A Systematic Review and Meta-Analysis of Low-Residue Diet Versus Clear Liquid Diet

Which Is Better for Bowel Preparation Before Colonoscopy?

ABSTRACT
The goal of this systematic review was to compare the clear liquid diet and the low-residue diet to determine which is better for bowel preparation before colonoscopy. A literature search for randomized controlled trials on the effects of employing the clear liquid diet and low-residue diets before colonoscopy was conducted in major online English databases (PubMed, Web of Science, and Ovid EMBASE). After the systematic review of all 16 studies, the outcomes including quality of bowel preparation, tolerance, willingness to repeat, and adverse effects were analyzed through meta-analysis. The statistical analysis was performed by using RevMan 5.3 software. No statistically significant difference was observed between the low-residue diet and clear liquid diet groups (odds ratio [95% confidence interval] = 1.19 [0.79, 1.81]; p = .41). There was no statistically significant difference between the Boston Bowel Preparation Scale (standard mean difference [95% confidence interval] = −0.04 [−0.21, 0.14]; p = .68) Ottawa Bowel Preparation Scale (standard mean difference [95% confidence interval] = −0.04 [−0.19, 0.11]; p = .59) scores of the two groups. The quality indicators for colonoscopy of the two groups were not statistically significant. However, patient tolerance to the low-residue diet was higher (odds ratio [95% confidence interval] = 1.86 [1.47, 2.36]; p < .01). More patients in the low-residue diet group were willing to repeat the low-residue diet for bowel preparation (odds ratio [95% confidence interval] = 2.34 [1.72, 3.17]; p < .01). More patients in the clear liquid diet group experienced hunger, nausea, and vomiting. People who employed the low-residue diet before colonoscopy had the same quality of bowel preparation as those with clear liquid diet. Meanwhile, the tolerance of people with low-residue diet was better than people with clear liquid diet, and these people were more willing to repeat the colonoscopy with less adverse events.

Colonoscopy is an effective tool that is extensively used for the screening and surveillance of colorectal lesions to reduce the incidence and mortality of colorectal cancer (Brenner, Stock, & Hoffmeister, 2014).

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Undoubtedly, the quality of bowel preparation is important for guaranteeing the quality of the colonoscopy. Unfortunately, many patients experience inadequate bowel preparation (Kang et al., 2016; Kluge et al., 2018). Therefore, we explored methods of improving the quality of bowel preparation. In addition to the true effects of bowel preparation on bowel cleansing, patient compliance, satisfaction, and tolerability are important factors that influence the quality of bowel preparation. Therefore, the low-residue (LRD) and clear liquid diets (CLD) have become of great interest to endoscopists.

**Background**

Traditionally, the CLD has been used before colonoscopy to ensure the quality of bowel preparation. However, some studies have shown that using the LRD was not inferior to using the CLD for bowel preparation. Simultaneously, compared with the CLD, the LRD seems more easily accepted by patients, resulting in higher tolerance, satisfaction, and compliance (Nguyen, Jamal, Nguyen, Puli, & Bechtold, 2016). Further studies have shown that the LRD can reduce the amount of purgative intake used during the CLD to achieve similar bowel cleansing (Lee et al., 2019). Additionally, the LRD can be implemented 1 day before colonoscopy and does not require multiple days of use (Gimeno-Garcia et al., 2019). These results suggest the superiority of the LRD. Moreover, the CLD may cause blood glucose fluctuations in patients with diabetes, thus affecting patient compliance (Alvarez-Gonzalez et al., 2016).

Furthermore, the potential risks of the CLD are unclear for those with gastrointestinal diseases. Nonetheless, because of the lack of randomized controlled trials (RCTs) comparing the LRD and CLD in large populations, many physicians are not convinced of the effectiveness of the LRD. Therefore, many medical institutions have not adopted the LRD.

Recently, more studies have been performed by several institutions to compare the CLD and LRD; however, the number of participants involved has been small. Therefore, the aim of this systematic review and meta-analysis was to compare the CLD with LRD before colonoscopy in terms of quality of bowel preparation, patient tolerance, willingness to repeat, and adverse effects and to determine whether the quality of bowel preparation of people with the LRD and CLD is consistent.

**Methods**

**Eligibility Criteria**

We formulated the eligibility criteria according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Liberati et al., 2009). Eligibility criteria mainly included study and report characteristics. Study characteristics were population (those able to undergo the colonoscopy were all researchable), intervention and comparator (bowel preparation with the LRD vs. the CLD), outcome (quality of bowel preparation assessed based on different scales of quality indicators for colonoscopy, tolerance to the method, willingness to repeat the method, and adverse events), and study designs of interest (only RCT that compared the LRD with the CLD for patients performing bowel preparation before colonoscopy). Report characteristics were language of the publication (only English was assessed), publication status (only full-text articles were assessed), and year of publication (only those published during or before September 2019 were assessed).

**Literature Search**

A comprehensive search of PubMed, Web of Science, and Ovid EMBASE databases was performed until September 2019. The terms used to perform the search were as follows: “colonoscopy” and “diet” and (“low-residue” or “low residue”) and (“clear liquid” or “clear-liquid” or “clear fluid”). All search strategies are summarized in the Appendix Table (see Supplemental Digital Content, available at: http://links.lww.com/GNJ/A63). Reference lists from the reviewed articles and other relevant studies were manually searched.

**Study Selection**

Titles and abstracts were independently reviewed by the two investigators. When discrepancies were found at this stage, a third investigator was consulted. Full-text articles were included according to the eligibility and exclusion criteria. Then, the two investigators independently reviewed and evaluated the full-text articles. The final decision was made by the third investigator when a controversial article was encountered.

**Data Extraction**

Two unblinded reviewers independently extracted relevant data for standardized tabulation. The data used for the appendix or “Web extra” were extracted by the reviewers as well. Divergence was solved by consulting the third reviewer. We did not contact the original authors to obtain more data. The data extracted from the RCTs were article descriptors (first author, year of publication), study population (participant age range, gender ratio, inclusion and exclusion criteria), study environment (country, type of hospital), study methods (study design, randomization procedure), intervention (provider, structure, content), and results (number of participants who achieved adequate bowel preparation, results of Boston Bowel Preparation Scale [BBPS] and
Quality Assessment
We adopted the Cochrane Collaboration’s Tool for Assessing Risk of Bias to assess the quality of the included articles. The Cochrane Collaboration’s Tool incorporated six items: selection bias (random sequence generation and allocation concealment), performance bias, detection bias, attrition bias, reporting bias, and other bias. We used “low risk of bias,” “unclear risk of bias,” and “high risk of bias” to describe the bias of the articles. The two investigators independently assessed the quality of the study, and the third investigator made the final decision when they encountered a controversial article.

Data Synthesis and Analysis
The odds ratio (OR) was used to evaluate the pooled effect for tolerance, willingness to repeat, and adverse events, which were categorical variables. Meanwhile, the standard mean difference (SMD) with 95% confidence intervals (CIs) was used to assess quality of bowel preparation, which was a numerical variable. We used Cochrane’s Q (expressed as $P$) qualitatively and the $I^2$ statistic quantitatively to evaluate the heterogeneity of the included studies (DerSimonian & Laird, 1986). If $I^2 > 50\%$ or $p < .10$, then we used the random-effects model because of the significant heterogeneity. Inversely, if $I^2 < 50\%$ or $p > .10$, then the fixed-effects model was used because of the homogeneity. If significant heterogeneity existed between studies, then a sensitivity analysis was performed by deleting the included studies one-by-one to determine the source. We performed all statistical analyses using RevMan 5.3 (Review Manager Version 5.3; Review Manager, Copenhagen, The Nordic Cochrane Centre, The Cochrane Collaboration, London, UK).

Results

Study Selection
One hundred fifty-five articles were identified through searching the database and references of the related articles. Thirty-nine articles were removed because they were duplicates. Eighty-nine articles were excluded for not meeting the eligibility criteria based on the titles and abstracts. Twenty-seven full-text articles were included according to the eligibility criteria. After reviewing these articles, we excluded five that were not RCTs and six that failed to compare CLD with LRD. Ultimately, 16 articles were included in the meta-analysis (Figure 1).

Characteristics of the Included Studies
The characteristics of the 16 included studies are described in Table 1. All are RCTs that compared the effectiveness of the LRD and CLD for bowel preparation. The studies were performed in nine different countries. Most studies had a sample size of 200, and the other three had sample sizes of only 100. Only one study was an RCT about pediatric colonoscopy. The mean age of patients in the other studies was between 51 and 65 years. The primary outcome of each study was the adequacy of bowel preparation; however, the definition of adequate bowel preparation differed in each study. The scales used to assess bowel preparation were also different (including BBPS, OBPS, Aronchick Scale, and Harefield Cleansing Scale [HCS]). All used bowel preparation solutions, but the types, times, and methods were different.

Quality Assessment
We used the Cochrane Collaboration’s Tool for Assessing Risk of Bias to evaluate the included 16 RCTs. Studies by Scott, Raymond, Thompson, and Galt (2005); Stolpman, Solem, Eastlick, Adlis, and Shaw...

FIGURE 1. Flowchart for filtering articles.
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| Study                          | Country       | Sample Size | Demographics | Definition of Adequate Bowel Preparation | Type of Bowel Preparation Solution |
|-------------------------------|---------------|-------------|--------------|-----------------------------------------|-------------------------------------|
| Scott et al., 2005            | United States | 92          | Female: 44 (47.3%) Mean age: 57 years | Aronchick Scale Adequate bowel preparation was excellent or good | NAP, the evening before, split-dose |
| Rapier & Houston, 2006        | United States | 16          | Female: 16 (42.1%) Mean age: 51 years | Aronchick Scale Adequate bowel preparation was excellent or good | Magnesium citrate and bisacodyl, the day before, oral and rectal |
| Park et al., 2009             | Korea         | 106         | Female: 47 (45.5%) Mean age: 53.1 years | Aronchick Scale Adequate bowel preparation was not described | 4L PEG-ES, the evening before, split-dose |
| Soweid et al., 2010           | Lebanon       | 98          | Female: 43 (43.9%) Mean age: 55.5 years | Aronchick Scale Adequate bowel preparation was excellent or good | 4L PEG-ES, the evening before, split-dose |
| Koh et al., 2011              | Korea         | 40          | Female: 14 (35%) Mean age: 51.4 years | Ottawa Scale Adequate bowel preparation was not described | 4L PEG-ES, the evening before, traditional or split-dose |
| Melchikova et al., 2013       | Canada        | 108         | Female: 49 (53%) Mean age: 56.5 years | Ottawa and Aronchick Scales Adequate bowel preparation was excellent or good | 4L PEG-ELS, the evening before, traditional or split-dose |
| Skipper et al., 2013          | United States | 105         | Female: 49 (48.7%) Mean age: 56.9 years | Ottawa and Aronchick Scales Adequate bowel preparation was not described | Ottawa and Aronchick Scales Adequate bowel preparation was not described |
| Sipe et al., 2013             | United States | 91          | Female: 53 (52.9%) Mean age: 51.4 years | Boston Bowel Preparation Scale Adequate bowel preparation was not described | Boston Bowel Preparation Scale Adequate bowel preparation was not described |
| Stolpman et al., 2014         | United States | 101         | Female: 39 (39.0%) Mean age: 56.0 years | Boston Bowel Preparation Scale Adequate bowel preparation was not described | Boston Bowel Preparation Scale Adequate bowel preparation was not described |
| Flemming et al., 2015         | Canada        | 116         | Female: 64 (61%) Mean age: 60.0 years | Boston Bowel Preparation Scale Adequate bowel preparation was not described | Boston Bowel Preparation Scale Adequate bowel preparation was not described |
| Mytyk et al., 2018            | Poland        | 96          | Female: 43 (44.1%) Mean age: 51.1 years | Boston Bowel Preparation Scale Adequate bowel preparation was not described | Boston Bowel Preparation Scale Adequate bowel preparation was not described |

(continues)
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| Study | Country     | Sample Size | Demographics | Definition of Adequate Bowel Preparation | Type of Bowel Preparation Solution |
|-------|-------------|-------------|--------------|----------------------------------------|-----------------------------------|
| Thukral et al., 2019 | United States | 107          | Female: 64 (58.2%) Mean age: 55.2 years | Boston Bowel Preparation Scale Adequate bowel preparation was score ≥2 per segment | 4L PEG, the evening before, single-dose |
| Alvarez-Gonzalez et al., 2019 | Spain | 132          | Female: 64 (58.2%) Mean age: 60.1 years | Boston Bowel Preparation Scale Adequate bowel preparation was score ≥2 per segment | 4L PEG, 16 hours before, single-dose |
| Gee et al., 2019 | Malaysia | 49           | Female: 66 (66%) Mean age: 55.2 years | Arabian Bowel Preparation Scale Adequate bowel preparation was score ≥2 per segment | 4L PEG, the evening before, split-dose |
| Gomez-Reyes et al., 2019 | Mexico | 105          | Female: 64 (64%) Mean age: 55.2 years | Arabian Bowel Preparation Scale Adequate bowel preparation was score ≥2 per segment | 4L PEG, 16 hours before, single-dose |

Note: Asc = ascorbic acid; CLD = clear liquid diet; OSS = oral sulfate solution; LRD = low-residue diet; PEG-ELS = polyethylene glycol electrolyte solution.

Quality of Bowel Preparation

Of the eligible articles, 12 \( (n = 2205) \) (Alvarez-Gonzalez et al., 2019; Butt, Bunn, Paul, Gibson, & Brown, 2016; Flemming, Green, Melicharkova, Vanner, & Hookey, 2015; Gee et al., 2019; Melicharkova, Flemming, Vanner, & Hookey, 2013; Mytyk et al., 2018; Rapier & Houston, 2006; Scott et al., 2005; Soweid et al., 2010; Stolpman et al., 2014; Thukral et al., 2019; Walter et al., 2017) evaluated the number of participants who achieved excellent or good bowel preparation. These studies used the BBPS, Aronchick Scale, or HCS to determine the eligibility criteria. The overall adequate bowel preparation rates were 86.4% (950/1099) for the LRD group and 83.5% (923/1106) for the CLD group. There was no statistically significant difference between the two groups regarding the quality of bowel preparation (OR [95% CI] = 1.19 [0.79, 1.81]; \( p = .41 \)) (Figure 3).

We selected the random-effects model because of the statistically significant heterogeneity \( (I^2 = 58%; p < .01) \). When conducting a sensitivity analysis, the main source of heterogeneity was observed in the study by Soweid et al. Similar results were obtained when we removed the study by Soweid et al. (OR [95% CI] = 1.04 [0.80, 1.37]; \( p = .76 \)), but there was no statistically significant difference in heterogeneity \( (I^2 = 15%; p = .30) \). This result also indicated the reliability of the conclusion. In the study by Soweid et al., we found that the consumption of polyethylene glycol electrolyte solution (PEG-ES) was significantly greater for the LRD group compared with the CLD group. Furthermore, Soweid et al. acknowledged that regardless of the type of diet used, the amount of purgative intake remarkably affected the quality of bowel preparation. This may have been the reason for the statistically significant difference in the quality of bowel preparation between the LRD and CLD groups and was one of the main sources of heterogeneity between groups.

A funnel plot is shown in the Appendix Figure (see Supplemental Digital Content, available at: http://links.lww.com/GNJ/A64). The other studies reported...
only BBPS or OBPS scores, but not the number of eligible participants (Gomez-Reyes et al., 2019; Koh et al., 2011; Park et al., 2009; Sipe et al., 2013). However, in each study, there was no statistically significant difference in the quality of bowel preparation between the LRD and cLD groups.

Seven studies in which 613 and 616 participants were randomly assigned to the LRD and cLD groups, respectively, adopted the BBPS or OBPS to evaluate the efficacy of colon cleansing and reported the results. Three studies (Mytyk et al., 2018; Sipe et al., 2013; Walter et al., 2017) used the BBPS to evaluate this index, and the results yielded no statistically significant differences between the two groups (SMD [95% CI] = -0.04 [-0.19, 0.11]; p = .59). Heterogeneity among the groups was not significant (BBPS: $I^2$ = 26% and $p = .26$; OBPS: $I^2$ = 34% and $p = .21$).

**Quality Indicators for Colonoscopy**

As shown in Figure 4, six studies (Alvarez-Gonzalez et al., 2019; Flemming et al., 2015; Gee et al., 2019; Gomez-Reyes et al., 2019; Stolpman et al., 2014; Walter et al., 2017) examined the polyp detection rates (PDRs), which were similar between the LRD and CLD groups (50.8% vs. 49.1%; OR [95% CI] = 1.07 [0.83, 1.38]; $p = .60$). Heterogeneity among the groups was not significant ($I^2$ = 36%; $p = .16$). Simultaneously, there was no statistically significant difference between the LRD and CLD groups in terms of the adenoma detection rate (ADR) (47.3% vs. 43.3%; OR [95% CI] = 1.18 [0.92, 1.51]; $p = .20$) when we conducted a meta-analysis of five studies.
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(Alvarez-Gonzalez et al., 2019; Flemming et al., 2015; Stolpman et al., 2014; Thukral et al., 2019; Walter et al., 2017) that focused on this aspect. No significant heterogeneity was observed ($I^2 = 25\%$; $p = .25$). Four studies (Alvarez-Gonzalez et al., 2019; Flemming et al., 2015; Gomez-Reyes et al., 2019; Walter et al., 2017) documented the cecal intubation rate (cIR). These studies indicated that there was no statistically significant difference between the LRD and cLD groups in terms of the cIR (94.6% vs. 94.8%; OR [95% CI] = 0.97 [0.53, 1.77]; $p = .91$) and no significant heterogeneity among groups ($I^2 = 0\%$; $p = .49$).

### Tolerance of Participants to Bowel Preparation

Eight included trials ($n = 1857$) were incorporated in the study. Of all the participants, 81.8% (780/954) could tolerate the bowel preparation before colonoscopy in the LRD group but only 71.8% (648/903) could tolerate it in the LLD group, indicating a statistically significant difference between the two groups (OR [95% CI] = 1.86 [1.47, 2.36]; $p < .01$). Heterogeneity among the groups was not significant ($I^2 = 0\%$; $p = .50$) (Figure 4).

### Willingness to Repeat

Six included trials ($n = 1069$) (Koh et al., 2011; Park et al., 2009; Scott et al., 2005; Soweid et al., 2010; Stolpman et al., 2014; Thukral et al., 2019) were incorporated in the study. More participants in the LRD group (84.8%) than in the CLD group (70.9%) were willing to repeat the bowel preparation before colonoscopy, indicating a statistically significant difference between groups (OR [95% CI] = 2.34 [1.72, 3.17]; $p < .01$). Heterogeneity among groups was not significant ($I^2 = 33\%$; $p = .19$) (Figure 4).

### Adverse Effects

Seven studies (Gee et al., 2019; Gomez-Reyes et al., 2019; Mytyk et al., 2018; Park et al., 2009; Scott et al., 2005; Soweid et al., 2010; Thukral et al., 2019) reported detailed adverse effects during bowel preparation. We conducted a meta-analysis of adverse effects such as including hunger (Gee et al., 2019; Scott et al., 2005; Soweid et al., 2010; Thukral et al., 2019), nausea (Gomez-Reyes et al., 2019; Mytyk et al., 2018; Park et al., 2009; Scott et al., 2005; Soweid et al., 2010; Thukral et al., 2019), vomiting (Gomez-Reyes et al., 2019; Mytyk et al., 2018; Park et al., 2009; Scott...
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FIGURE 4. Forest plot of quality indicators, tolerance, and willingness for colonoscopy between LRD and CLD groups. (A) Polyp detection rate (PDR). (B) Adenoma detection rate (ADR). (C) Cecal intubation rate (CIR). (D) Tolerance of participants for colonoscopy between LRD and CLD groups. (E) Willingness of participants for colonoscopy between LRD and CLD groups.
et al., 2005; Soweid et al., 2010; Thukral et al., 2019), and abdominal pain or discomfort (Gomez-Reyes et al., 2019; Mytyk et al., 2018; Park et al., 2009; Scott et al., 2005; Soweid et al., 2010; Thukral et al., 2019). More participants in the CLD group consistently experienced hunger, nausea, and vomiting (hunger: OR, 0.34, and p < .01; nausea: OR, 0.73, and p = .03; vomiting: OR, 0.63, and p = .04). Heterogeneity among groups was not significant (hunger: $I^2 = 18\%$ and $p = .30$; nausea: $I^2 = 22\%$ and $p = .27$; vomiting: $I^2 = 27\%$ and $p = .23$). However, there was no statistically significant difference between groups for abdominal pain or discomfort (OR, 0.98; p = .86). Heterogeneity among groups was not significant ($I^2 = 0\%$; $p = .70$) (Figure 5).

### Discussion

In our study, it was found that people who employed the LRD before colonoscopy had the same quality of bowel preparation as those with the CLD. Meanwhile, the tolerance, willingness to repeat, and adverse events of people with the LRD were better than those with the CLD.

The quality of bowel preparation is crucial to the quality of the colonoscopy (Kizilcik, Unver, Yildiz, Albayrak, & Fidan, 2020). Low-quality bowel preparation tends to result in lower ADR and more frequent repeat colonoscopies (Clark, Rustagi, & Laine, 2014). However, to improve the quality of bowel preparation, endoscopists prefer strict bowel preparation regimens, which may reduce patient tolerance and compliance. Poor patient tolerance and compliance are not

### FIGURE 5

Forest plot of adverse effects between LRD and CLD groups: (A) hunger, (B) nausea, (C) vomiting, and (D) abdominal pain or discomfort.
conducive to the completion of the colonoscopy, and strict bowel preparation regimens may cause patients to avoid undergoing colonoscopies (Laiyemo et al., 2019; Radaelli et al., 2017; Stolpman et al., 2014). Therefore, an optimal bowel preparation regimen should consider bowel cleansing and the preferences of patients.

Our meta-analysis indicated that there was no significant statistical difference between LRD and CLD regarding the quality of bowel preparation. Although the overall heterogeneity was large, the categorical data analysis indicated that heterogeneity was small only after the removal of the study by Soweid et al., thus indicating that the study by Soweid et al. may have been the main source of heterogeneity. The conclusion was consistent regardless of whether the study by Soweid et al. was included. This conclusion was proven not only by categorical data but also by numerical data. Therefore, these two points illustrated the reliability of the conclusion.

The quality indicators for colonoscopy (PDR, ADR, and CIR) were not statistically significant. Therefore, the LRD is not worse than the CLD for bowel preparation in terms of bowel cleansing and colonoscopy quality. However, the LRD seems to have more advantages than the CLD in terms of patient preference. The tolerance of patients to bowel preparation with the LRD was better than the tolerance of patients to bowel preparation with the CLD. More patients who have used the LRD were willing to repeat the LRD. Simultaneously, fewer participants in the LRD group experienced adverse effects such as hunger, nausea, and vomiting. Because the LRD is not inferior to the CLD in terms of bowel cleansing and quality of colonoscopy, and because it can improve the willingness of patients to undergo colonoscopy, we believe that the LRD is better for bowel preparation than the CLD, especially for patients with diabetes or other diseases who cannot tolerate the CLD.

**Compared to Other Studies**

Three previous meta-analyses explored and compared the effectiveness of the LRD and CLD, and their results were similar to ours (Avalos, Sussman, Lara, Sarkis, & Castro, 2017; Nguyen et al., 2016; Song et al., 2016). In terms of eligibility criteria, our study included the most recent RCT from 2015 to September 2019. We also excluded studies that did not compare different diets individually but did compare the bowel preparation pattern for a particular type of diet combined with a particular laxative (Delegge & Kaplan, 2005). We only assessed full-text articles, which facilitated the evaluation of the quality of the included studies and allowed us to obtain complete data; however, this also may have resulted in a deficiency of the quantity of included studies.

We used both categorical and numerical data to demonstrate the similarities in the quality of bowel preparation with the two diets. Our conclusion is consistent with that of two previous studies, thus indicating the reliability of our conclusion. We considered the quality of bowel preparation and the quality indicators for colonoscopy, which comprehensively showed that the LRD was not inferior to the CLD. Previous studies concluded that there was no statistical difference in the overall adverse events of the two groups. However, when we analyzed some common adverse events separately, we found that hunger, nausea, and vomiting were less common in the LRD group, but there was no statistically significant difference in abdominal pain or discomfort between the two groups, thus illustrating the safety of the LRD.

**Strengths and Limitations**

Any meta-analysis inevitably has many obvious strengths and limitations. The strengths of this meta-analysis were equally apparent. First, all included studies were RCTs, resulting in improved study quality and increased reliability of the conclusions. Second, participants in the studies included in the meta-analysis were from different regions, in different age groups, and had different genders, and the types of bowel preparation solutions were not identical among the studies, which suggested that the LRD could be used by different populations for bowel preparation. Third, the study included 16 studies that met the eligibility criteria of the past decade, resulting in a meta-analysis of data of 2,912 patients and reliable conclusions.

Our study also had limitations. First, only RCTs published in English were included, which resulted in an English language bias and made it easier to yield the expected conclusion. However, none of the 16 included studies or other related literature (Tariq et al., 2019) reported that the quality of bowel preparation with the CLD was superior to that with the LRD, suggesting that we should not strongly consider the effects of this bias. Second, different studies adopted different schemes so that patients could use the LRD. Some of them used a prepackaged LRD; however, in most cases, they let the patients follow a specialized diet. The number of meals allowed were different in the included studies. Some patients were asked to replace three meals with the LRD, whereas others were asked to replace breakfast and lunch or even just breakfast with the LRD before the colonoscopy. Furthermore, the types (PEG, NaP, magnesium citrate and bisacodyl, and oral sulfate solution), times (the morning, afternoon, or evening before the colonoscopy), and methods (split-dose or not) of the bowel preparation...
solution were different. These differences might have been sources of bias. Third, the included studies adopted different scales to assess the bowel preparation and define its adequacy, including the OBPS, BBPS, Aronchick Scale, and HCS. Finally, we included only full-text articles. Studies that were not available via full-text but which may have otherwise met our inclusion and exclusion criteria were not assessed.

**Conclusion**

The LRD is not inferior to the CLD for bowel preparation before colonoscopy. People who employed the LRD before colonoscopy had the same quality of bowel preparation as those with the CLD. Meanwhile, the tolerance of people with LRD was better than people with CLD, and these people were more willing to repeat the colonoscopy with less adverse events.

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