Anti-hyperlipidemia of garlic by reducing the level of total cholesterol and low-density lipoprotein
A meta-analysis
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Abstract
Background: This study aimed to understand the impact of garlic on improving blood lipids using a meta-analysis.

Methods: A literature search of the PubMed, EMBASE, and Cochrane Library databases was performed using keywords such as “garlic” and “hypercholesterolemia,” and the deadline “July 14 (th), 2017.” After extracting relevant details, each selected literature was evaluated for quality according to the quality evaluation criteria of bias risk recommended by Cochrane Collaboration recommendations and heterogeneity tests were performed. Standardized mean difference (SMD) and 95% confidence interval (CI) were evaluated using R 3.12 software. The publication bias was assessed using Egger method.

Results: A total of 14 eligible papers published from 1981 to 2016 were included. The quality of the literatures was of moderate to high qualities. The values of TC (SMD = −1.26, 95% CI, −1.86 to −0.66), low-density lipoprotein (LDL) (SMD = −1.07, 95% CI, −1.67 to −0.47), and high-density lipoprotein (HDL) (SMD = 0.50, 95% CI, 0.06–0.94) after taking garlic in the experimental group and the control group have statistical significance, while there was no significant difference of TG in the 2 groups (SMD = −0.16, 95% CI, −0.87–0.55). However, the result of HDL was reversed when removed some of the literatures. No significant publication bias among the eligible studies with values of TC (P = .0625), LDL (P = .0770), HDL (P = .2293), and TG (P = .3436).

Conclusion: Garlic can reduce the level of TC and LDL instead of HDL and TG, indicating the ability of anti-hyperlipidemia.

Abbreviations: BG = aged black garlic, BMI = body mass index, CI = confidence interval, CVD = cardiovascular disease, GO = garlic oil, GP = garlic powder, HDL = high-density lipoprotein, HMG-CoA = 3-hydroxy-3-methylglutaryl-coenzyme A, LDL = low-density lipoprotein, PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses, SMD = standardized mean difference, TC = total cholesterol, TG = triglyceride.

Keywords: cardiovascular disease, garlic, high-density lipoprotein, hypercholesterolemia, low-density lipoprotein, total cholesterol, triglyceride

High Lights
1. Garlic had anti-hyperlipidemia ability.
2. Intake of garlic induced the level of TC and LDL.
3. The level of TG in serum had no obvious difference with and without garlic treatment.

1. Introduction
Recently, cardiovascular disease (CVD), a complex and multifactorial disease, remains one of the serious diseases that threaten human health worldwide with increasing incidence and mortality year by year.[1]Unfortunately, 17 million people die to CVD each year and it is estimated to reach 24.8 million in 2030 in the world.[2] The most important risk factors of CVD are hypertension, high cholesterol, alcohol intake, and tobacco usage, etc. according to the World Health Organization.
participants in the experimental group was hyperlipidemia.

2.1. Data sources

The related clinical researches were obtained from the electronic databases PubMed (http://www.ncbi.nlm.nih.gov/pubmed/), Embase (http://www.embase.com), and Cochrane Library (http://www.cochranelibrary.com) with garlic (“ALLIUM SATIVUM” OR “Garlic”) and hypercholesterolemia (“Hypercholesterolemia” OR “Hypercholesterolemia” OR “Hypercholesterolemic” OR “Hyperlipidemic” OR “Hyperlipidaemia” OR “Hyperlipidemia” OR “Dyslipidemia” OR “Dyslipidemias”) as searched keywords; and a deadline of “July 14 (th); 2017.”

2.2. Eligibility criteria

Articles meeting the following criteria were selected (based on the PICOS principle): published English literatures to study the efficacy of garlic in the treatment of hypercholesterolemia (P); participants in the experimental group was hyperlipidemia patients treated with garlic (I) and that in the control group was hyperlipidemia patients with placebo (C) treatment; the outcomes of the study included the initial values as well as the values after treatment of TC (serum total cholesterol), LDL (low density lipoprotein), HDL (high density lipoprotein), and TG (triglyceride), and the amount of changes was included (O); the study type was randomized parallel study (study design: parallel; crossover study: excluded) (S). The following articles were removed: studies with incomplete data or can't be used for statistical analysis; literatures such as reviews, reports, comments, and letters. Besides, if multiple literatures were repeatedly published or multiple literatures studied based on the same population data, only the latest research or the research with complete information was included.

2.3. Data extraction and quality evaluation of literature

Data were independently extracted from the included literatures by 2 reviewers and included details such as: first author, published year, area of study, year of study, the type and dose of garlic, follow-up time, number as well as general demographic data (e.g., sex ratio, age composition, body mass index [BMI], etc.) of inclusion in the garlic group and the control group; the initial values as well as the values after treatment of TC, LDL, HDL, and TG in the garlic group and the control group.

The aggregate quality of the included studies was evaluated according to the quality evaluation criteria of bias risk, recommended by Cochrane Collaboration recommendations.[18] A third reviewer should join in and discuss with the other 2 reviewers to get an agreement if there was disagreement in the process of data extraction and quality evaluation.

2.4. Statistical analysis

The meta-analysis of direct comparison was conducted using R 3.12 software (R Foundation for Statistical Computing, Beijing, China, “meta” package), SMD (standardized mean difference), and 95% confidence interval (CI) were used to show the effect index of quantitative data. The heterogeneity test between studies was assessed based on the Q test[19] and the I² statistic, and P < 0.05 or I² > 50% was used as the heterogeneity threshold. The random effect model was chosen when they had significant heterogeneity; otherwise, the fixed-effect model was chosen to pool the data.[20] The publication bias was assessed using Egger method. Finally, the sensitivity analysis was performed by examining the effect of this document on the overall SMD value by ignoring a document each time.

3. Results

3.1. Characteristics of the selected literature

A total of 956 articles (243 articles came from PubMed database, 645 articles came from Embase database, 68 ones came from Cochrane Library) were identified based on the literature search criteria. Among them, 207 articles were repeated, and 618 articles were irrelevant after reading title and abstract. In addition, 117 articles (including 15 letters, 11 case series/report, 28 reviews, 31 animal study, 13 descriptive studies, 12 non-RCT, and 7 reduplicative studies) of the remaining 131 articles were removed by reviewing full text. Finally, 14 eligible papers which were published from 1981 to 2016 were included (Fig. 1).[5,6,16,21–31]
Table 1 Characteristics of the included literatures.

| Author          | Year  | Study location | Type | Dose       | Duration | Group | N  | Sex (M/F) | Age          | BMI/Body weight |
|-----------------|-------|----------------|------|------------|----------|-------|----|-----------|--------------|----------------|
| Adler AJ        | 1997  | Canada         | GP   | 900mg/d    | 12 w     | Garlic| 12 | 12 (M)    | 45.9±12.6   | 27.2±3.0       |
| Ahmad Alobaidi AH| 2014  | Iraq           | GO   | 500mg/d    | 4 w      | Garlic| 150| 66/84     | 56.9±5.25   | 25.1±5.9       |
| Ashraf R        | 2005  | Pakistan       | GP   | 300mg/d    | 12 w     | Garlic| 35 | 15/20     | 60.5±0.4    | 62.2±10.45kg  |
| Aslani N        | 2016  | Iran           | Garlic | 20 g/d | 8 w     | Garlic| 27 | 14/13     | 50.5±4.8    | 63.9±80kg     |
| Bordia A        | 1981  | India          | GO   | 15mg/d     | 10m      | Garlic| 28 | 16/12     | 43.2±6.2    | 27.2±3.2       |
| Gardner CDa     | 2007  | USA            | Others | 4g/d | 6 m     | Raw garlic | 49 | 22/27     | 49±9        | 25±3          |
| Jain AK         | 1993  | USA            | GP   | 900mg/d    | 12 w     | Garlic| 20 | 11/9      | 48±15       | 78±17kg       |
| Jung ES         | 2014  | Korea          | ABG  | 6g/d       | 12 w     | Garlic| 30 | 8/22      | 50.5±9.9    | 63.5±9.96kg   |
| Kannar D        | 2001  | Australia      | GP   | 880mg/d    | 12 w     | Garlic| 22 | 12/10     | 50.2±6.4    | 25.4±2.6      |
| Peleg A         | 2003  | Israel         | GP   | 22.4mg/d   | 16 w     | Garlic| 18 | 8/10      | 52.4±7.5    | 69.3±11.8kg   |
| Satthivapree P  | 2003  | Thailand       | Others | 333mg/d | 12 w    | Garlic| 70 | 23/47     | 47.6±6.6    | 24.3±3.3      |
| Sobrenin LA     | 2008  | Russia         | GP   | 600mg/d    | 12 w     | Garlic| 23 | 42 (M)    | 57.2±2.0    | 26.6±0.6      |
| Sobrenin LA     | 2010  | Russia         | GP   | 300mg/d    | 12 m     | Garlic| 26 | 14/12     | 56.7±1.8    | 27.0±0.9      |
| Superko HR      | 2000  | USA            | GP   | 900mg/d    | 12 w     | Garlic| 29 | NA        | 53±107      | 163±30lbs     |

Garlic type: a = raw garlic group, ABG = aged black garlic, BMI = body mass index, GO = garlic oil, GP = garlic powder, M/F = Male/Female.
| Author            | Year | Group   | N  | TC   | LDL  | HDL  | Triglyceride |
|-------------------|------|---------|----|------|------|------|--------------|
|                   |      |         |    | Base, mg/dL | Posttreatment, mg/dL | Base, mg/dL | Posttreatment, mg/dL | Base, mg/dL | Posttreatment, mg/dL |
| Adler AJ          | 1997 | Garlic  | 12 | 6.54 ± 0.25a | 5.79 ± 0.23a | 3.31 ± 0.25a | 3.17 ± 0.04a | 1.26 ± 0.06a | 1.29 ± 0.08a |
|                   |      | Placebo | 11 | 6.46 ± 0.26a | 6.49 ± 0.31a | 3.19 ± 0.28a | 3.15 ± 0.10a | 1.20 ± 0.01a | 1.26 ± 0.06a |
| Ahmad in Hobaidi A H | 2014 | Garlic  | 150| 217 ± 46 | 170 ± 34.7 | 134 ± 32.6 | 110 ± 35.4 | 38 ± 13.5 | 42 ± 13.7 |
|                   |      | Placebo | 150| 213 ± 41.5 | 196 ± 35.4 | 134 ± 33.6 | 111 ± 35.4 | 38 ± 13.5 | 42 ± 13.7 |
| Ashraf R          | 2005 | Garlic  | 35 | 228.23 ± 4.54 | 200.77 ± 5.07 | 163.57 ± 4.66 | 133.42 ± 6.41 | 38 ± 1.73 | 41.35 ± 1.31 |
|                   |      | Placebo | 33 | 220.45 ± 2.25 | 218.34 ± 3.05 | 167 ± 3.37 | 164.32 ± 3.56 | 36.58 ± 3.45 | 37.25 ± 3.86 |
| Astani N          | 2016 | Garlic  | 27 | 234.4 ± 26.5 | 215.3 ± 23 | 119.7 ± 19.0 | 127.2 ± 22.1 | 41.4 ± 6.5 | 41.3 ± 7.8 |
|                   |      | Placebo | 28 | 239 ± 18.8 | 243 ± 14.2 | 119.2 ± 19.0 | 127.2 ± 22.1 | 41.4 ± 6.5 | 41.3 ± 7.8 |
| Bordia A          | 1981 | Garlic  | 20 | 238.4 ± 22.7 | 228.0 ± 13.5 | NA | NA | 17.0 ± 1.1 | 30.0 ± 2.6 |
|                   |      | Placebo | 62 | 260.1 ± 25.1 | 262.4 ± 19.0 | NA | NA | 17.0 ± 1.1 | 30.0 ± 2.6 |
| Gardner CDa       | 2007 | Raw garlic | 49 | 236 ± 18 | NA | 151 ± 15 | 142 ± 22 | 58 ± 15 | 58 ± 14 |
|                   |      | Placebo | 48 | 228 ± 21 | NA | 150 ± 14 | 133 ± 21 | 54 ± 14 | 52 ± 13 |
| Jain AK           | 1993 | Garlic  | 20 | 262 ± 35 | 247 ± 40 | 188 ± 37 | 168 ± 43 | 47 ± 12 | 46 ± 13 |
|                   |      | Placebo | 22 | 276 ± 34 | 274 ± 29 | 191 ± 34 | 185 ± 25 | 49 ± 14 | 50 ± 17 |
| Jung ES           | 2014 | Garlic  | 30 | 241.07 ± 23.97 | 233.50 ± 24.63 | 150.64 ± 14.12 | 155.75 ± 21.94 | 46.86 ± 9.40 | 50.36 ± 8.85 |
|                   |      | Placebo | 30 | 228.93 ± 23.17 | 227.33 ± 22.51 | 150.11 ± 15.65 | 156.33 ± 22.83 | 50.81 ± 9.19 | 50.46 ± 9.76 |
| Kannar D          | 2001 | Garlic  | 22 | 7.5 ± 0.8a | 7.4 ± 1.1a | 5.3 ± 0.9a | 5.4 ± 1.1a | 1.34 ± 0.34a | 1.33 ± 0.39a |
|                   |      | Placebo | 24 | 7.6 ± 0.9a | 7.1 ± 0.9a | 5.3 ± 0.9a | 4.9 ± 0.9a | 1.35 ± 0.49a | 1.26 ± 0.47a |
| Pelig A           | 2003 | Garlic  | 18 | 262.6 ± 25.3 | 259.6 ± 36.8 | 172.7 ± 18.8 | 171.0 ± 28.3 | 54.0 ± 11.9 | 49.8 ± 13.3 |
|                   |      | Placebo | 21 | 275.4 ± 23.6 | 267 ± 29.6 | 186.6 ± 16.8 | 182.0 ± 23.5 | 54.9 ± 15.8 | 54.0 ± 11.9 |
| Sathipawee P      | 2003 | Garlic  | 70 | 6.65 ± 0.89a | 6.59 ± 0.93a | 4.52 ± 0.86a | 4.52 ± 0.77a | 1.50 ± 0.37a | 1.45 ± 0.26a |
|                   |      | Placebo | 66 | 6.85 ± 0.83a | 6.80 ± 0.90a | 4.60 ± 0.90a | 4.65 ± 0.83a | 1.55 ± 0.26a | 1.47 ± 0.26a |
| Sobinina LA       | 2008 | Garlic  | 23 | 6.9 ± 0.20a | 6.41 ± 0.22a | 5.00 ± 0.17a | 4.37 ± 0.20a | 1.06 ± 0.07a | 1.17 ± 0.09a |
|                   |      | Placebo | 19 | 7.04 ± 0.18a | 7.24 ± 0.18a | 4.93 ± 0.18a | 5.07 ± 0.18a | 1.20 ± 0.09a | 1.16 ± 0.10a |
| Sobinina LA       | 2010 | Garlic  | 26 | 269.2 ± 11.5 | 235.7 ± 8.4 | 185.9 ± 9.3 | 156.8 ± 7.8 | 50.9 ± 3.6 | 51.5 ± 3.1 |
|                   |      | Placebo | 25 | 252.5 ± 9.1 | 242.0 ± 6.9 | 173 ± 9.1 | 169.9 ± 7.2 | 48.7 ± 2.5 | 50.7 ± 2.2 |
| Superko HR        | 2000 | Garlic  | 25 | 250 ± 29 | 246 ± 23 | 169 ± 25 | 167 ± 25 | 51.3 ± 11.5 | 51.2 ± 10.1 |
|                   |      | Placebo | 25 | 239 ± 23 | 246 ± 22 | 162 ± 18 | 159 ± 19 | 51.9 ± 12.3 | 52.1 ± 11.0 |

a = mmol/L, HDL = high density lipoprotein, LDL = low density lipoprotein, TC = serum total cholesterol, TG = triglyceride.
3.4. Sensitivity analysis

The sensitivity analysis results revealed that any of the literature can’t change the results of TC, LDL, and TG, indicating that the results of TC, LDL, and TG were stable. However, the result of HDL was reversed when removed some of the literatures (Ashraf[23] and Bordia[24]).

4. Discussion

In order to evaluate the reliability of previous studies, a meta-analysis evaluating the hypolipidemic effect of garlic was conducted in this study. Our finding revealed that the values of TC, LDL, and HDL after taking garlic in the experimental group and the control group have statistical significance. However, there was no significant difference of TG in the 2 groups.

Garlic is gained substantial interest by many researchers because of the its impact on lipid levels.[32,33] Garlic is discovered has multiple useful cardiovascular effects including reduction in cholesterol and TG, lowering of blood pressure, and enhancement of fibrinolytic activity.[34] Many studies have demonstrated that different extracts of garlic can alone lower the level of serum TC, LDL, and TG in humans and rodents.[35,36] Similarly, Maha et al[37] have revealed that the level of plasma TC and LDL-C can be decreased by adding 8% raw garlic into the diet of rats. In 1993, Warshafsky et al[38] have proved that intake of garlic can reduce the cholesterol level by about 10%. Besides, combination of lemon juice and garlic obviously decreased serum TC, LDL-C, and blood pressure.[6] Nevertheless, someone have indicated that garlic powder doesn’t reduce cholesterol levels, which may due to the loss of active compound(s) during processing.[39] Garlic may decrease the absorption of cholesterol, and the synthesis of cholesterol and fatty acid, and thereby reduces the level of cholesterol.[40] The human enzymes required in cholesterol biosynthesis such as squalene monooxygenase and HMG-CoA (3-hydroxy-3-methylglutaryl-coenzyme A) reductase can be inhibited by garlic and various constituents.[41–45] Garlic may decrease the level of LDL-C by reduction of hepatic cholesterol 7α-hydroxylase, HMG-CoA reductase, pentose-phosphate pathway activities,[46] enhancement of bile acid excretion, microsomal triglyceride transfer protein,[47] cholesteryl ester transfer protein activity,[48] bile acid excretion,[38] and prohibiting hepatic fatty acid synthesis,[49] which was conducted by allicin and/or other components in garlic.[51] Our finding showed the significant differences of TC, LDL, and HDL between the experimental group and the control group, nevertheless, the level of LG was not obviously different. Our results might suggest that the ability of garlic to lower cholesterol and LDL was better than that to lower TG.

Based on the heterogeneity test results, all results including TC, LDL, HDL, and TG were pooled using random model indicating the exist of significant heterogeneity. The appearance of heterogeneity may be due to the following reasons: garlic types were different between different articles, the patients in studies published by Ahmad Alobaidi[16] and Bordia[24] were treated via garlic oil, and that in the study of Jung et al[5] were given via aged black garlic; the dose and duration were dissimilar between different articles, indicating the dose and duration can affect the result of anti-hyperlipidemia; altered detected method might be the influencing factor; the unit of BMI/body weight was dissimilar, Ashraf,[23] Jain et al,[21] Jung et al,[5] and Peleg et al[28] evaluated the physical quality via body weight, while others evaluated that by BMI, thus, it is difficult to compare the physical quality, suggesting physical quality might also affect the results. Besides, in the present study, when removed the literatures published by Ashraf[23] and Bordia,[24] the result of HDL was reversed. The reason might be that garlic increased the level of HDL, and the participants with type 2 diabetes and coronary heart disease were enrolled in the two studies.

Figure 2. Quality assessments of the included studies. A. Sensitivity and specificity of the included studies. B. Bias risk of the included studies. “+”: low risk of bias; “-”: high risk of bias, and “?”: unclear risk of bias.
Figure 3. Comparison of TC value after garlic treatment between the experimental group and the control group. TC = serum total cholesterol.

| Study            | Experimental Total Mean SD | Control Total Mean SD | Standardised mean difference SMD 95%-CI (W[fixed]) W(random) |
|------------------|---------------------------|-----------------------|---------------------------------------------------------------|
| Adler AJ 1997    | 12 5.79 0.23              | 11 6.49 0.31          | -2.49 [-3.63; -1.35] 1.5% 6.5%                                |
| Ahmad Aloabaidi AH 2014 | 150 176.00 34.70       | 150 196.60 35.40      | -0.64 [-0.86; -0.41] 34.8% 8.4%                              |
| Ashraf R 2005    | 35 200.77 5.07            | 33 218.34 3.05        | -4.12 [-4.96; -3.26] 2.6% 7.3%                                |
| Aslam N 2016     | 27 215.30 23.00           | 28 243.10 14.20       | -1.44 [-2.04; -0.84] 5.3% 7.9%                                |
| Bordia A 1987    | 20 228.00 13.50           | 62 282.40 18.00       | -3.16 [-3.97; -2.36] 3.8% 7.8%                                |
| Jan AK 1993      | 20 247.00 40.00           | 22 274.00 29.00       | -0.76 [-1.39; -0.13] 4.7% 7.8%                                |
| Jung ES 2014     | 30 233.50 24.63           | 30 227.33 32.51       | 0.21 [-0.30; 0.72] 7.3% 8.0%                                  |
| Kannar D 2001    | 22 7.40 1.10              | 24 7.10 0.90          | -0.29 [-0.26; 0.68] 5.5% 7.9%                                 |
| Peleg A 2003     | 18 259.60 38.60           | 21 267.70 29.60       | -0.23 [-0.87; 0.40] 4.7% 7.8%                                 |
| Sathippawee P 2003 | 70 6.50 0.93              | 66 6.80 0.90          | -0.23 [-0.57; 0.11] 16.5% 8.3%                                |
| Sobenin LA 2006  | 23 6.41 0.22              | 19 7.24 0.18          | -4.01 [-5.10; -2.92] 1.6% 6.7%                                |
| Sobenin LA 2010  | 26 235.70 6.40            | 25 242.00 6.50        | -0.81 [-1.36; -0.23] 5.7% 7.9%                                |
| Superko HR 2000  | 25 248.00 23.00           | 25 248.00 22.00       | 0.00 [-0.55; 0.55] 6.1% 7.9%                                  |

Fixed effect model 478 516 -0.72 [-0.86; -0.59] 100% --
Random effects model -1.26 [-1.86; -0.66] -- 100%

Heterogeneity: I² [squared]=64.0%, tsq [squared]=1.192, p=0.0001

Figure 4. Comparison of LDL value after garlic treatment between the experimental group and the control group. LDL = low density lipoprotein.

| Study            | Experimental Total Mean SD | Control Total Mean SD | Standardised mean difference SMD 95%-CI (W[fixed]) W(random) |
|------------------|---------------------------|-----------------------|---------------------------------------------------------------|
| Adler AJ 1997    | 12 3.77 0.24              | 11 4.26 0.31          | -1.71 [-2.70; -0.73] 1.8% 7.0%                                |
| Ahmad Aloabaidi AH 2014 | 150 98.30 30.13       | 150 119.10 35.40      | -0.63 [-0.86; -0.40] 32.8% 8.5%                              |
| Ashraf R 2005    | 35 133.42 4.61            | 33 164.30 3.56        | -7.38 [-8.75; -6.02] 0.9% 5.9%                                |
| Aslam N 2016     | 27 105.10 23.00           | 28 127.20 22.20       | -0.97 [-1.53; -0.41] 5.6% 8.0%                                |
| Gardiner CDA 2007 | 49 142.00 22.00           | 48 133.00 21.00       | 0.42 [0.01; 0.82] 10.9% 8.2%                                  |
| Jan AK 1993      | 20 166.00 43.00           | 22 185.00 25.00       | -0.46 [-1.10; 0.13] 4.7% 7.9%                                |
| Jung ES 2014     | 30 155.75 21.84           | 30 163.33 29.83       | -0.02 [-0.53; 0.48] 6.9% 8.1%                                 |
| Kannar D 2001    | 22 5.40 1.10              | 24 4.90 0.90          | -0.49 [-0.10; 1.08] 5.1% 7.9%                                |
| Peleg A 2003     | 18 171.00 28.30           | 21 182.00 23.50       | -0.42 [-1.05; 0.22] 4.4% 7.8%                                |
| Sathippawee P 2003 | 70 4.52 0.77              | 66 4.65 0.63          | -0.16 [-0.90; 0.63] 15.6% 8.3%                                |
| Sobenin LA 2008  | 23 4.37 0.20              | 19 5.07 0.16          | -3.75 [-4.70; -2.71] 1.6% 6.8%                                |
| Sobenin LA 2010  | 28 155.60 7.80            | 25 159.00 7.20        | -1.87 [-2.54; -1.21] 4.0% 7.7%                                |
| Superko HR 2000  | 25 157.00 25.00           | 25 159.00 19.00       | 0.35 [-0.20; 0.91] 5.7% 8.0%                                  |

Fixed effect model 507 502 -0.48 [-0.61; -0.34] 100% --
Random effects model -1.07 [-1.67; -0.47] -- 100%

Heterogeneity: I² [squared]=64.2%, tsq [squared]=1.081, p=0.0001

Figure 5. Comparison of HDL value after garlic treatment between the experimental group and the control group. HDL = high density lipoprotein.
However, this research had some limitations as following: this study did not adjust for covariates, and no further conduct subgroup analysis due to the incomplete data of some studies; the reason why specific heterogeneity exit was not determined; the results of HDL value were unstable due to the reverse finding after removed some of the articles.

In conclusion, this study using a meta-analysis demonstrated that garlic can reduce the level of TC and LDL instead of HDL after removed some of the articles.

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\begin{table}
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
\textbf{Variable} & \textbf{Sample size} & \textbf{Test of association} & \textbf{Test of heterogeneity} & \textbf{Egger's test}\tabularnewline
& & \textbf{K} & \textbf{Cases} & \textbf{Control} & \textbf{SMD (95\% CI)} & \textbf{Z} & \textbf{P} & \textbf{Q} & \textbf{P} & \textbf{t} & \textbf{P}\tabularnewline
\hline
TC & 13 & 13 & 20 & -1.2575 [-1.8582; -0.6568] & <.0001 & Random & 198.43 & <.001 & 94.0 & 2.0722 & .0625\tabularnewline
LDL & 13 & 507 & 502 & -1.0705 [-1.6669; -0.4741] & -3.5178 & .0004 & Random & 208.50 & <.001 & 94.2 & 1.9511 & .0770\tabularnewline
HDL & 14 & 527 & 564 & 0.4986 [0.0579; 0.9394] & 2.2172 & .0266 & Random & 146.16 & <.001 & 91.1 & 1.2666 & .2293\tabularnewline
TG & 13 & 507 & 502 & -0.1616 [-0.8708; 0.5477] & -0.4465 & .6553 & Random & 295.84 & <.001 & 95.9 & 0.8989 & .3436\tabularnewline
\hline
\end{tabular}
\caption{Results of meta-analysis.}
\end{table}
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P < .05 is considered statistically significant; OR = odds ratio; CI = confidence interval; K = number of studies combined.

1 Random-effects model was used when the P for heterogeneity test < .05, otherwise the fixed-effect model was used.

2 P < .05 is considered statistically significant for Q statistics.

3 Egger’s test to evaluate publication bias.

Author contributions

Conceptualization: Weidong Wang, Yue-E Sun.
Data curation: Jie Qin.
Formal analysis: Jie Qin.
Writing – original draft: Yue-E Sun.
Writing – review and editing: Weidong Wang.

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