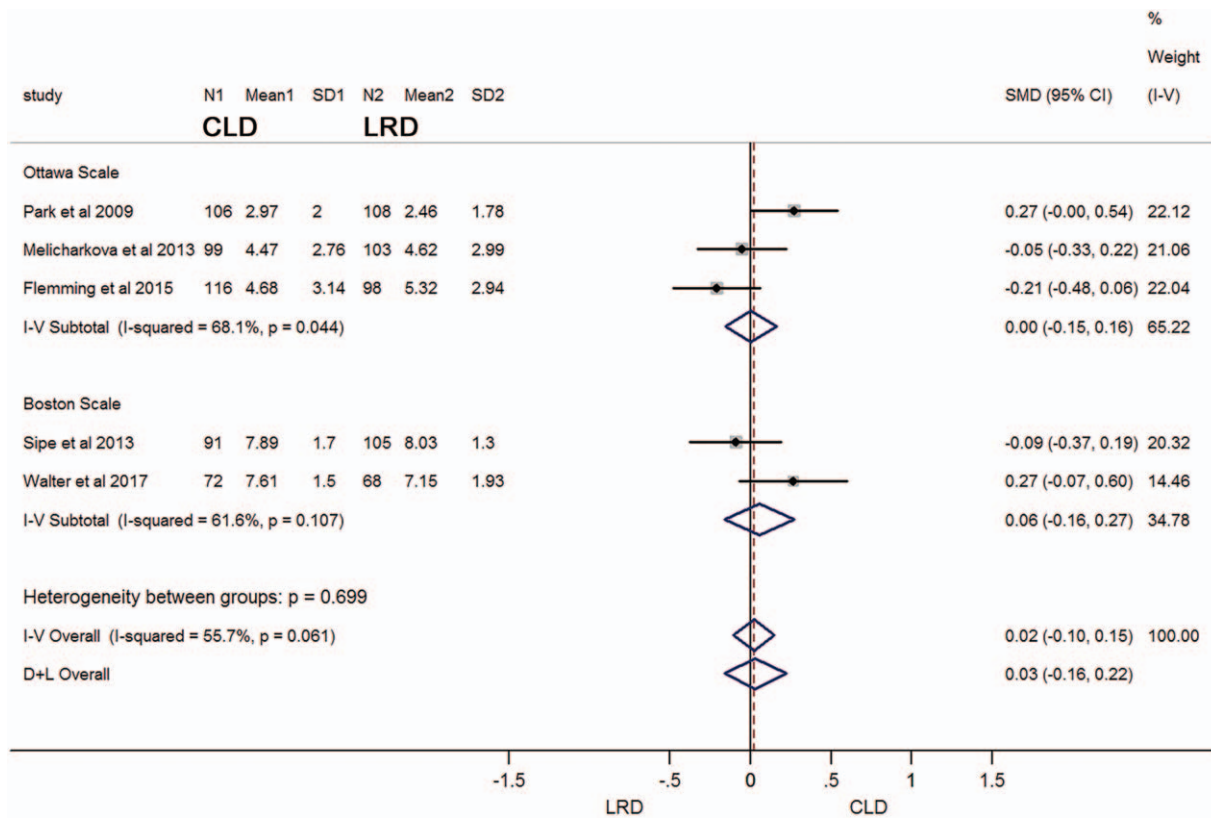


Figure 3. Forest plot comparing the scale scores of adequate intestinal preparations between a low-residue diet and clear liquid diet before colonoscopy for metrological data. CI, confidence interval; SMD, standardized mean difference.

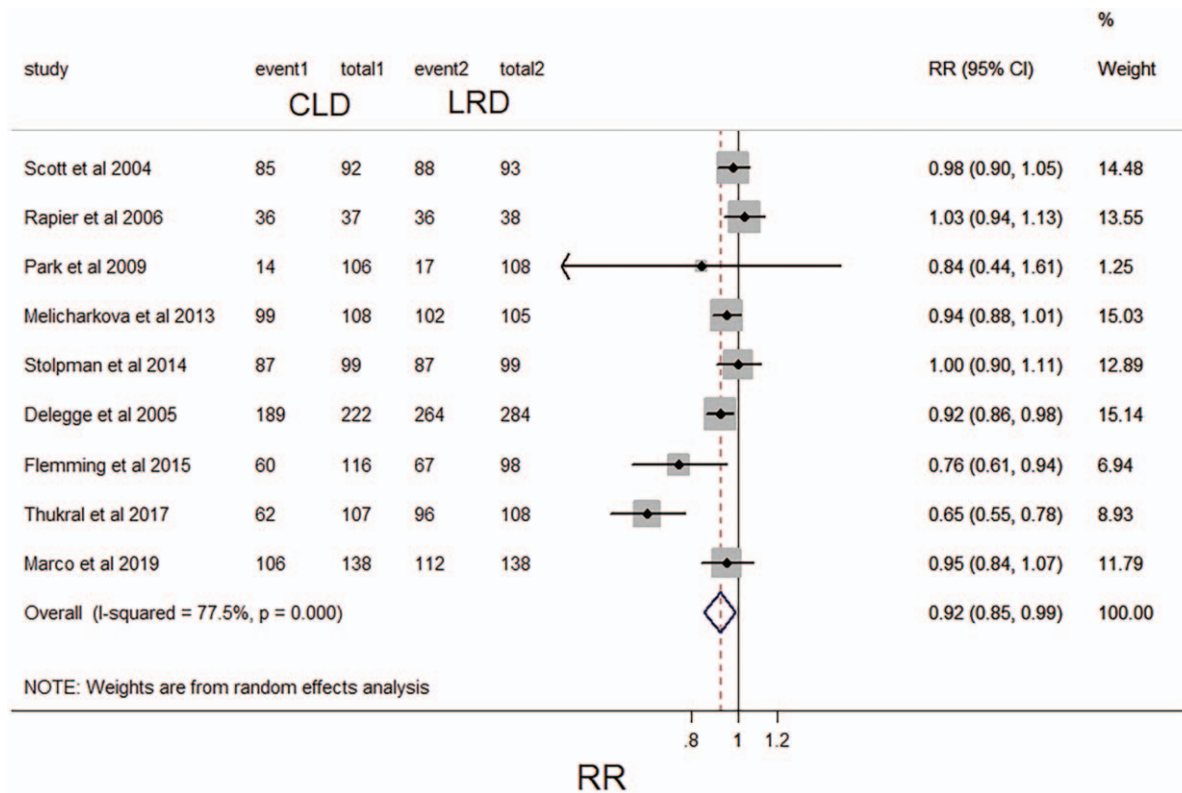


Figure 4. Forest plot comparing reported tolerability of intestinal preparations between a low-residue diet and clear liquid diet before colonoscopy. CI, confidence interval; RR, relative risk.

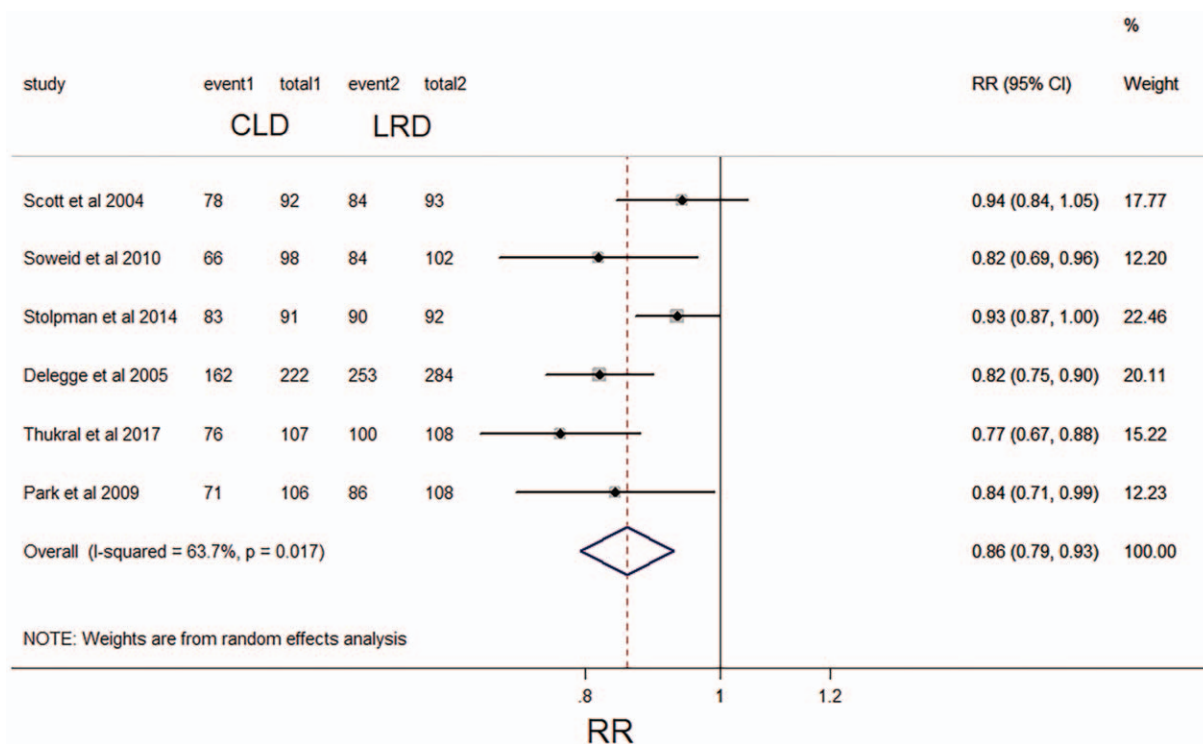


Figure 5. Forest plot comparing willingness to repeat intestinal preparation between a low-residue diet and clear liquid diet before colonoscopy. CI, confidence interval; RR, relative risk.

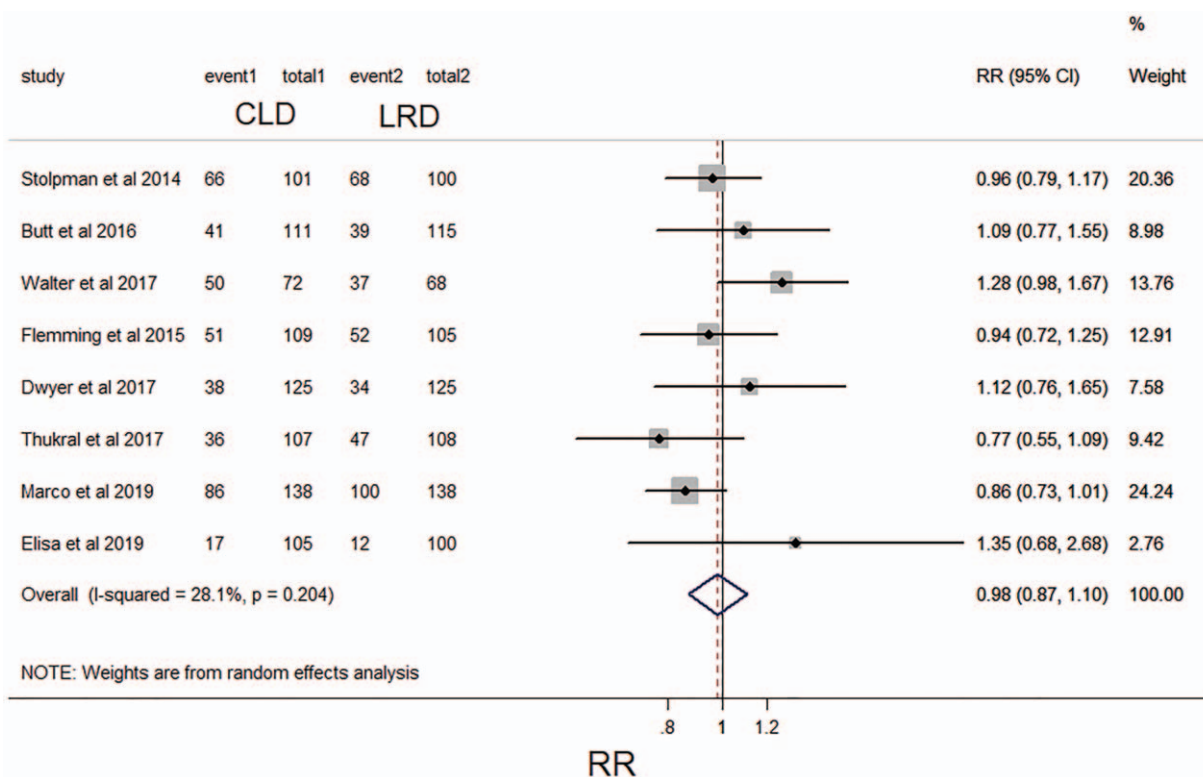


Figure 6. Forest plot comparing the frequency of detecting polyp between a low-residue diet and clear liquid diet before colonoscopy. CI, confidence interval; RR, relative risk.

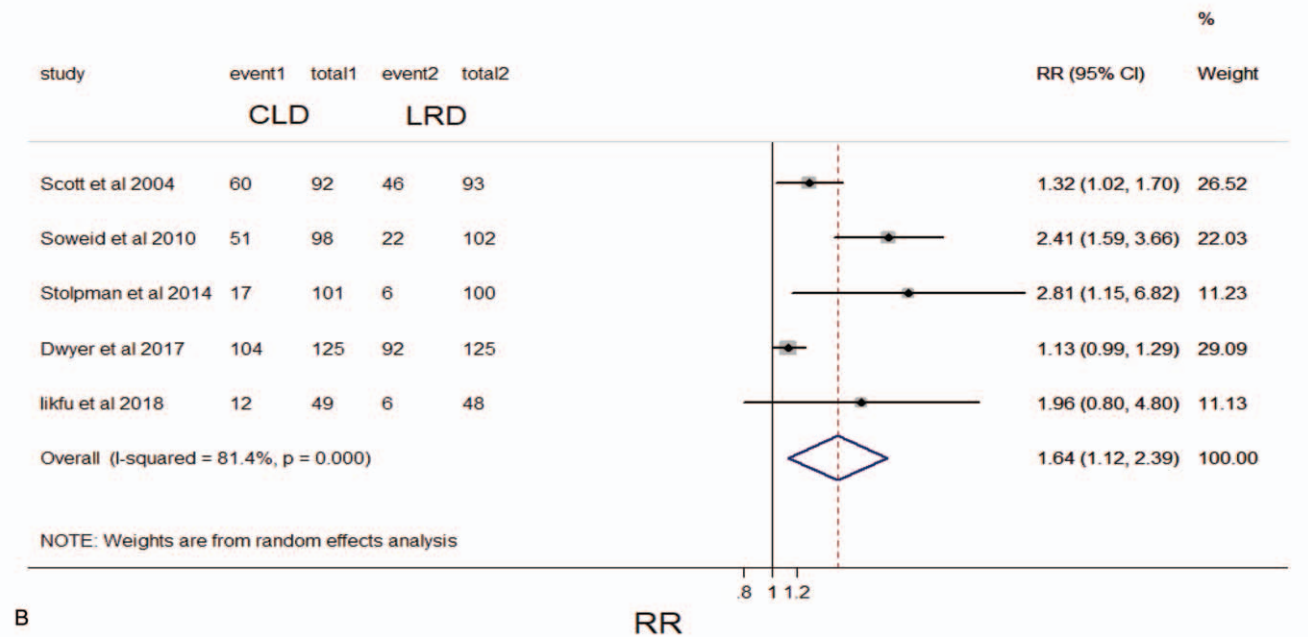
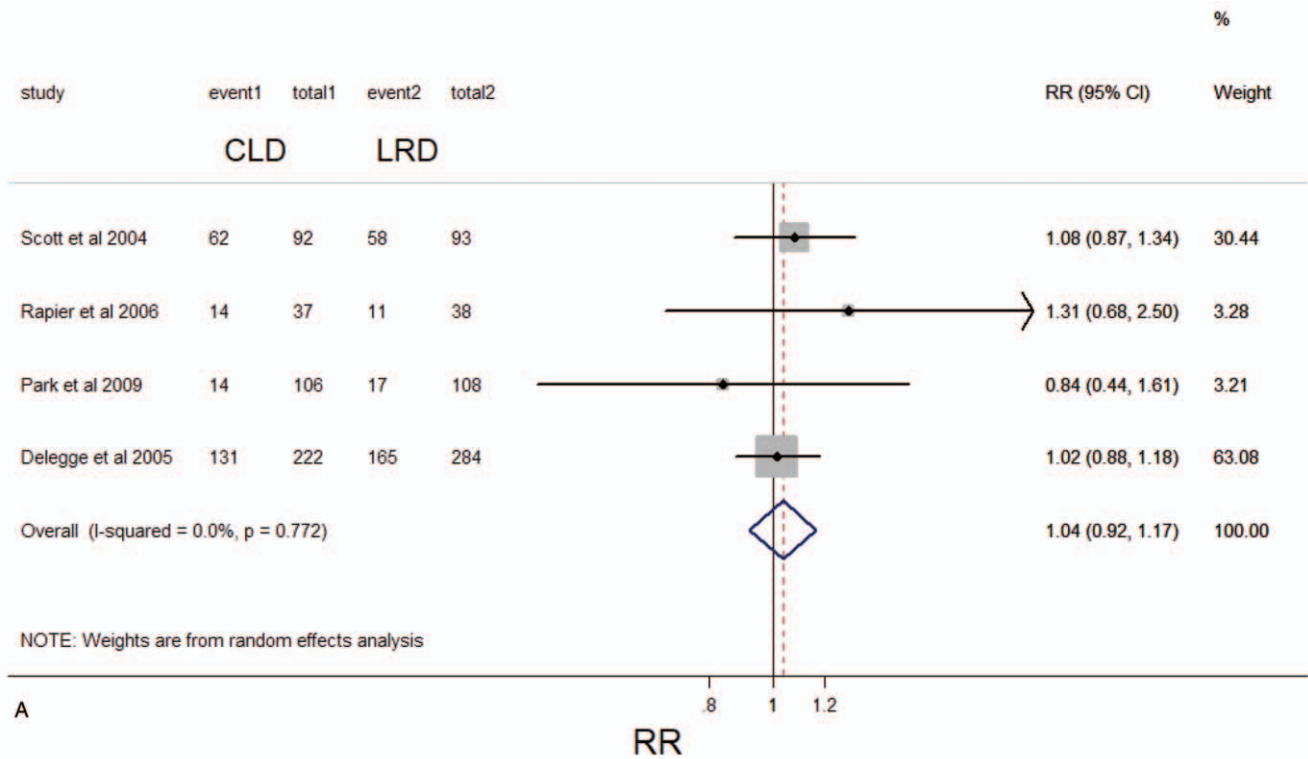


Figure 7. Forest plot comparing the frequency of (A) overall adverse reactions and (B) hunger between a low-residue diet and clear liquid diet before colonoscopy. CI, confidence interval; RR, relative risk.

discomfort. There was no statistical difference between LRD group (251/523, 48.0%) and CLD group (221/457, 48.4%) in terms of adverse reactions (RR, 1.04; 95%CI, 0.92–1.17; $P > .05$; $I^2 = 0.0\%$, $P = .772$) in the pooled analysis (Fig. 7A). The Grading of Recommendations Assessment, Development, and Evaluation evidence for this result was considered moderate because only 4 studies reported on adverse reactions that could be collected.

Furthermore, we analyzed hunger separately as an indicator, because the feeling of hunger was not so friendly and can significantly affect the willingness of colonoscopy, if repeated intestinal preparation was needed. The analysis showed that a total of 5 studies (N=933) involved the indicator of hunger.^[13,15,19,21,26] In the pooled analysis, the hunger sensation in the CLD group (52.5%, 244/465) was significantly more severe

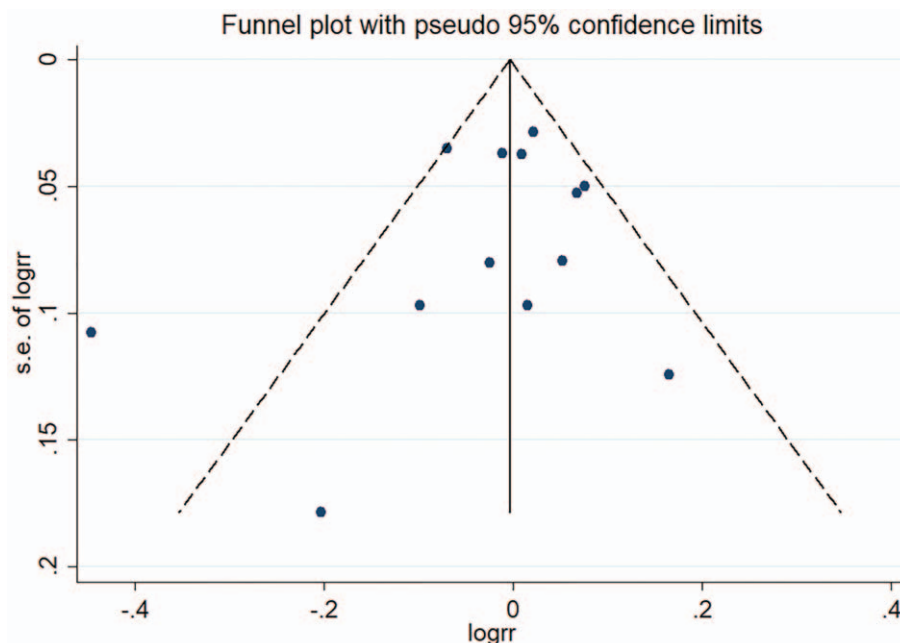


Figure 8. Funnel plot showing no publication bias. RR, relative risk; SE, standard error.

than that in the LRD group (36.8%, 172/468). (RR, 1.64, 95% CI, 1.12–2.39; $P < .05$; $I^2 = 81.4\%$, $P < .01$) (Fig. 7B). The Grading of Recommendations Assessment, Development, and Evaluation evidence for this result can be considered high.

3.8. Publication bias

No publication bias was found in the case of asymmetry of the funnel plot. (Fig. 8)

4. Discussions

Adequate intestinal preparation is very beneficial in all aspects of colonoscopy, especially in terms of accuracy. A prospective study of repeated colonoscopy found that when intestinal preparation was inadequate, the missed rate of adenomas larger than 5 mm was 3 times higher.^[27] Current international guidelines are not entirely consistent. The US Multi-Society Task Force on CRC recommends that both CLD and LRD are acceptable until the night before colonoscopy.^[28] However, Europe's latest 2019 version of European Society of Gastrointestinal Endoscopy Guideline still recommends a LRD the day before the colonoscopy.^[29] The meta-analysis from Nguyen et al^[10] in 2016 has done some work in this field, and its results show that the LRD the day before colonoscopy seems to be equally effective for the quality of intestinal preparation, but shows higher tolerance and willingness to repeat intestinal preparation, suggesting that a LRD should be used instead of a CLD before colonoscopy. Since then, 7 new RCT studies have been released, and there are still some contradictory conclusions in these clinical studies.^[11–17] Moreover, based on these recent studies, we analyzed and compared the detection of adenomas under colonoscopy in patients who received a LRD and a clear fluid diet. Obviously, it is extremely important for colonoscopy screening for early cancer and precancerous lesions. Therefore,

we immediately analyzed, updated and summarized the findings of these studies, hoping to make some contribution in this field.

The purpose of this study was to compare the intestinal preparation, tolerance, willingness to repeat intestinal preparation, detection of adenomas and overall adverse reactions in patients who received low residue diet and clear fluid diet respectively the day before the colonoscopy. These results of this study may provide some constructive reference for endoscopists.

In terms of the adequacy of intestinal preparation, 13 articles included in this study used categorical data to compare intestinal preparation between the LRD group and the CLD group. In addition, in view of the fact that some studies used metrological data to show intestinal preparation in the LRD group and the CLD group, we also conducted a separate subgroup analysis, of which 3 RCT studies^[12,20,24] were conducted with Ottawa scale scoring criteria, 2 RCT studies^[23,25] based on Boston scale scoring criteria. The pooled analysis showed that there was no significant difference in intestinal preparation between the 2 groups, whether expressed by RR or SMD (RR, 0.99, 95% CI, 0.94–1.04; $P > .05$; SMD, 0.03, 95% CI: -0.16–0.22). However, there is a significant heterogeneity in the analysis, which is different from the meta-analysis results of Nguyen et al., which is in line with the US guidelines and makes it a recommendation level of weak. In terms of the tolerance of intestinal preparation and the willingness to repeat intestinal preparation, the pooled analysis of LDR group and CLD group showed that the performance of LRD group was significantly better than that of CLD group ($P < .05$) in these 2 aspects. However, it is worth noting that they have significant heterogeneity, which is also distinct from the results of Nguyen et al, so the recommendation evidence is still weak.

Intriguingly, in terms of an indicator that has not been analyzed before, a vital indicator, namely the detection of adenomas, there are 8 RCT studies involving this indicator. Pooled analysis showed that the detection rate of intestinal adenomas in the LRD group was not weaker than that in the CLD group ($P > .05$), and there was no significant heterogeneity (I^2 ,

28.1%, $P = .204$), so the recommended evidence level should be considered to be high. In terms of overall adverse reactions, there was no significant difference in meta-analysis between LRD group and CLD group, and there was no significant heterogeneity. In the past, endoscopists often worried that low residual diet would lead to insufficient intestinal preparation, resulting in a decrease in the detection rate of intestinal precancerous lesions or adenomas. The results of this study showed clear evidence that the detection rate of intestinal lesions in the LRD group was not lower than that in the CLD group. At the same time, we separately listed the index of hunger for subgroup analysis, because the hunger before intestinal preparation brought the most intuitive feeling, the analysis showed that hunger in the CLD group was significantly greater than that in the LRD group. When it is already known that it does not affect these important indicators, such as the detection rate of intestinal adenomas, using LRD to reduce hunger can improve patients' subjective experience of colonoscopy.

Any meta-analysis has its advantages and limitations. There is no doubt that this study only included the RCT studies, which dramatically increased the credibility of the level of evidence. Second, this study uses RR as the result analysis index, which is more commonly used in prospective cohort studies than OR, and its clinical significance is clear.^[30] In addition, compared with the previous meta-analysis, this study added a new comparative study on the detection rate of intestinal adenomas, and the recommended level of evidence is high. Finally, this study was widely included RCT studies from all the world, and the same intestinal preparations were used in the same study, which was comparable. At the same time, different intestinal preparations were used in different studies, indicating that the results of the study can be extrapolated to different intestinal preparations.

Certainly, the limitations of the study are also inevitable. First of all, the analysis results of several indicators show significant heterogeneity, although the random effect model has been used, which makes the evidence recommendation level of these conclusions is not so high. However, there is no significant heterogeneity in the detection of intestinal adenomas, so that endoscopists do not have to worry about affecting the detection rate of intestinal lesions while taking care of patients to avoid the subjective experience of hunger. Secondly, it was noted that in the study of adequate intestinal preparation, several studies were represented by metrological data and were not merged into a collection of 13 categorical data, but we analyzed them separately according to their scoring criteria, and the results were similar to those of categorical data.

5. Conclusions

In summary, based on the meta-analysis of existing RCT studies, LRD the day before colonoscopy seems to be equally effective for the quality of intestinal preparation, but patients show better tolerance and willingness to repeat intestinal preparation, but the recommended level of evidence is weak. However, in terms of the detection rate of intestinal adenomas, the LRD group is not weaker than the CLD group, for its evidence level is high, and can significantly reduce the hunger experience of patients.

Author contributions

E.G.C designed the study, analyzed and interpreted the data, and wrote the manuscript. L.C and F.W acquisition of data. W.Z and

X.L.C statistical analysis. G.Y.C study supervision. All authors have vouched for the data analysis, approved the final version, and agreed to publish the manuscript.

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