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# Effects of Cinnamon Supplementation on Lipid Profile: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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**Conflict of Interest**
The authors declare that they have no competing interests.

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Not applicable.

## ABSTRACT

Since the effects of cinnamon supplementation on lipid profiles are still controversial, this study conducted a meta-analysis of randomized controlled trials to assess the effect of cinnamon supplementation on lipid profiles. The study was designed and conducted according to the guidelines of the 2020 preferred reporting items for systematic reviews and meta-analysis (PRISMA) statements. A systematic and comprehensive search was performed in several databases from inception up to 11 November 2023. The meta-analysis on the impact of Cinnamon on lipid profiles indicates a non-significant overall effect on low-density lipoprotein (weighted mean differences [WMD], −2.48; 95% confidence interval [CI], −9.70, 4.72). However, significant reductions are seen with doses < 500 mg/day (−10.26), and non-significant increases with doses ≥ 500 mg/day (1.18). The overall effect on high-density lipoprotein is non-significant (WMD, 3.97; 95% CI, −7.877, 15.831), showing varying responses at different doses. Triglycerides exhibit a significant overall reduction (WMD, −6.88; 95% CI, −12.62, −1.15), particularly in the < 500 mg/day group. The overall effect on cholesterol is non-significant (WMD, −4.314; 95% CI, −15.011, 6.384), with diverse responses at different doses. High heterogeneity underlines the importance of standardized study designs and further exploration of dosage-specific effects. Findings from this study suggest that cinnamon supplements might be beneficial to modulate the blood lipid profile.

**Keywords:** Cinnamon; Lipids; Meta-analysis; Randomized controlled trial

## INTRODUCTION

Since cardiovascular diseases are still the primary cause of morbidity and death globally, it is critical to investigate new and practical approaches for controlling cardiovascular risk factors [1]. Among the many possible therapies, the spice known for its long history in traditional medicine—cinnamon—has recently attracted interest due to its potential health benefit [2]. Given the importance of lipids in cardiovascular health, it is imperative to clarify how cinnamon supplementation affects lipid profiles in this era of evidence-based medicine [3].

**Author Contributions**

Conceptualization: Fateh HL; Formal analysis: Fateh HL; Methodology: Fateh HL; Software; Supervision: Fateh HL; Validation: Amin SM; Writing - review & editing: Fateh HL.

Cinnamon (*Cinnamomum*) is one of the most commonly used spices in the world and one of the oldest herbal remedies used to treat certain diseases and inflammation [4]. Cinnamon can modulate immune system function via regulation of anti- and proinflammatory gene expression [5,6]. Cinnamaldehyde is the major active ingredient of cinnamon and its anti-inflammatory effects have been observed in several studies [7,8].

Numerous clinical trials and studies exploring the effects of cinnamon on lipid profiles have employed varying doses, contributing to a nuanced understanding of its potential therapeutic range [9,10]. The selection of a daily dose of 500 mg is often grounded in the existing literature, where doses within this range have consistently shown significant effects on lipid parameters and higher doses may pose an increased risk of adverse effects, prompting researchers to establish a dosage within a range deemed safe and well-tolerated. This cautious approach aims to balance the potential therapeutic benefits of cinnamon with the need to mitigate any potential risks associated with elevated intake. By adhering to a 500 mg/day dosage, researchers aim to optimize the likelihood of observing positive effects on lipid parameters while minimizing the possibility of unwanted side effects [11]. This dose has been identified as a potentially efficacious level for achieving positive outcomes in terms of lipid profile modulation. This strategic dose selection not only enhances the reliability and reproducibility of findings but also aids in the formulation of evidence-based recommendations for individuals seeking to leverage cinnamon for lipid management.

Several clinical studies have investigated the potential impact of cinnamon on lipid profiles, shedding light on its role in cardiovascular health. In a randomized, double-blind trial conducted by Vafa et al., [10] participants with type 2 diabetes who consumed cinnamon experienced notable reductions in total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglyceride (TG) levels compared to the placebo group. Similarly, a study by Khan et al. [12] demonstrated significant improvements in lipid parameters among individuals with type 2 diabetes after a 40-day cinnamon supplementation period. Furthermore, the meta-analysis conducted by Maierean et al. [9] amalgamated data from ten randomized controlled trials (RCTs), revealing a consistent trend towards decreased TC and TGs in subjects supplemented with cinnamon. These clinical findings provide compelling evidence for the potential lipid-modulating effects of cinnamon, indicating its promising role in managing cardiovascular risk factors.

Also, some previous studies suggest a potential role of cinnamon and its components in improving insulin sensitivity [13,14], reducing fasting blood glucose [12,15], postprandial blood glucose levels (2-h post break-fast) [16,17], glycosylated haemoglobin [18], TC [12], serum TG [12], LDL-C [12], blood antioxidant levels [19], systolic blood pressure [19] and percent body fat [19].

The aim of this study is to provide guidance for clinical practice and public health efforts, in addition to adding to the expanding body of information on the effects of cinnamon through our systematic review and meta-analysis. We can address possible sources of variability, investigate subgroups, and assess the robustness of reported effects thanks to the synthesis of data from RCTs. In doing so, our research aims to close current gaps, guide future studies, and maybe impact dietary guidelines for those who want to improve their cardiovascular health. In order to tackle this, we conduct a thorough investigation using a systematic review and meta-analysis of RCTs with the goal of distilling a thorough knowledge of how cinnamon supplementation affects lipid profiles.


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## MATERIALS AND METHODS

Our study was designed, conducted, and reported according to the guidelines of the 2020 preferred reporting items for systematic reviews and meta-analysis (PRISMA) statements.

### Literature search strategy

A thorough and methodical search of the PubMed, Web of Science, Embase, and Cochrane library databases up until November 10, 2023, produced pertinent material. Only works published in English were included. The keywords were merged using MeSH in the search. The following is the search string: "Cinnamon" or "Cinnamomum verum" or "Ceylon cinnamon" and "lipid" or "intervention study" or "intervention" or "controlled trial" or "randomized" or "random" or "randomly" or "placebo" or "assignment." In order to find any pertinent research that could have been overlooked, the reference lists of each study, systematic reviews, and meta-analyses were also examined.

### Criteria for inclusion and exclusion

Original studies that satisfied the following criteria were chosen for inclusion in the meta-analysis: (a) the study design had to be a randomized controlled trial that looked into how cinnamon affected blood lipids; (b) the outcome had to include all changes in TC, LDL-C, high-density lipoprotein cholesterol (HDL-C), or TG level; and (c) all data had to be complete and available. The exclusion standards listed below were applied: (a) research that blatantly did not fit the aforementioned requirements; (b) experiments on cells, animals, meta-analyses, reviews, conference papers, case reports, and editorials.

### Evaluation of quality

The Cochrane risk of bias tool's seven validity questions were used to evaluate the literature quality of the included studies. The tool evaluated the following biases: incomplete outcome data, selective outcome reporting, blinding of outcome assessment, blinding of personnel, blinding of participants, and random sequence generation. Based on the Cochrane Handbook guidelines, every item was assessed as having a "Low," "High," or "Unclear" risk of bias.

### Data analysis

Stata 15.0 was used for all statistical analyses, with $p < 0.05$ being deemed statistically significant. The average change (final value minus baseline value) was subtracted to determine the mean value of the pertinent indicators. The value of the final endpoint was utilized if there were several endpoints. By contrasting the change from control to baseline and the change from intervention to baseline, we were able to determine the mean difference in effectiveness (MD) for the parallel controlled research. Serum lipid levels were taken at the conclusion of the intervention and control periods, and MD in effect was computed for the crossover test. This formula was used to compute the net change in standard deviation (SD) in cases where the study did not give one. The original literature did not give all of the data consistently, thus we translated the various blood lipid level units to millimoles per liter (1 mg/dL = 0.0258 mmol/L).

Furthermore, we computed the SD as appropriate because some studies only supplied the standard error and 95% confidence intervals (CIs) of the data. In addition, the mean net change was computed by deducting the endpoint mean value from the matching basal line mean value. With a correlation value of R = 0.5, the net change of SD was computed using the following formula: SDchange = (SD2baseline + SD2endpoint − 2R × SDbaseline × SDendpoint) ½ [20].


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The research spanned multiple countries, encompassing four studies conducted in Iran [6-9], two in India [10,11], one in Sweden [12], one in Pakistan [13], one in Germany [14], and one in the United States [15]. This diverse geographical distribution ensured a global perspective and contributed to a comprehensive understanding of the effects of cinnamon supplementation on lipid profiles across different regions.

To evaluate the heterogeneity, $\chi^2$ statistics and $I^2$ metrics were applied. The random-effects model was used when the $I^2 > 50\%$ or the p value of the $\chi^2$ test < 0.10, which denotes a significant degree of heterogeneity. Furthermore, subgroup analyses were carried out according to the individuals' backgrounds and the source of MUFA. Egger's regression test and funnel plots were used to look at possible publication bias. Moreover, the impact of a single research on the total outcomes was assessed using the sensitivity analysis.

## RESULTS

### Literature search and study characteristics

The complete flow diagram of the selected studies is shown in **Figure 1**. Initially, a thorough search of pertinent databases produced 8,901 documents in total. Nevertheless, no entries were found in registers, suggesting that electronic databases served as the main source of research for this systematic study. In order to ensure the dataset's clarity and prevent

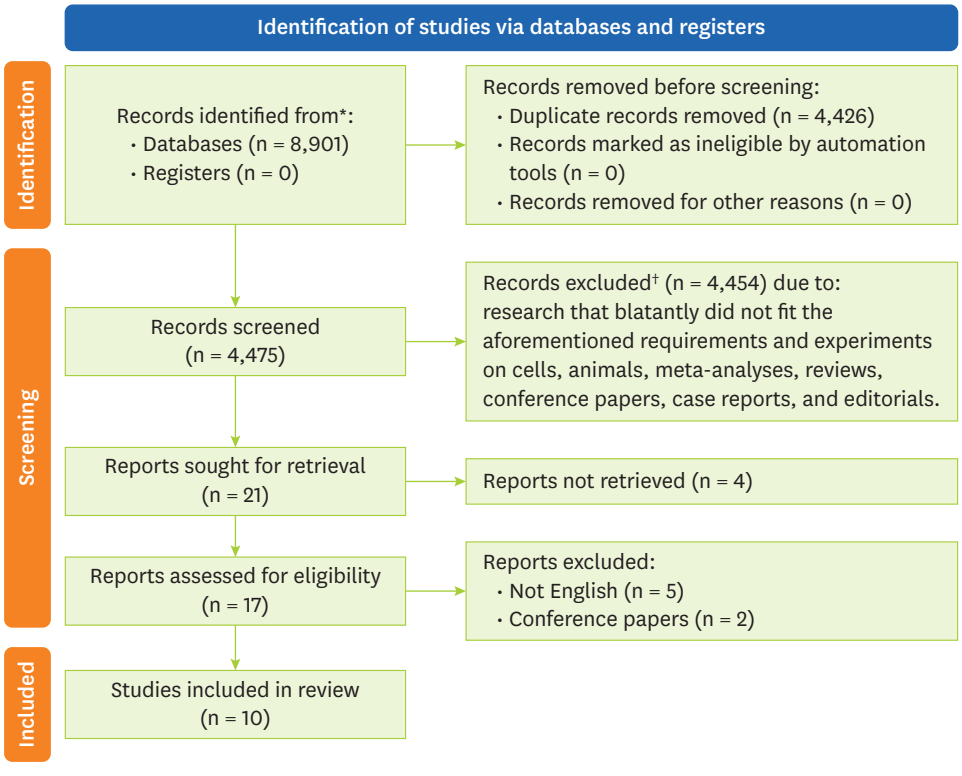


**Figure 1.** The flow diagram of trial selection.
*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
†If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.


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redundancy, 4,426 duplicate records were found and eliminated before the screening procedure. After that, the first screening procedure was applied to the 4,475 unique records that were still present. In the first stage of the evaluation, 4,475 records were reviewed in total. In order to establish the titles and abstracts' possible relevance to the study issue, a preliminary assessment of the materials was conducted in this stage. 4,454 of the screened data were rejected on the basis of preset inclusion and exclusion standards. Exclusion criteria included everything from incompatible study designs to irrelevant themes.

## Study characteristics

**Table 1** provides a more in-depth summary of the key characteristics of the included studies, offering detailed insights into various aspects. The assessment of the risks of bias in these studies is visually represented in **Figures 1-3**. These figures present a comprehensive overview of the methodological rigor and potential biases within the scope of the included studies.

Shishehbor et al. [21] demonstrated a study with low risk of bias, showcasing a robust methodology. Their allocation concealment, indicating selection bias, was appropriately addressed. Furthermore, their approach to handling incomplete outcome data exhibited a low risk of attrition bias, contributing to the overall reliability of their findings [21].

On the other hand, Wickenberg et al. [22] presented a study with an unclear risk of bias in terms of allocation concealment. This uncertainty in selection bias could potentially influence the study's internal validity. It is crucial to acknowledge and consider this uncertainty when interpreting the results.

In the investigations led by Askari et al. [23], Farooq et al. [24], Gupta Jain et al. [25], and Zare et al. [26], a low risk of bias was identified. Contrastingly, Khan et al. [12] exhibited a high risk of bias in blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), and selective reporting (reporting bias). These factors introduce potential sources of bias that may impact the study's internal validity and the accuracy of the reported results.

In the case of Ziegenfuss et al., [19] a high risk of bias was identified specifically in the domain of selective reporting (reporting bias).

**Table 1.** Characteristic of included studies in meta-analysis

| Studies | Year | Country | Study design | Participant | Sample size and sex | Duration (wk) | Sample size | | Means age, mean CG | Intervention, dose (mg/d) | Control group |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | IG | CG | | | |
| Khan et al. [12] | 2003 | Pakistan | SB | Diabetes | 30 F, 30 M | 6 | 30 | 30 | 52 | 400 mg | Placebo |
| Ziegenfuss et al. [19] | 2006 | US | DB | Metabolic syndrome | 11 F, 11 M | 12 | 12 | 10 | 46 | 500 mg | Placebo |
| Solomon TP et al.[14] | 2007 | Germany | DB | Diabetes | 21 F, 44 M | 12 | 33 | 32 | 62 | 112 mg | Placebo |
| Wickenberg et al. [22] | 2014 | Sweden | DB, PC | IGT | 10 F, 7 M | 12 | 9 | 8 | 72 | 500 mg | Placebo |
| Askari et al. [23] | 2014 | Iran | DB, PC | Fatty liver disease | 50 M, F | 12 | 32 | 22 | 56 | 1,500 mg | Placebo |
| Gupta Jain et al. [25] | 2017 | India | DB, PC | Metabolic syndrome | 52 F, 64 M | 16 | 58 | 58 | 45 | 3,000 mg | Placebo |
| Hajimonfarednejad et al. [33] | 2018 | Iran | DB | Polycystic ovary syndrome | 80 F | 8 | 33 | 33 | 28 | 1,000 mg | Placebo |
| Shishehbor et al. [21] | 2018 | Iran | DB, PC | Rheumatoid arthritis | 36 F | 8 | 18 | 18 | 46 | 500 mg | Placebo |
| Zare et al. [26] | 2019 | Iran | TB, PC | Diabetes | 63 F, 75 M | 12 | 69 | 69 | 52 | 500 mg | Placebo |
| Farooq et al. [24] | 2023 | India | SB | Fatty liver disease | 29 F, 31 M | 8 | 30 | 30 | 44 | 500 mg | Placebo |

IG, intervention group; CG, control group; DB, double-blinded; PC, placebo-controlled; F, female; IGT, impaired glucose tolerance; M, male; SB, single-blinded; TB, triple-blinded.


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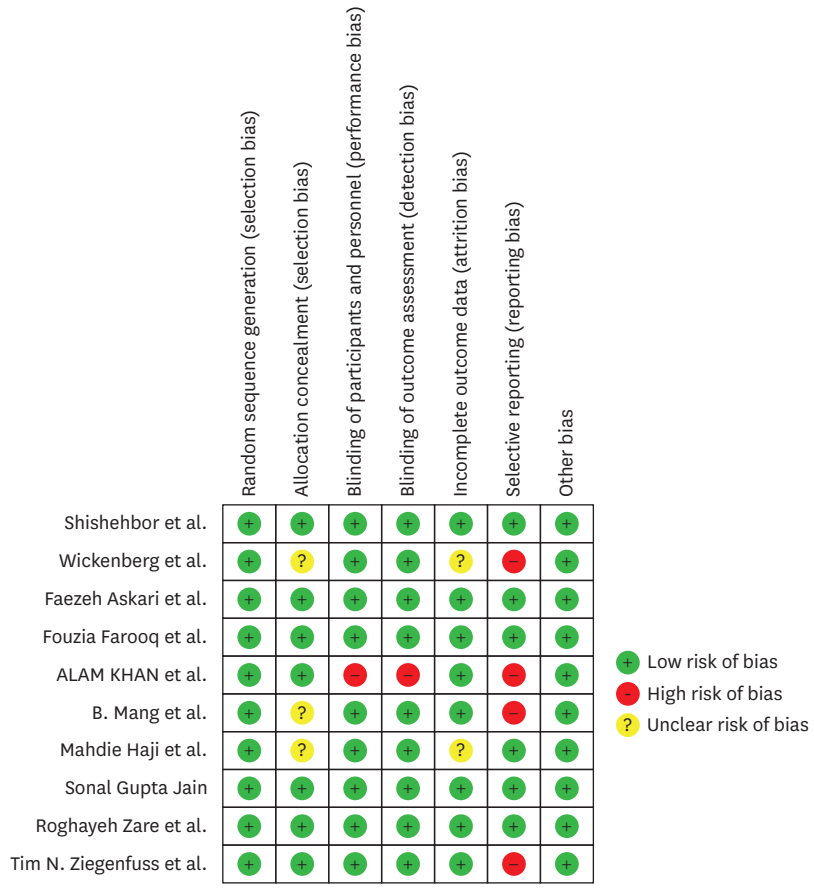


**Figure 2.** Risk of bias summary of included studies.

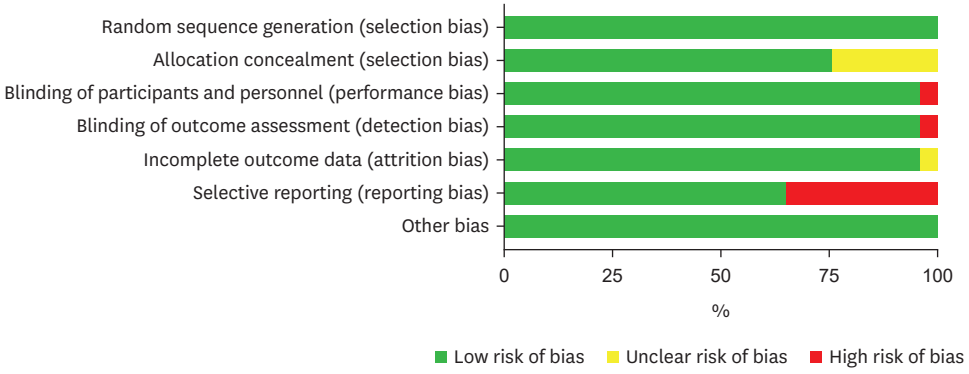


**Figure 3.** Risk of bias graph for all included studies.

## Results of meta-analysis

**Figure 4** shows the meta-analysis of ten studies investigating the effect of cinnamon supplementation on lipid profiles unveiled noteworthy findings across key parameters. For LDL, the overall effect did not demonstrate statistical significance (weighted mean differences [WMD], −2.48; 95% CI, −9.70, 4.72; p = 0.499), suggesting that cinnamon did not exert a significant influence on LDL levels. However, a substantial degree of heterogeneity was observed among the studies ($I^2$ = 96.0%), indicating considerable variability in the reported outcomes. Conversely, HDL exhibited no significant overall effect as well (WMD, 3.97; 95% CI, −7.877, 15.831; p = 0.511), and a strikingly high level of heterogeneity was noted ($I^2$ = 99.5%).


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TG showed a significant reduction with cinnamon supplementation (WMD, −6.88; 95% CI, −12.62, −1.15; p = 0.019), accompanied by notable heterogeneity ($I^2$ = 97.4%). TC did not register a statistically significant overall effect (WMD, −4.314; 95% CI, −15.011, 6.384; p = 0.429), with a substantial degree of heterogeneity ($I^2$ = 97.6%). These results underscore the complexity of cinnamon's impact on lipid profiles, highlighting the need for further exploration and consideration of contextual factors contributing to the observed heterogeneity.

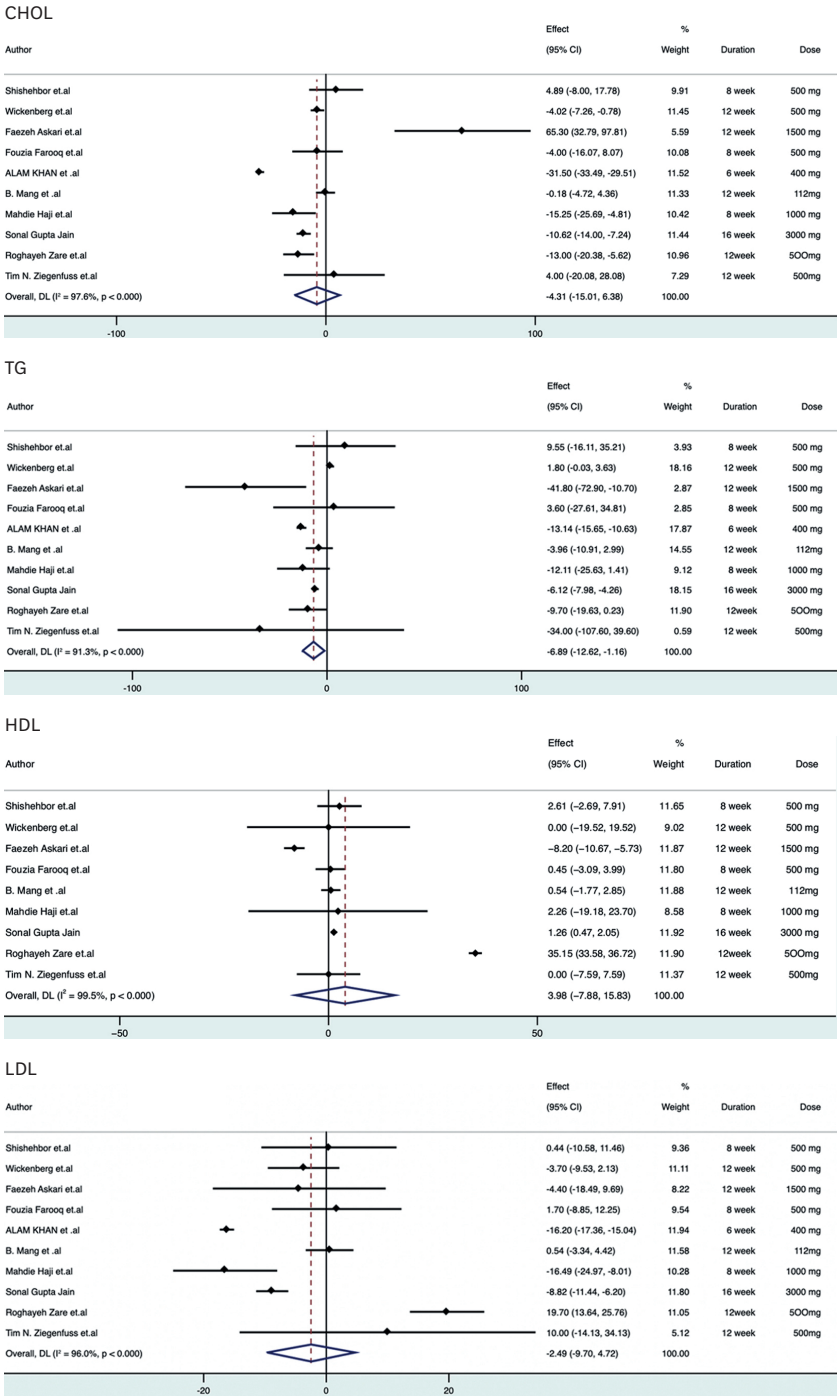


**Figure 4.** Effect of cinnamon on CHOL, TG, HDL and LDL.
CHOL, cholesterol; TG, triglycrid; HDL, high-density lipoprotein; LDL, low-density lipoprotein.


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## Subgroup analysis and sensitivity analysis

**Table 2** and **Figure 5** presents a detailed exploration of the impact of cinnamon supplementation on lipid profiles, stratified by intervention dosage, specifically focusing on TC, TG, HDL, and LDL. The findings reveal intriguing insights into the differential effects based on the administered dosage. For LDL, an intervention dose of less than 500 mg/day demonstrated a significant reduction (WMD, −10.26; 95% CI, −15.62, −4.90; p = 0.001), with a modest level of heterogeneity ($I^2$ = 40.4%). In contrast, higher doses (≥ 500 mg/day) exhibited a non-significant increase in LDL levels (WMD, 1.18; 95% CI, −10.28, 12.65; p = 0.840), accompanied by pronounced heterogeneity ($I^2$ = 97.2%). HDL levels displayed a non-significant reduction for both lower (WMD, −2.72; 95% CI, −11.294, 5.841; p = 0.533) and higher (WMD, 6.01; 95% CI, −9.562, 21.599; p = 0.449) intervention doses, with considerable heterogeneity observed ($I^2$ = 96.1% and 99.4%, respectively). In terms of TG, lower doses

**Table 2.** The effect of Cinnamon on LDL, HDL, TG and Chol

| Variables | No. | WMD (95% CI) | p value | Heterogeneity | |
|---|---|---|---|---|---|
| | | | | p heterogeneity | $I^2$ |
| LDL | | | | | |
| Overall effect | 10 | −2.48 (−9.70, 4.72) | 0.499 | 0.001 | 96.0% |
| Intervention dose (mg/day) | | | | | |
| < 500 | 3 | −10.26 (−15.62, −4.90) | 0.001 | 0.187 | 40.4% |
| ≥ 500 | 7 | 1.18 (−10.28, 12.65) | 0.840 | 0.001 | 97.2% |
| HDL | | | | | |
| Overall effect | 10 | 3.97 (−7.877, 15.831) | 0.511 | 0.001 | 99.5% |
| Intervention dose (mg/day) | | | | | |
| < 500 | 3 | −2.72 (−11.294, 5.841) | 0.533 | 0.001 | 96.1% |
| ≥ 500 | 7 | 6.01 (−9.562, 21.599) | 0.449 | 0.001 | 99.4% |
| TG | | | | | |
| Overall effect | 10 | −6.88 (−12.62, −1.15) | 0.019 | 0.001 | 97.4% |
| Intervention dose (mg/day) | | | | | |
| < 500 | 3 | −12.65 (−25.29, −0.008) | 0.050 | 0.057 | 65.2% |
| ≥ 500 | 7 | −4.66 (−13.52, 4.20) | 0.303 | 0.001 | 93.5% |
| Chol | | | | | |
| Overall effect | 10 | −4.314 (−15.011, 6.384) | 0.429 | 0.001 | 97.6% |
| Intervention dose (mg/day) | | | | | |
| < 500 | 3 | 3.566 (−17.58, 24.71) | 0.741 | 0.001 | 90.8% |
| ≥ 500 | 7 | −6.969 (−20.97, 7.03) | 0.329 | 0.001 | 98.1% |

LDL, low-density lipoprotein; HDL, high-density lipoprotein; TG, triglycrid; Chol, cholesterol; WMD, weighted mean differences; CI, confidence interval.

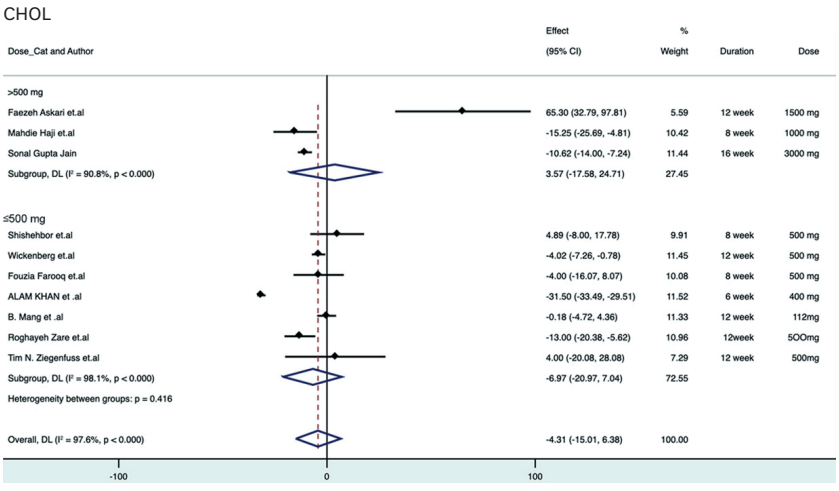


**Figure 5.** Effect of cinnamon by dosage on CHOL, TG, HDL and LDL.
CHOL, cholesterol; TG, triglycrid; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

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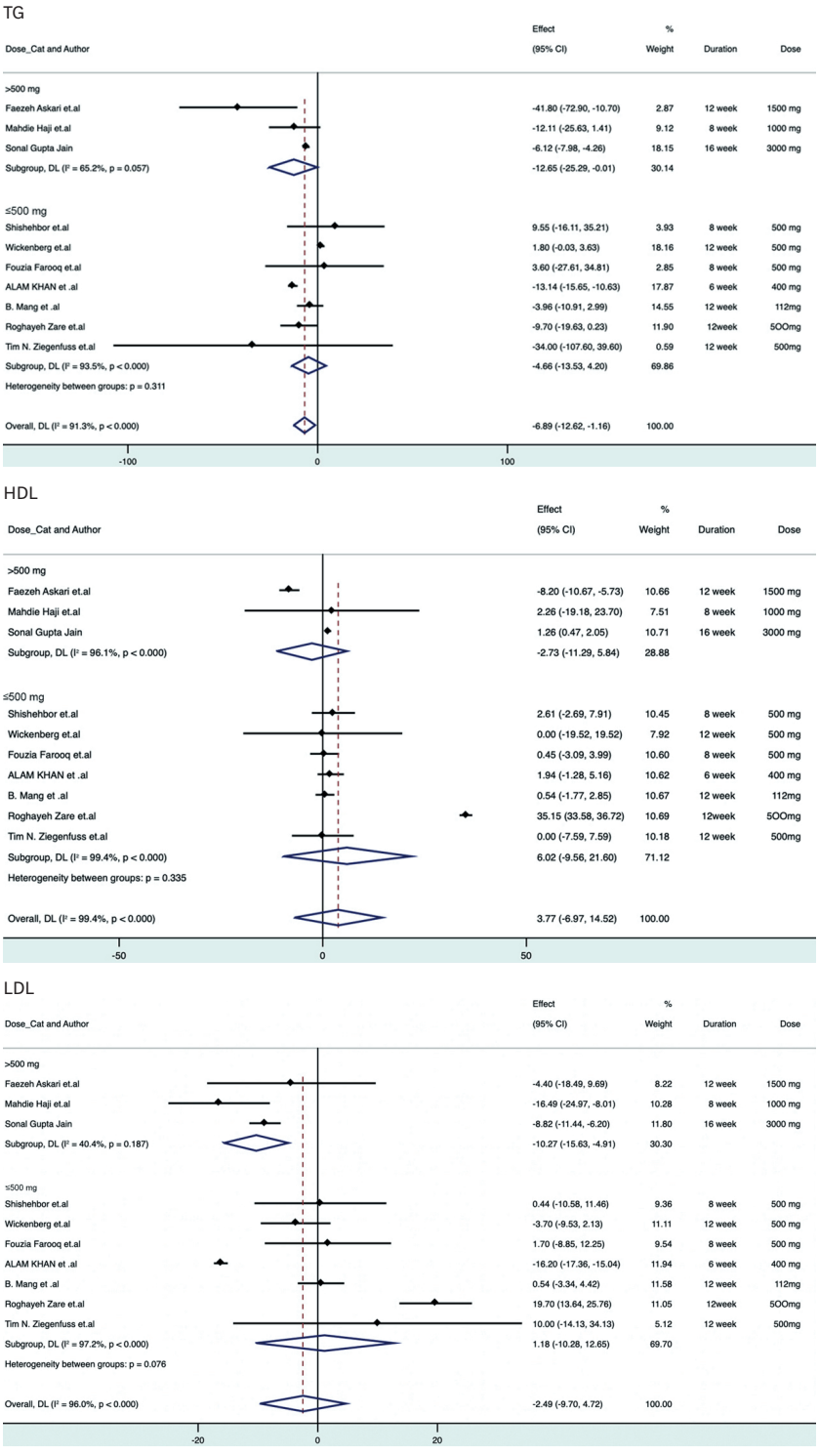


**Figure 5.** (Continued) Effect of cinnamon by dosage on CHOL, TG, HDL and LDL.
CHOL, cholesterol; TG, triglycrid; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

exhibited a significant reduction (WMD, –12.65; 95% CI, –25.29, –0.008; p = 0.050), with moderate heterogeneity ($I^2$ = 65.2%). Higher doses, however, showed a non-significant decrease in TG levels (WMD, –4.66; 95% CI, –13.52, 4.20; p = 0.303), accompanied by


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notable heterogeneity ($I^2$ = 93.5%). Lastly, cholesterol levels demonstrated a non-significant increase for lower doses (WMD, 3.566; 95% CI, −17.58, 24.71; p = 0.741) and a non-significant decrease for higher doses (WMD, −6.969; 95% CI, −20.97, 7.03; p = 0.329), with substantial heterogeneity observed in both strata ($I^2$ = 90.8% and 98.1%, respectively). These nuanced findings underscore the dosage-dependent nature of cinnamon's effects on lipid profiles, necessitating further investigation and consideration in clinical applications.

The sensitivity analysis, a crucial component of our study, involved a meticulous examination of the influence of individual studies on the overall effect sizes for key lipid parameters, including LDL, HDL, TG, and TC. Notably, the study by Shishehbor et al. [21] significantly impacted the overall effect of LDL, revealing a value of −2.78 (−10.38, 4.80). This finding suggests that the exclusion or inclusion of this particular study may substantially influence the overall conclusion regarding the effect of cinnamon on LDL levels. Similarly, the study by Askari et al. [23] played a pivotal role in the sensitivity analysis for HDL, demonstrating a value of 5.18 (−6.59, 16.96). Additionally, the study by Wickenberg et al. [22] significantly influenced the sensitivity analysis for TG, indicating a value of −8.74 (−13.47, −4.01). Lastly, for TC, the study by Askari et al. [23] exhibited a substantial impact with a value of −8.47 (−19.15, 2.20). These sensitivity analyses underscore the importance of individual studies in shaping the overall conclusions of our meta-analysis and emphasize the need for careful consideration of their respective contributions to the synthesized evidence.

### Publication bias

**Figure 6** employs funnel plots to assess the potential presence of publication bias in studies examining the effect of cinnamon supplementation on lipid profiles, specifically focusing on LDL, HDL, TG, and TC. For LDL, Egger's test yielded a p value of 0.030, suggesting a potential presence of publication bias. HDL, TG, and cholesterol, however, exhibited p values of 0.400, 0.254, and 0.002, respectively. While HDL and TG did not show significant evidence of publication bias, the significant p value for cholesterol suggests the need for cautious interpretation due to the potential influence of bias in the reported findings.

## DISCUSSION

The meta-analysis on the impact of Cinnamon on lipid profiles indicates a non-significant overall effect on LDL. However, significant reductions are seen with doses < 500 mg/day, and non-significant increases with doses ≥ 500 mg/day. TG exhibit a significant overall reduction, particularly in the < 500 mg/day group. High heterogeneity underlines the importance of standardized study designs and further exploration of dosage-specific effects.

This research provides a comprehensive overview of diverse clinical studies investigating the effects of cinnamon on various health conditions. In Iran, Shishehbor et al. [21] focused on rheumatoid arthritis with a dosage of 500 mg/day, while Askari et al. [23] examined fatty liver disease using a higher dosage of 1,500 mg/day. Similarly, in Sweden, Wickenberg et al. [22] explored impaired glucose tolerance (IGT) with a common dosage of 500 mg/day. In India, Farooq et al. [24] investigated fatty liver disease with a dosage of 500 mg/day, and Gupta Jain et al. [25] targeted metabolic syndrome, utilizing a higher dosage of 3,000 mg/day. The studies exhibit variations in participant demographics, intervention duration, and conditions studied, contributing to a rich understanding of cinnamon's potential effects across different contexts.


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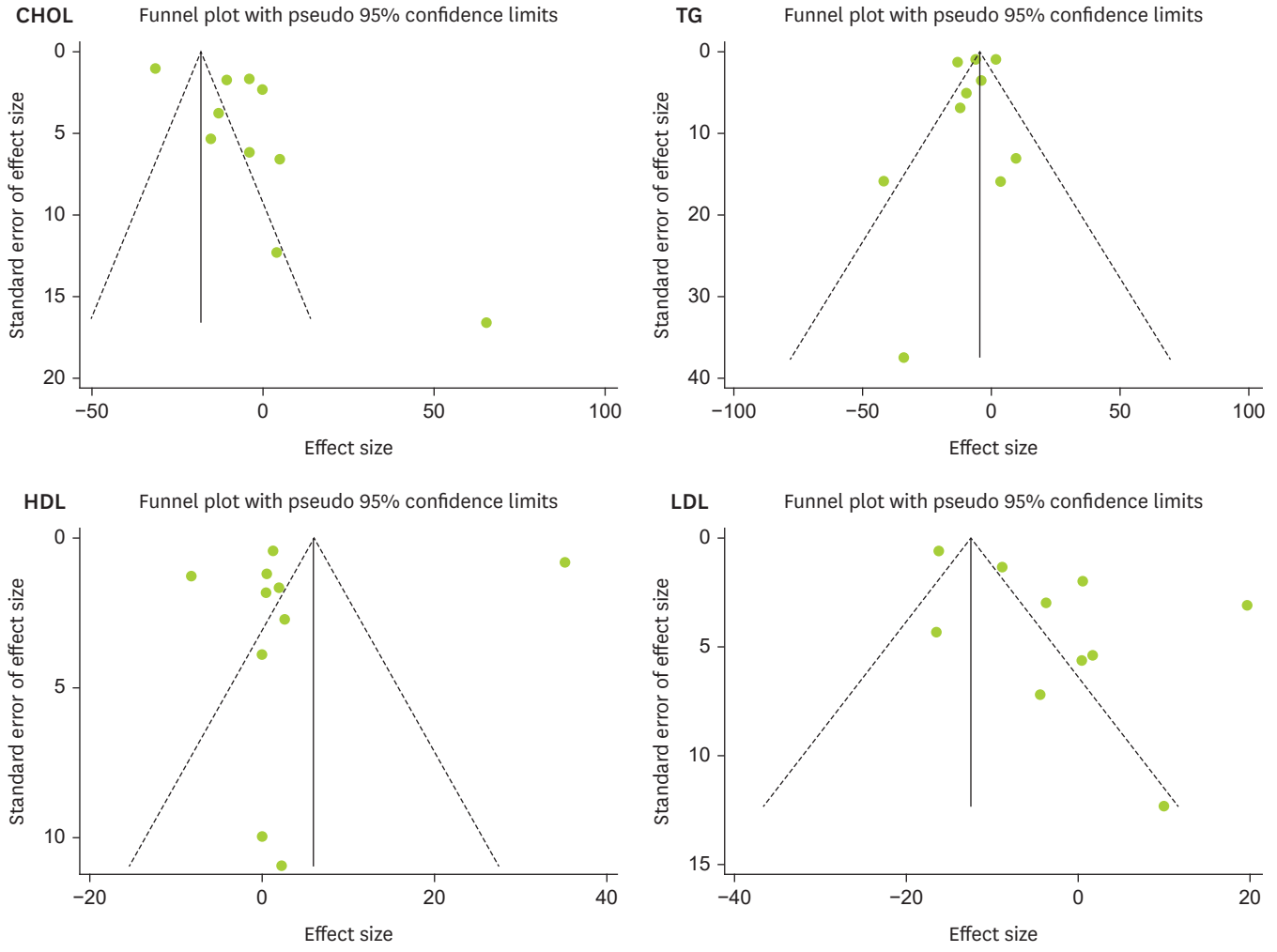


**Figure 6.** Funnel plots to evaluate publication bias, and the effect of cinnamon for CHOL, TG, HDL and LDL Egger's test.
CHOL, cholesterol; TG, triglycrid; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

Furthermore, the studies also highlight the importance of considering the safety and efficacy of different cinnamon dosages. For instance, Khan et al. [12] in Pakistan explored diabetes with a dosage of 400 mg/day, and Solomon TP et al. [14] in Germany studied diabetes with a relatively lower dosage of 112 mg/day. These variations in dosage underscore the need for a nuanced approach to cinnamon supplementation, considering both therapeutic benefits and potential adverse effects. Overall, the diverse range of conditions, dosages, and participant demographics in these studies contributes valuable insights to the ongoing exploration of cinnamon's role in promoting health.

Lipid metabolism is intricately linked to cardiovascular health, with lipid profiles serving as crucial indicators [21]. These profiles encompass measurements of lipoproteins, TG, and cholesterol, providing valuable insights into an individual's cardiovascular status. Dysregulation in these lipid markers, commonly referred to as dyslipidemia, holds a significant position in the pathophysiology of atherosclerosis and the occurrence of cardiovascular events [23]. To elaborate, abnormalities in lipid metabolism can lead to an imbalance in lipoprotein levels, increased TG concentrations, and alterations in cholesterol distribution. These disruptions contribute to the formation of atherosclerotic plaques,


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initiating a cascade of events that may culminate in cardiovascular events such as heart attacks or strokes [22].

Comparing these findings with existing literature, several studies have reported conflicting results regarding the influence of cinnamon on LDL levels. Some studies align with the current findings, suggesting a potential LDL-lowering effect, especially at lower doses [24]. However, there are studies that report no significant impact or even an increase in LDL levels with cinnamon supplementation. The observed heterogeneity in the current meta-analysis, as indicated by the high $I^2$ value (96.0%), underscores the variability in study designs, participant characteristics, and possibly cinnamon formulations, which may contribute to the inconsistent results.

The effect of Cinnamon on HDL, the overall effect is non-significant (WMD, 3.97; 95% CI, –7.877, 15.831). However, when examining different intervention doses, both groups show non-significant changes, with a slight reduction in HDL for those receiving less than 500 mg/day and a slight increase for those receiving 500 mg/day or more. In comparison to the existing literature, the current study's findings on HDL align with the mixed results reported in previous research [9]. Some studies indicate positive effects on HDL levels with cinnamon supplementation [3,25,27], while others do not find any significant changes [10,28,29,30]. The high level of heterogeneity in this analysis ($I^2$ = 99.5%) emphasizes the need for further investigation into the factors contributing to the variability in HDL outcomes across studies.

The results of the current study, demonstrate a significant overall reduction in TG with cinnamon supplementation (WMD, −6.88; 95% CI, –12.62, –1.15). Stratification by intervention dose reveals a more substantial reduction for doses less than 500 mg/day compared to 500 mg/day or more. Comparing these findings with existing literature, there is some agreement with studies reporting a TG-lowering effect of cinnamon [9,31,32]. However, the dose-specific response observed in this meta-analysis adds a valuable layer to the understanding of cinnamon's impact on TG levels. The significant heterogeneity ($I^2$ = 97.4%) prompts further exploration of potential influencing factors.

Finally, the effect of Cinnamon on cholesterol. The overall effect is non-significant (WMD, −4.314; 95% CI, –15.011, 6.384), and when stratified by intervention dose, both groups show non-significant changes, with a slight reduction for doses less than 500 mg/day and a slight increase for doses 500 mg/day or more. Comparing these results with existing literature, the non-significant overall effect is consistent with the mixed findings reported in previous studies. The heterogeneity observed in this analysis ($I^2$ = 97.6%) raises questions about the diverse responses to cinnamon across different studies.

the current meta-analysis sheds light on the nuanced effects of cinnamon on lipid profiles, particularly LDL, HDL, TG, and cholesterol. The observed variations highlight the importance of considering intervention dosage and underscore the need for further well-controlled studies to elucidate the potential benefits and mechanisms of cinnamon supplementation on lipid parameters.

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