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*Published in:*
Phytotherapy Research

*DOI:*
10.1002/ptr.8025

Received: 13 April 2023 | Revised: 12 September 2023 | Accepted: 18 September 2023

DOI: 10.1002/ptr.8025

REVIEW

WILEY

# Quality of systematic reviews with meta-analyses of resveratrol: A methodological systematic review

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**Funding information**
Scientific and Technological Innovation Project of China Academy of Chinese Medical Sciences, Grant/Award Number: CI2021B003

## Abstract

Recently, several meta-analyses (MAs) have focused on the health effects of resveratrol. However, the methodological and reporting quality of these MAs has not yet been fully evaluated so far. Therefore, the present study evaluated the quality of these MAs through a methodological systematic review. Systematic searches were conducted in PubMed, Embase, Web of Science, and Cochrane Library from inception until May 20, 2022, and PubMed was used to update the search until September 6, 2023. The methodological and reporting quality of the selected MAs was evaluated using AMSTAR-2 and PRISMA 2009. Fifty-one MAs published during 2013–2023 were included. In each review, the number of primary studies ranged from 3 to 37, and the number of participants ranged from 50 to 2114. Among the first-listed primary outcomes, only 23 (45.10%) were "positive." As for the methodological quality, most MAs (44, 86.27%) on resveratrol were rated critically low. Inadequate reporting of the included MAs mainly involved items 2 ("Structured summary"), 5 ("Protocol and registration"), 8 ("Search"), 9 ("Study selection"), 10 ("Data collection process"), 12 ("Risk of bias in individual studies"), and 24 ("Summary of evidence") based on the PRISMA 2009. Additionally, journal's impact factor, number of authors, and funding support were positively associated with the overall methodological quality but were not statistically significant ($p > 0.05$). Future MAs on resveratrol require better design, implementation, and reporting by following the Cochrane Handbook, AMSTAR-2, and PRISMA.

**KEYWORDS**
AMSTAR-2, meta-analyses, PRISMA, quality, resveratrol

## 1 | INTRODUCTION

Evidence-based medicine requires that all clinical decision-making should be informed by the best available evidence while considering the clinician's experience and patient's preferences and values (Djulbegovic & Guyatt, 2017; Jadad et al., 1996; Lu et al., 2019). Systematic reviews and meta-analyses (MAs) have been widely acknowledged as the highest degree of evidence in the evidence pyramid (Brunström et al., 2022). The quality of a systematic review usually depends on two aspects: "methodological quality" and "reporting quality" (Shea et al., 2007). The methodological quality considers "how well a systematic review is conducted," while the reporting quality considers "how well the methodology and results of a systematic review are reported" (Shea et al., 2007). Unfortunately, poorly conducted and reported systematic reviews and MAs can lead to inaccurate estimates of treatment effects and deceptive conclusions (Pussegoda et al., 2017), reduce clinical usability (Hoffmann et al., 2017), and hinder the reproducibility of the results (Tugwell

et al., 2020), resulting in avoidable resource waste (Moher et al., 2016; Tugwell et al., 2020) and posing potential harms to patients. Accumulating studies have proved that the methodological and reporting quality of systematic reviews and MAs are suboptimal or even poor in various clinical disciplines (Croitoru et al., 2020; Jiang et al., 2019; Lu et al., 2021; Xu et al., 2021). For instance, a recent overview conducted by our team confirmed that the methodology and reporting completeness of MAs on saffron need substantial improvement (Lu et al., 2021).

Resveratrol is a polyphenolic compound with high abundance in many plants, such as grapes and peanuts (Tian & Liu, 2020). Several studies have shown that resveratrol poses various biological effects, such as antioxidant, anti-inflammatory, immunomodulatory, anti-aging, anti-cancer, and antidiabetic activities (Delpino & Figueiredo, 2022; Tian & Liu, 2020; Wu et al., 2022). Although numerous systematic reviews with MAs on resveratrol have been published (Delpino & Figueiredo, 2022; Mousavi et al., 2019; Sahebkar, 2013; Zeraattalab-Motlagh et al., 2021), only a few have successfully investigated the methodological quality of these MAs thus far. For instance, Zeraattalab-Motlagh et al. (2021) conducted an umbrella review to summarize the clinical effects of resveratrol on patients with type 2 diabetes, metabolic syndrome, and nonalcoholic fatty liver disease in 28 MAs of randomized trials. Furthermore, they assessed the methodological quality of these MAs using AMSTAR-2 (A MeaSurement Tool to Assess systematic Reviews; Shea et al., 2017). However, the reporting quality of the published MAs on resveratrol has not yet been evaluated thoroughly. Therefore, conducting a methodological systematic review to comprehensively investigate the quality of published MAs on resveratrol is of great significance in providing a basis for health decision-making and future studies.

## 2 | MATERIALS AND METHODS

### 2.1 | Registration and reporting

The present systematic review is not registered on PROSPERO (https://www.crd.york.ac.uk/prospero/; which accepts the registration for only systematic reviews of effectiveness and/or safety), as we mainly focused on the methodological and reporting quality of the included MAs. However, the methodological systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2009 statement (Appendix S1; Moher et al., 2009).

### 2.2 | Literature search

Systematic searches were performed in PubMed, Embase, Web of Science, and Cochrane Library from inception until May 20, 2022, and PubMed was used to update the search until September 6, 2023. A combination of Medical Subject Headings terms and keywords was used to establish the search strategies, as presented in Appendix S2. The key search terms included "systematic reviews as topic," "meta-analysis as topic," "resveratrol," "systematic review," and "meta-analysis." In addition to the electronic database search, the reference lists of the included publications were also manually checked to identify potentially eligible MAs.

### 2.3 | Study selection

All records identified from the electronic databases were imported into Endnote (Version X9; Clarivate Analytics) to select the eligible MAs. The literature selection was performed by two investigators independently after the removal of duplicate records. Any discrepancy was resolved through consultation with the leading author (CCL).

The included publications were selected based on the following criteria: (1) types of research: systematic reviews reporting at least an MA of clinical studies. The definition of MA was consistent with that of a previously reported article (Lu et al., 2021) published by the leading author; (2) types of intervention: resveratrol alone versus other interventions such as placebo, and resveratrol combined with other interventions versus other interventions such as active medication or exercise, or comparison of different doses among resveratrol; (3) types of participants: human subjects; (4) types of outcomes: any effectiveness or safety outcome; (5) language of publications: English; and (6) source of publications: peer-reviewed journals. Narrative reviews, qualitative systematic reviews, overviews, conference abstracts, comments, editorials, preclinical MAs, network MAs, individual patient data MAs, protocols, or papers inaccessible to full-texts were excluded from this study.

### 2.4 | Data abstraction

Data of the following variables were extracted from the selected MAs: title, name of the first author, publication year, location of publications (defined by the country of the corresponding author), number of authors, journal's name, and its 2-year impact factor ($IF_{2022}$), number and study design of primary studies, total sample size, data on registration and protocol, search of clinical trial registries, use of reporting guidelines (e.g., PRISMA), use of GRADE (Grading of Recommendations Assessment, Development, and Evaluation; Santesso et al., 2020), information on funding support and conflicts of interest declaration, tools for quality assessment, and attribute of the first-reported primary outcome (i.e., a "positive" result refers to a statistically significant first-reported primary outcome, that supports the use of resveratrol; otherwise it is "negative"). The first-reported primary outcome was identified according to the following rule: the first-listed one was selected if the primary outcomes were defined by the author in the methods; otherwise, the first-synthesized one in the results was identified. The process of data abstraction was achieved by three independent reviewers utilizing a predesigned Excel form, and any disagreement was resolved through consultation with the first author.

## 2.5 | Assessment of methodological and reporting quality

The methodological and reporting quality of eligible systematic reviews was assessed by two independent investigators using AMSTAR-2 (Shea et al., 2017) and PRISMA 2009 (Liberati et al., 2009; Moher et al., 2009), and any conflict was resolved through consultation with the leading author.

AMSTAR-2 is widely adopted to evaluate the methodological quality of interventional MAs (Bojcic et al., 2022; De Santis et al., 2022). The tool consists of 16 items and can rate the overall methodological quality of an MA as high, moderate, low, or critically low based on the answers to critical (items 2, 4, 7, 9, 11, 13, and 15) and noncritical items. For answering the leading questions required by these items, the one in "Y" (Yes), "PY" (Partial Yes), and "N" (No) options was used. Considering the limited ability of AMSTAR-2 in discriminating the overall methodological quality (Li et al., 2022; Lu et al., 2022), the total score of each review was also used to indicate the overall methodological quality, i.e., a larger total score represents a higher methodological quality. "Y," "PY," and "N" were assigned to 2, 1, and 0 points for the critical items and 1, 0.5, and 0 points for the noncritical items, respectively.

The reporting quality was defined by the reporting completeness of key information required by each item using PRISMA 2009, which contains 27 items. Similarly, "Y," "PY," and "N" were used to assess whether the key information was fully and clearly reported by the review's authors, but no score was assigned, as PRISMA 2009 has no rating rules for the overall reporting completeness (Liberati et al., 2009).

## 2.6 | Data analysis

The basic characteristics of the included reviews were summarized descriptively. The adherence to the items of AMSTAR-2 and PRISMA-2009 was presented as number and percentage with 95% confidence interval (CI). Additionally, univariate and multivariate linear regression analyses were conducted to explore the associations between publication year, number of authors, $IF_{2022}$, and funding support and the overall methodological quality score. Multicollinearity was significant when the variance inflation factor (VIF) was not <5 (Li et al., 2019). A bubble plot was constructed to display the results of the methodological quality of MAs. This plot consisted of an *X*-axis, a *Y*-axis, and some bubbles. In the plot, X-axis indicated the attribute of the first reported primary outcome, *Y*-axis indicated the year of publication, and each bubble represented an MA article. The size of the bubbles was proportional to the total sample size, while the color of the bubbles indicated the overall rating of an MA according to AMSTAR-2. A radar chart was used to display the reporting quality according to PRISMA 2009. Statistical analysis was conducted using R 4.2.3 (R Project for Statistical Computing) and Excel 2016 (Microsoft Corporation). $p < 0.05$ was considered statistically significant.

# 3 | RESULTS

## 3.1 | Search and selection

Overall, 827 records were identified from database searches, of which 578 records were screened based on the titles and abstracts after removing 249 duplicates. Next, 64 full-texts were selected for further screening, and of those, 43 articles were deemed eligible. Additionally, the updated search revealed eight eligible MAs. Ultimately, a total of 51 articles (Appendix S3) were included to investigate the methodological quality and reporting completeness of the MAs on resveratrol (No additional eligible MA was identified from the reference lists of the included MAs). The literature selection process is displayed in Figure 1.

## 3.2 | Characteristics of the included MAs

A total of 51 MAs (23 articles were published from 2013 to 2019, and 28 [54.90%] were published in 2020 and after) were included in this study. As for the country to which the corresponding author's institution belongs, Iran (22, 43.14%) and China (12, 23.53%) published most MAs on resveratrol. Fifty (98.04%) reviews included randomized clinical trials, and the number of primary studies ranged from 3 to 37 in individual reviews; the number of participants per the included review ranged from 50 to 2114, and 22 (43.14%) reviews assessed <500 participants. Only eight (15.69%) MAs searched the trial registries. Seventeen (33.33%) reviews stated that they had protocols or reached a consensus before initiating the study, while only 12 (23.53%) reviews registered their studies. The PROSPERO (11, 91.67%) website was the most common database to register them. The Cochrane criteria (37, 72.55%) and Jadad scale (13, 25.49%) were the most commonly used tools for quality assessment (Higgins et al., 2011; Jadad et al., 1996); 39 (76.47%) reviews provided citations on the quality assessment tools. GRADE was used in only six (11.76%) MAs, and four provided a citation on GRADE.

Forty-five MAs referenced the reporting guidelines, including PRISMA (44, 86.28%) and QUOROM (1, 1.96%; Tao et al., 2011). As for the journal of publications, seven were published in three journals with IFs not less than nine, that is, *Critical Reviews in Food Science and Nutrition* (4, 7.84%, $IF_{2022} = 10.2$) and *Pharmacological Research* (3, 5.89%, $IF_{2022} = 9.3$). Each review was conducted by one to 12 researchers, while MAs with five to seven authors accounted for more than half of all publications (28, 54.90%). As for the attribute of the first-reported primary outcome, only 23 (45.10%) were "positive." Furthermore, 29 (56.86%) reviews reported that they received funding support, and 48 (94.12%) MAs declared that they did not have any conflict of interest. The details of the included MAs are presented in Table 1.

## 3.3 | Methodological quality of the included MAs

According to the rating criteria of AMSTAR-2 (Shea et al., 2017), the methodological quality of only one (1.96%) MA was rated high, while

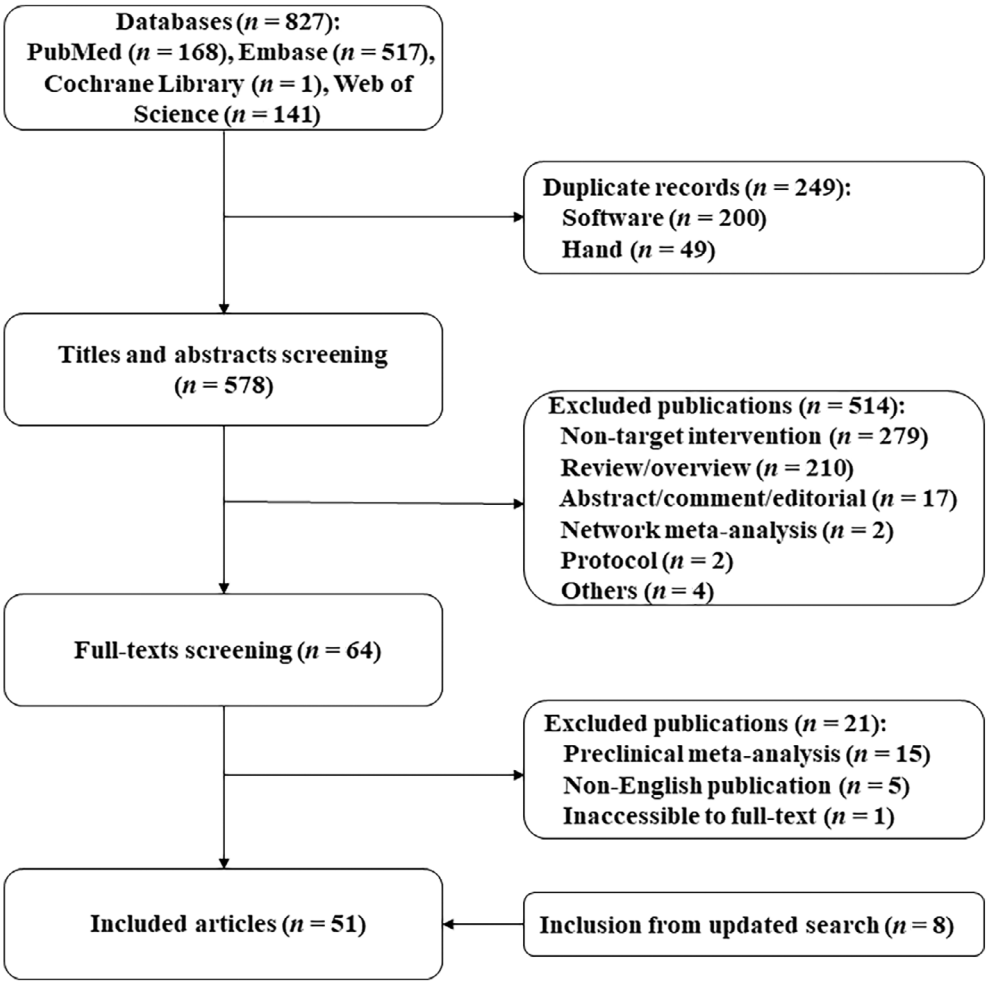



**FIGURE 1** Flowchart of study selection for this review.

that of six (11.76%) MAs was low, and that of the remaining 44 (86.27%) MAs was critically low (Figure 2, Appendix S4). As for item 1 ("Did the research questions and inclusion criteria for the review include the components of PICO?"), all the included MAs were graded "Y." While for item 2 ("Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?"), only 12 (23.53%, 95% CI: 14.00%–36.76%) MAs were graded "Y," and other reviews were graded "N" (34/51, 95% CI: 52.97%–78.03%) and "PY" (5/51, 95% CI: 4.26%–20.98%). As for item 3, only one (1.96%, 95% CI: 0.35%–10.30%) MA explained the reason for selecting randomized clinical trials, which was graded "Y," while the others (50/51, 95% CI: 89.70%–99.65%) were rated "N."

Forty-seven (92.16%, 95% CI: 81.50%–96.91%) reviews were graded "Y" in terms of item 4, as they used a comprehensive search strategy. Furthermore, 30 (58.82%, 95% CI: 45.17%–71.25%) reviews reported that study selection was performed in duplicate (item 5), while only 25 (49.02%, 95% CI: 35.86%–62.32%) MAs stated that data extraction was conducted in duplicate (item 6), and therefore, they were graded "Y" in the corresponding items. As for item 7 ("Did the review authors provide a list of excluded studies and justify the exclusions?"), only four (7.84%, 95% CI: 3.09%–18.50%) reviews were rated "Y," while only five (9.80%, 95% CI: 4.26%–20.98%) MAs were rated "Y" in terms of item 10 ("Did the review authors report on the sources of funding for the studies included in the review?"). Forty-six (90.20%, 95% CI: 79.02%–95.74%) reviews were graded "Y" in terms of item 8, as they described the features of original studies in detail. As for item 9, 37 (72.55%, 95% CI: 59.05%–82.89%) MAs were graded "Y," as they utilized a satisfactory method for evaluating the risk of bias in original studies, while the others were graded "PY" or "N."

Regarding item 11, 49 (96.08%, 95% CI: 86.78%–98.92%) MAs were graded "Y" as they used proper methods for statistical analysis. Only 23 (45.10%, 95% CI: 32.27%–58.62%) reviews were graded "Y," as they included only low risk of bias studies or analyzed the potential impact of risk of bias in the primary studies on the synthesized results (item 12). As for item 13 ("Did the review authors account for risk of bias in individual studies when interpreting/discussing the results of the review?"), almost half of the included reviews (22/51, 95% CI: 30.50%–56.73%) were graded "N." As for item 14, 48 (94.12%, 95% CI: 84.08%–97.98%) MAs were graded "Y," as they adequately discussed the heterogeneity. As for item 15, 35 (68.63%, 95% CI: 54.98%–79.67%) reviews were graded "Y," as they inadequately investigated and discussed publication bias. Lastly, regarding item 16, 48 (94.12%, 95% CI: 84.08%–97.98%) reviews were graded "Y," as they reported no conflicts of interest.

**TABLE 1** Basic characteristics of the included MAs.

| Basic characteristics | N | Percentage |
|---|---|---|
| Publication year | | |
| 2013–2017 | 10 | 19.61 |
| 2018–2019 | 13 | 25.49 |
| 2020–2023 | 28 | 54.90 |
| Location of publication | | |
| Iran | 22 | 43.14 |
| China | 12 | 23.53 |
| Other | 17 | 33.33 |
| Journal impact factor ($IF_{2022}$) | | |
| <4 | 17 | 33.33 |
| 4–7 | 19 | 37.25 |
| ≥7 | 15 | 29.42 |
| Number of authors in each review | | |
| 1–4 | 11 | 21.57 |
| 5–7 | 28 | 54.90 |
| 8–12 | 12 | 23.53 |
| Protocol | | |
| Yes | 17 | 33.33 |
| No/not reported | 34 | 66.67 |
| Registration | | |
| Yes | 12 | 23.53 |
| No/not reported | 39 | 76.47 |
| Search of trial registries | | |
| Yes | 8 | 15.69 |
| No | 43 | 84.31 |
| Reporting guidelines mentioned | | |
| PRISMA | 44 | 86.28 |
| QUORUM | 1 | 1.96 |
| No | 6 | 11.76 |
| Type of included studies | | |
| Only RCTs | 50 | 98.04 |
| Not only RCTs | 1 | 1.96 |
| Number of included studies in single review | | |
| 3–5 | 9 | 17.65 |
| 6–12 | 16 | 31.37 |
| 13–21 | 13 | 25.49 |
| 22–37 | 13 | 25.49 |
| Number of patients per included review | | |
| <500 | 22 | 43.14 |
| 500–1000 | 15 | 29.41 |
| ≥1000 | 14 | 27.45 |
| First-reported primary outcome | | |
| Positive | 23 | 45.10 |
| Negative | 28 | 54.90 |
| Tools for quality assessment[a] | | |
| Category | | |
| Cochrane tool | 37 | 72.55 |
| Jadad scale | 13 | 25.49 |
| Other | 2 | 3.92 |
| With reference | | |
| Yes | 39 | 76.47 |
| No | 12 | 23.53 |
| Use of GRADE | | |
| Category | | |
| Yes | 6 | 11.76 |
| No | 45 | 88.24 |
| With reference | | |
| Yes | 4 | 66.67 |
| No | 2 | 33.33 |
| Funding support | | |
| Yes | 29 | 56.86 |
| No/not reported | 22 | 43.14 |
| Conflict of interest | | |
| No | 48 | 94.12 |
| Not declared | 3 | 5.88 |

Abbreviations: GRADE: Grading of Recommendations Assessment, Development, and Evaluation; IF: 2-year Impact Factor; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; QUOROM: Quality of Reporting of Meta-analyses; RCTs: Randomized Clinical Trials.

[a]Cochrane tool and Jadad scale were used simultaneously in one paper.

## 3.4 | Factors affecting methodological quality score

In the present study, univariate and multivariate linear regression analyses were utilized to explore the associations between four study characteristics and the overall methodological quality score. Compared with the reference group, the results showed that funding support, number of authors, and $IF_{2022}$ were positively associated with the overall methodological quality score in both regression analyses ($VIF_{max} = 1.28$). Surprisingly, the overall methodological quality score of recent publications was lower than that of older publications. However, none of the results were found to be statistically significant ($p > 0.05$), except for one group where a significant difference ($p = 0.04$) was observed in the univariate analysis of the number of authors. The detailed results are presented in Table 2 and Figure 3.

## 3.5 | Reporting quality of the included MAs

The reporting quality of the included MAs was assessed based on PRISMA 2009 (Figure 4; Appendix S4; Liberati et al., 2009). All MAs reported adequate information required by items 3 ("Rationale"), 7 ("Information sources"), 20 ("Results of individual studies"), and 21 ("Synthesis of results"). Only one (1.96%, 95% CI: 0.35%–10.30%) review was rated "N" in terms of item 1, as it did not mention "meta-analysis" in the title; 24 (47.06%, 95% CI: 34.05%–60.48%) reviews

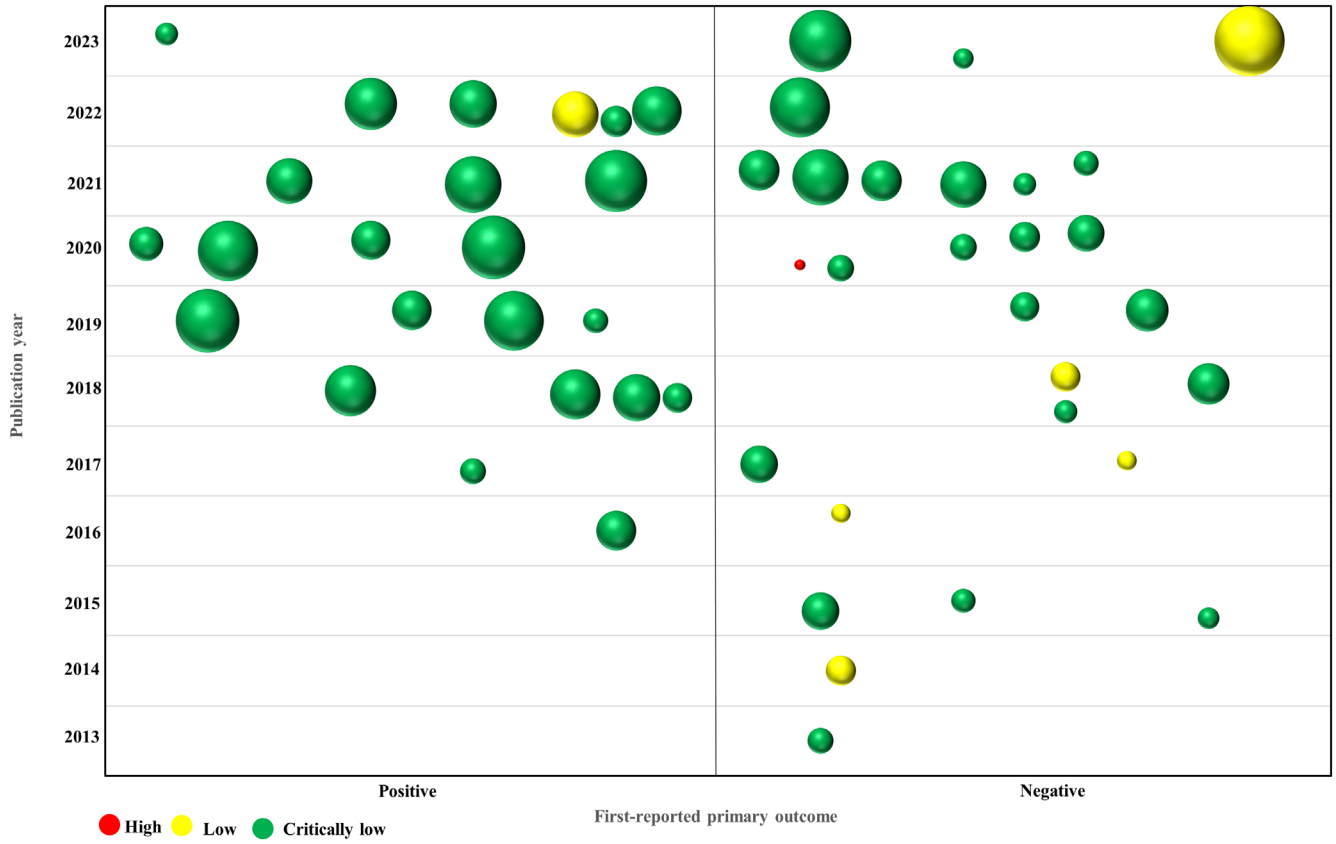



**FIGURE 2** Evidence map of methodological quality.

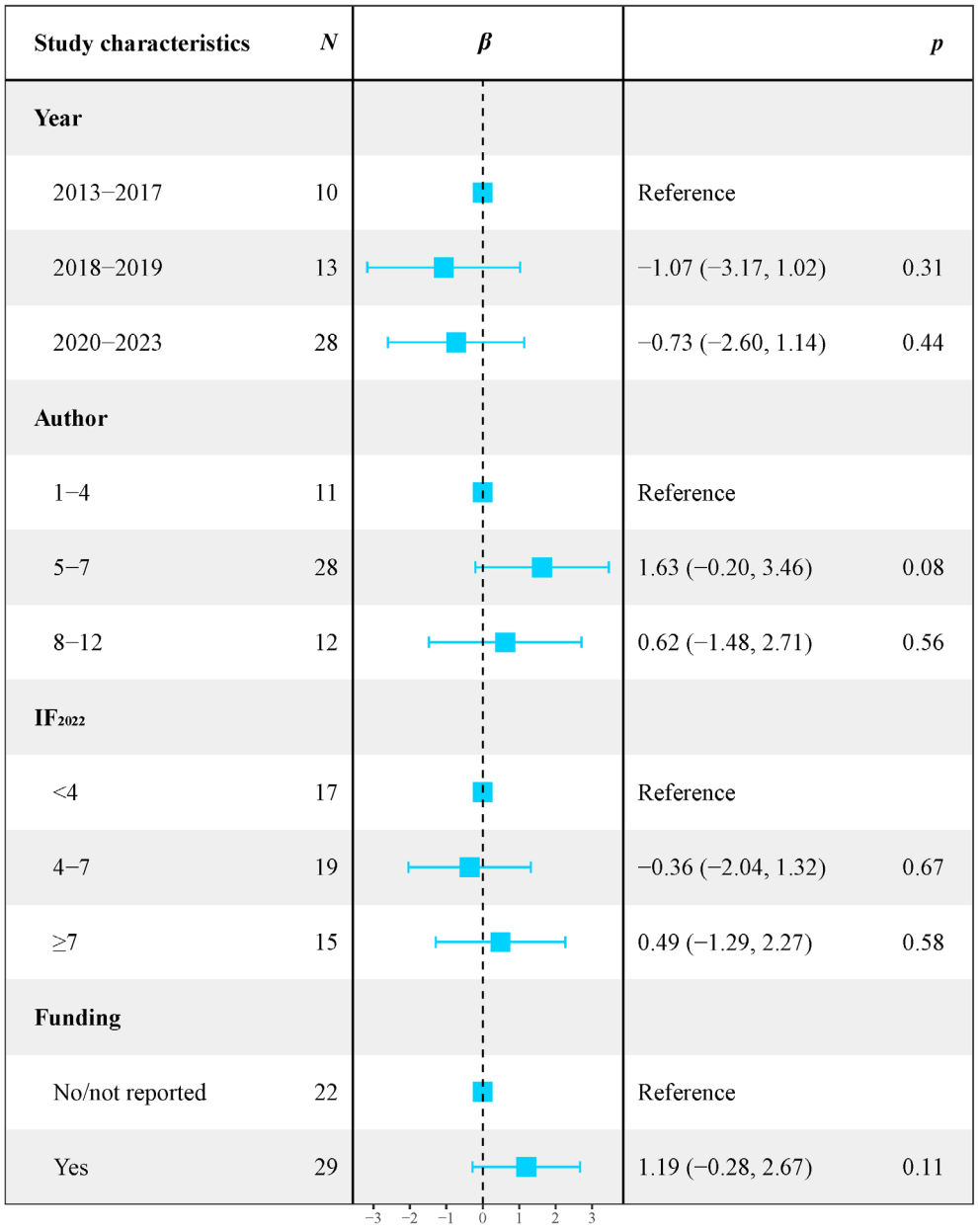
**TABLE 2** Univariate and multivariate linear regression to explore the potential factors influencing the methodological quality.

| | Univariate analysis | | Multivariate analysis | |
|---|---|---|---|---|
| **Study characteristics** | ***β* (95% CI)** | ***p*** | ***β* (95% CI)** | ***p*** |
| Year | | | | |
| 2013–2017 | Reference | | Reference | |
| 2018–2019 | −0.85 (−2.92, 1.23) | 0.42 | −1.07 (−3.17, 1.02) | 0.31 |
| 2020–2023 | −0.05 (−1.87, 1.76) | 0.95 | −0.73 (−2.60, 1.14) | 0.44 |
| Author | | | | |
| 1–4 | Reference | | Reference | |
| 5–7 | 1.78 (0.11, 3.46) | 0.04 | 1.63 (−0.20, 3.46) | 0.08 |
| 8–12 | 0.40 (−1.56, 2.36) | 0.68 | 0.62 (−1.48, 2.71) | 0.56 |
| $IF_{2022}$ | | | | |
| <4 | Reference | | Reference | |
| 4–7 | −0.05 (−1.70, 1.62) | 0.96 | −0.36 (−2.04, 1.32) | 0.67 |
| ≥7 | 0.32(−1.44, 2.08) | 0.71 | 0.49 (−1.29, 2.27) | 0.58 |
| Funding | | | | |
| No/not reported | Reference | | Reference | |
| Yes | 1.21 (−0.14, 2.56) | 0.08 | 1.19 (−0.28, 2.67) | 0.11 |

Abbreviations: CI, Confidence Interval; IF, 2-year Impact Factor.

were graded "PY" in terms of item 2 ("Structured summary"), as they did not adequately report key information, such as implications of key results and study limitations. As for item 4 ("Objectives"), 13 (25.49%, 95% CI: 15.55%–38.87%) MAs were graded "PY," while the other 38 (74.51%, 95% CI: 61.13%–84.45%) reviews were graded "Y." As for item 5 ("Protocol and registration"), only 15 (29.41%, 95% CI:

**FIGURE 3** Multivariate linear regression analysis results.




18.71%–43.00%) reviews were graded "Y," as they clearly reported whether they had drafted protocols and registered their studies. Moreover, 66.67% (34/51, 95% CI: 52.97%–78.03%) of the included MAs were graded "Y" in terms of item 6 ("Eligibility criteria").

As for item 8 ("Search"), only 20 (39.22%, 95% CI: 27.03%–52.91%) reviews were graded "Y," as they provided the full search strategy for at least one electronic database. As for item 9 ("Study selection"), one (1.96%, 95% CI: 0.35%–10.30%) review and 20 (39.22%, 95% CI: 27.03%–52.91%) MAs were graded "N" and "PY," respectively. Only 24 (47.06%, 95% CI: 34.05%–60.48%) reviews clearly stated the methods used to extract data; therefore, they were rated "Y" in terms of item 10 ("Data collection process"). As for items 11 ("Data items") and 12 ("Risk of bias in individual studies"), 46 (90.20%, 95% CI: 79.02%–95.74%) and 25 (49.02%, 95% CI: 35.86%–62.32%) MAs were graded "Y," respectively. Additionally, 92.16% (47/51, 95% CI: 81.50%–96.91%) and 90.20% (46/51, 95% CI: 79.02%–95.74%) of reviews were graded "Y" in terms of items 13 ("Summary measures") and 14 ("Synthesis of results"), respectively. As for item 15 ("Risk of bias across studies"), 45 (88.24%, 95% CI: 76.62%–94.49%) MAs were graded "Y," as they clearly reported the information on publication bias in the method sections. As for item 16 ("Additional analyses"), 43 (84.31%, 95% CI: 71.99%–91.83%) reviews were rated "Y," as they reported at least one additional analysis method, such as sensitivity or subgroup analysis.

Forty-four (86.27%, 95% CI: 74.28%–93.19%) MAs reported the detailed selection process of studies; therefore, they were graded "Y" in terms of item 17 ("Study selection"). As for item 18 ("Study characteristics"), 46 (90.20%, 95% CI: 79.02%–95.74%) reviews were graded "Y," as they adequately reported the characteristics of the included primary studies. Additionally, 38 (74.51%, 95% CI: 61.13%–84.45%)

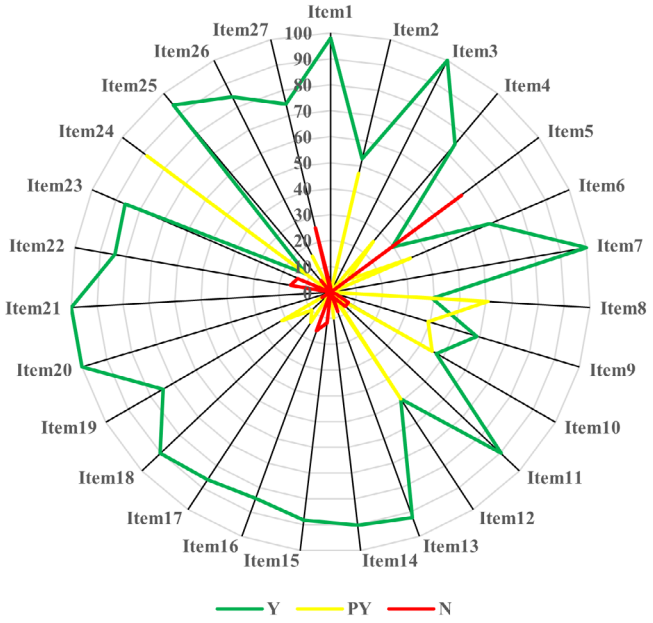



**FIGURE 4** Radar plot of reporting quality.

and 43 (84.31%, 95% CI: 71.99%–91.83%) MAs were graded "Y," as they reported complete information required for items 19 ("Risk of bias within studies") and 22 ("Risk of bias across studies"), respectively. As for items 23 ("Additional analysis") and 26 ("Conclusions"), 44 (86.27%, 95% CI: 74.28%–93.19%) and 43 (84.31%, 95% CI: 71.99%–91.83%) reviews were graded "Y," respectively. As for item 24 ("Summary of evidence"), only six (11.77%, 95% CI: 5.51%–23.38%) reviews were graded "Y," as they summarized the strength of evidence based on the GRADE method. For item 27 ("Funding"), 38 (74.51%, 95% CI: 61.13%–84.45%) MAs clearly reported the information on funding support.

## 4 | DISCUSSION

In this methodological systematic review, 51 MAs on resveratrol were selected and included to investigate the methodological and reporting quality, and the results revealed that the quality of these reviews was suboptimal. The methodological and reporting gaps identified in this study could be used to strengthen future studies and improve healthcare decision-making.

With regard to the reporting quality of MAs on resveratrol, the reporting on information required by items 2 ("Structured summary"), 5 ("Protocol and registration"), 8 ("Search"), 9 ("Study selection"), 10 ("Data collection process"), 12 ("Risk of bias in individual studies"), and 24 ("Summary of evidence") of PRISMA 2009 should be significantly improved, as the percentages of "Y" were all <60%. Recently, "reproducibility crisis" has attracted increasing attention in many scientific fields, such as biomedicine (Niven et al., 2018) and social science (Moody et al., 2022). Reproducibility refers to obtaining the same results when the same data and the same methods are used (Wang et al., 2022). Moreover, reproducibility could be improved through transparent and complete reporting of the detailed methods and data sources used by the investigators (Tugwell et al., 2020; Wang et al., 2022). As such, some significant efforts have been made on reproducibility in evidence syntheses. For instance, Polanin et al. (2020) evaluated the transparency and reproducibility of MAs in psychology and concluded that some aspects (e.g., moderator information, processes for study screening, and data extraction) should be reported transparently in a reproducible manner. Recently, Page et al. (2021) developed a "REPRISE" project to systematically investigate the reproducibility and replicability problems in evidence synthesis, which would be useful to promote the methodology and reporting quality of future evidence syntheses. Some empirical studies have demonstrated that the use of reporting guidelines (e.g., PRISMA) is associated with more complete reporting of MAs on health topics (Leclercq et al., 2019; Moher et al., 2009). Therefore, it is recommended that future systematic reviews and MAs on resveratrol should report their methods and results following PRISMA and its extensions, such as PRISMA harms (Zorzela et al., 2016).

Based on AMSTAR-2 (Shea et al., 2017), the methodological flaws of MAs on resveratrol mainly involved the following aspects: not registered protocol (item 2), stated the reason for the inclusion of study designs (item 3), performed study selection and data extraction in duplicate (items 5 and 6), provided a list of excluded studies with explicit reasons (item 7), reported the sources of funding of primary studies (item 10), evaluated the potential impact of bias on the pooled results (item 12), and accounted for risk of bias of individual studies when interpreting the results (item 13). These limitations are generally consistent with the results of a recent study (Lu et al., 2022) conducted by our team, which evaluated the methodological quality of MAs on Kanglaite as adjunctive therapy in treating cancers. Of the aforementioned items, items 2, 7, and 13 were considered critically important in AMSTAR-2 (Shea et al., 2017). It is generally acknowledged that all decision-making should be made upon bias-free evidence. Therefore, the tool requiring an MA should have a prior protocol and register it on public websites (e.g., PROSPERO), as a preregistered protocol can inform the process of conducting an MA, reduce duplicate efforts, and help identify selective reporting bias (Page et al., 2014; Tawfik et al., 2020). An empirical study (Zheng et al., 2021) revealed that the prospective registration of protocols was positively associated with methodological and reporting quality of systematic reviews on type 2 diabetes mellitus. Selective inclusion of studies could result in biased or even entirely contrary findings (Palpacuer et al., 2019). Therefore, the developers of AMSTAR-2 proposed that an MA should provide a list of excluded studies at the full-text screening stage to ensure that the readers can judge the impact of excluded studies on the pooled results while explaining the reasons underlying the exclusion of publications (Shea et al., 2017).

In addition to assessing the methodological quality, the associations between publication year, number of authors, $IF_{2022}$, and funding support and the overall methodological score were examined. The results were not statistically significant, which was contradictory to other large-sample sizes methodological research. For instance,

Fleming et al. (2014) evaluated 327 systematic reviews of medical interventions and concluded that those published in higher IF journals were significantly associated with higher methodological score obtained from AMSTAR, which is the older version of the AMSTAR-2 tool. Cheung et al. (2022) investigated the methodological quality of 148 systematic reviews on herbal medicines and reported significant positive associations between IF, number of authors, and methodological quality. Overall, the MA's authors should pay more attention to the methodological flaws identified by our research. Practically, researchers could refer to AMSTAR-2 and Cochrane Handbook while designing and conducting a systematic review. In addition, journal editors and peer reviewers should play a critical role in improving the scientific quality of this type of publication.

### 4.1 | Strengths and limitations

This study has some strengths. To the best of our knowledge, this is the first research to fully investigate the methodological quality and reporting completeness of MAs on resveratrol, filling the previous knowledge gap. The quality evaluation results were visualized using the evidence map method (Lu et al., 2021). Quality score was calculated to indicate the overall methodological quality due to the limited discrimination ability of AMSTAR-2 on the overall methodological quality of systematic reviews (De Santis et al., 2022; Li et al., 2022). Finally, the associations between the four study features and the methodological quality score were explored using univariate and multivariate linear regression analyses.

However, this methodological review has several limitations. First, only four commonly used databases were searched, and only the articles published in English were included. Therefore, some articles published in non-English language might have been missed. Second, the widely recognized tools were used to assess the quality of the included MAs on resveratrol, but some subjectivity might exist in the evaluation process, owing to the differences in understanding these tools. However, the bias was minimized as much as possible by an independent and duplicate evaluation process. Third, the quality assessments were based only on the contents reported by the reviewers; therefore, there might be some gaps between our findings and those actually conducted by the authors of the included MAs (Lu et al., 2020).

## 5 | CONCLUSION

The present methodological research demonstrates that the methodological and reporting quality of MAs on resveratrol is not optimal. The implementation and reporting of some critical aspects should be improved, such as protocol and registration, search methods, data extraction and study selection procedures, and risk of bias assessment. In particular, relevant methodological and reporting guidelines (e.g., Cochrane Handbook, AMSTAR-2, and PRISMA) should be followed when performing a future systematic review with MA on resveratrol.

## AUTHOR CONTRIBUTIONS

**Cuncun Lu:** Conceptualization; data curation; formal analysis; investigation; methodology; resources; software; visualization; writing – original draft; writing – review and editing. **Lixin Ke:** Data curation; formal analysis; resources; writing – review and editing. **Qiang Zhang:** Formal analysis; resources; writing – review and editing. **Xiuxiu Deng:** Data curation; formal analysis; investigation; writing – review and editing. **Wenru Shang:** Data curation; writing – review and editing. **Xiaoxiao Zhao:** Validation; writing – review and editing. **Yuanyuan Li:** Validation; writing – review and editing. **Yanming Xie:** Project administration; supervision; writing – review and editing. **Zhifei Wang:** Funding acquisition; project administration; supervision; validation; writing – review and editing.

## ACKNOWLEDGMENTS

None.

## FUNDING INFORMATION

This work was supported by the Scientific and Technological Innovation Project of China Academy of Chinese Medical Sciences (No. CI2021B003).

## CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/Supporting Information, further inquiries can be directed to the corresponding authors.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Lu, C., Ke, L., Zhang, Q., Deng, X., Shang, W., Zhao, X., Li, Y., Xie, Y., & Wang, Z. (2024). Quality of systematic reviews with meta-analyses of resveratrol: A methodological systematic review. *Phytotherapy Research*, *38*(1), 11–21. https://doi.org/10.1002/ptr.8025