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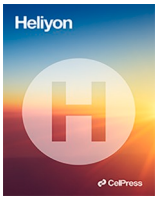

Research article

The effect of therapeutic massage on patients with obesity: A systematic review and meta-analysis

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ABSTRACT

Background: Obesity is related to various diseases such as endocrine metabolism and cardiovascular diseases. We provide an evidence-based evaluation for the effect of massage on patients with obesity.

Methods: Relevant literature published in PubMed, Embase, Web of Science, Cochrane, China National Knowledge Infrastructure (CNKI) and other databases were searched until October 2023. Meta-analysis was performed using RevMan 5.4. A p value less than 0.05 indicates a statistically significant difference.

Results: Twelve studies were finally included. Compared with conventional therapy, massage therapy were more effective, mainly in terms of (1) weight [mean difference (MD) = -3.71, 95% CI = −6.51,-0.88]; (2) body mass index (BMI), [MD = −2.00, 95%CI = −3.38, −0.62]; (3) Waist circumference (WC), [MD = −6.24, 95%CI = −8.71, −3.77]; (4) total cholesterol (TC), [MD = −0.65, 95%CI = −1.08, −0.22]; (5) triglycerides (TG), [MD = −0.92, 95%CI = −1.37, −0.47].

Conclusion: Massage therapy may be more effective for patients with obesity than conventional treatment. Given the number of studies and potential heterogeneity, more high-quality randomized controlled trials are needed to confirm our conclusions.

1. Introduction

Obesity is due to the combined effect of its own factors and environmental factors, resulting in the increase in the volume and number of fat cells in the body, resulting in an abnormally high percentage of body fat to body weight (BW) and excessive fat deposition in certain localities, the root cause of which is that the body's caloric intake is much greater than its caloric consumption. Body Mass Index (BMI) is considered to be the easiest and most effective way to confirm a diagnosis of obesity. An adult with a BMI between 25.0 and 29.9 kg/m^2 is defined as overweight, and if it exceeds 30 kg/m^2 it is defined as obesity [1]. In 2016 there were already 1.9 billion overweight adults (18 years and older) in the world, including 650 million adults with obesity, and up to 13% of adults worldwide were obese [2]. Without effective solutions, the global prevalence of obesity will reach 18% in men and more than 21% in women by 2025 [3]. Excessive obesity can lead to more than 200 related chronic diseases such as cardiovascular disease, diabetes, osteoarthritis and other skeletal and muscular diseases, and cancer [1]. The quality of life of patients with obesity is affected,

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and in severe cases they are threatened by disease and death [4]. This will relate to family financial burden and social health care coverage issues, while the growing population of patients with obesity has a test on the social workforce [5]. The obesity epidemic does not occur in relation to ethnicity, age, or culture, and can affect the healthy development of the entire human race.

Currently, patients with obesity are mostly treated with lifestyle interventions such as diet, exercise, psychology and other methods such as drugs and surgery. Lifestyle interventions are healthier and less financially burdensome than drug and surgical treatments. Studies have found that this approach can achieve up to 5% weight loss from initial BW. However, for this approach patients have poor compliance and need to have a high level of self-control in the long term, otherwise their weight will rebound, which is difficult for many patients with obesity [6]. For long-term weight loss, medication or surgery is currently the most common treatment. The main available medications include sympathomimetics, pancreatic lipase inhibitors, $GABA_A$ receptor activators, a serotonin 2C receptor agonist, opioid antagonist, dopamine–norepinephrine reuptake inhibitor, and glucagon-like peptide-1 (GLP-1) receptor agonists, which can be effective in helping patients lose weight. However, there are also many requirements for the selection of drugs, such as the need for body mass over 30 kg/m^2, the presence of type 2 diabetes, and cardiovascular disease, so they need to be taken only under the guidance of a physician [7]. Although weight loss drugs are effective, studies have shown that they need to be taken for a long time to maintain weight, and once you stop taking them, you will experience weight regain, which is not good for the financial stress and health of patients with obesity. Surgical weight loss is currently a more promising treatment for long-term weight loss by reducing stomach volume and nutrient absorption. Surgery can be used if the patient has a body mass between 35 and 40 kg/m^2 in combination with diabetes, cardiovascular disease or a body mass above 40 kg/m^2, thus reducing the probability of death from obesity and metabolic disease from 40% to 23% [8]. Although the results of surgical treatment are obvious, the damage to the body is just as great. Surgical removal destroys the normal organ structure of the body, the damage is irreversible, and the effects of surgical treatment on the body are unforeseeable for years afterwards.

With a large base of patients with obesity, the mortality and morbidity of metabolic diseases due to obesity cannot be underestimated, and it becomes especially important to improve the obesity status and lipid levels of patients. Common treatment options have certain drawbacks, so there is an urgent need for an effective option that is less financially stressful, has no toxic side effects, and has a shorter treatment period. We found from complementary medicine that Massage treatment for patients with obesity meets the above requirements and can improve patients' body shape and blood lipid level as soon as possible with safe and non-toxic side effects, thus achieving the effect of weight loss.

Massage uses the treatment method of "unblocking the meridians" and "regulating the qi and blood" to achieve the effect of regulating the qi and blood of the whole body and helping to dispel diseases by manipulating the meridians and acupuncture points. In contrast, the treatment of obesity by Massage has a broad base of prior clinical and experimental studies [9,10] and is valuable for further research. In this study, we systematically evaluated the existing research reports related to the treatment of simple obesity patients with Massage manipulation based on the external treatment method of Massage in Chinese medicine, and explored the efficacy related to the treatment of simple obesity with Massage to provide more effective solutions for the clinical treatment of simple obesity.

2. Methods

2.1. Inclusion and exclusion criteria

2.1.1. Inclusion criteria

(1) The included study design was a randomized controlled trial (RCT);
(2) We included adult patients with obesity, and the definition of obesity depended on the researchers in the literature.
(3) The experimental intervention was massage therapy, with no restrictions on types of massage, duration of massage, locations of treatments. The control intervention included placebo or conventional treatment;
(4) Consider that there is great heterogeneity in the definition of total effectiveness among studies. We only performed meta-analysis on objective outcome measures. Our primary outcome was BMI after intervention. Secondary outcomes included post-intervention BW, waist circumference (WC), waist-to-hip ratio (WHR), and laboratory findings.

2.1.2. Exclusion criteria

(1) Tuina combined with other complementary and alternative therapies such as moxibustion or acupuncture were excluded;
(2) Patients with obesity with other medical conditions were excluded;
(3) Studies on minors, pregnant women and postpartum women were excluded;
(4) For multiple studies that included people from the same source, the study with the largest sample size was selected for inclusion;
(5) Studies that did not report results on objective outcome measures were excluded for meta-analysis;

2.2. Search strategy

We systematically searched PubMed, EMBASE, Web of Science, Cochrane library, China National Knowledge Infrastructure, Wanfang database, VIP database, and SinoMed from inception to 22 October 2023 for RCTs assessing the effectiveness of massage for patients with obesity. The following search terms were used in combination: (Massage OR Tuina OR Tui Na OR anmo OR manipulation

OR Massage Therapy OR therapeutic massage OR Zone Therapy OR Zone Therapies OR musculoskeletal manipulations) AND (obesity OR obes* OR adiposity OR adiposis OR obese OR adipose OR fat OR overweight) AND (randomized controlled trial OR randomized controlled OR controlled trial OR clinical trial OR randomized OR randomised OR randomly OR randomization OR randomization OR random allocation OR blind OR placebo). Supplementary Table 1 outlined the detailed search strategies of these databases. In addition, we also checked the list of available original studies and reviews to avoid missing any relevant studies. The literature search was conducted by two individuals independently and disagreements were solved by third individual.

2.3. Study selection and data extraction

According to pre-established inclusion and exclusion criteria, all identified literature underwent a three-step parallel review of the title, abstract, and full text. Two investigators independently completed this process without language restriction, and any discrepancies were resolved by the third investigator. Data extraction was independently conducted by two investigators. The following study characteristics were extracted from each included study: basic information of the study (first author, year of publication, country), study design, number of patients, demographic characteristics (age and sex), baseline weight and BMI, experimental interventions (including types of massage, duration of massage, locations of treatments), control interventions, and reported outcome indictors. In case of dispute over the extracted data, it is still referred to a third informant for final decision.

2.4. Quality evaluation

For final inclusion in the study, the literature was collated according to the Cochrane Evaluation Manual requirements. (1) Selection bias: (i) Whether the random assignment method describes in detail the method used to generate the random assignment sequence so that comparability between groups can be assessed; (ii) Whether the person implementing the allocation in the allocation program covertly has strictly implemented the results of random numbers. (2) Implementation bias: subjects, whether or not the investigator was blinded. (3) Measurement bias: whether the assessors were all blinded. (4) Follow-up bias: whether the outcome data are complete and whether the shedding cases (missed visits, withdrawals, non-compliance) are kept within a very small range to ensure a balance of shedding cases between groups. (5) Reporting bias: whether one selectively reports results favorable to one's research direction and can conceal results unfavorable to one's own. (6) Other sources of bias: conflict of interest, small sample size, and non-equilibrium at baseline.

For each of the included studies, bias was judged and marked by the two investigators in a pre-designed data collation form according to the prescribed symbols according to the seven points mentioned above: "$\surd$" indicates low bias, "?" indicates unknown risk, and " $\times$ " indicates high bias. In case of disagreement, a third researcher will be sought researcher for the final decision. The results were

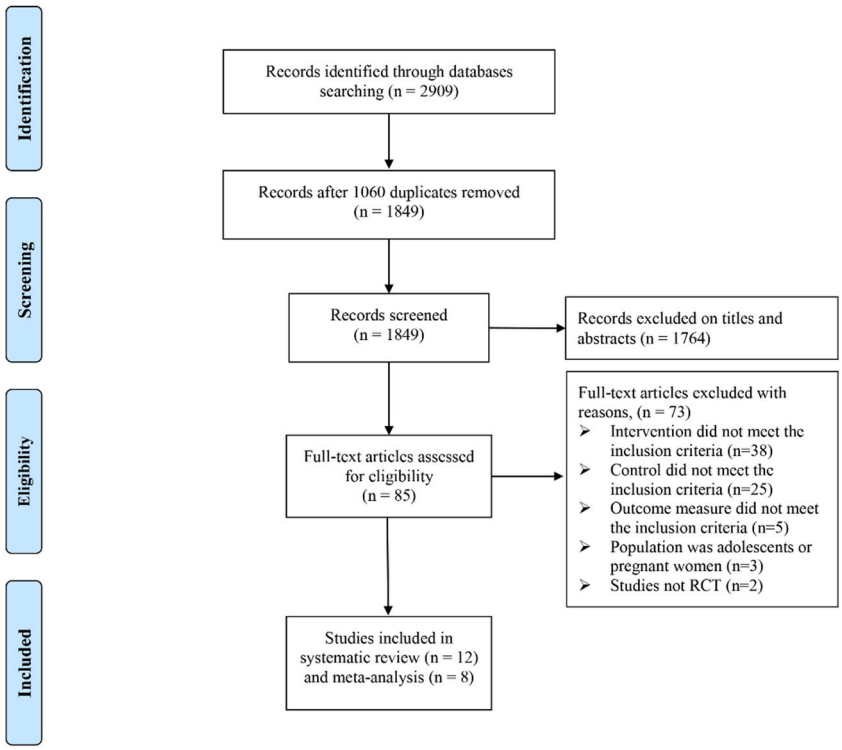

Fig. 1. Flowchart of literature selection.

Table 1
The characteristics of the included studies.

First author, year	Sample size (E/C)	Age, years (E/C)	Male ratio (E/C)	Baseline weight, kg (E/C)	Baseline BMI, kg (E/C)	Experimental intervention	Control intervention	Outcome
Zhang XL, 2022	30/30	66.53 ± 5.61/69.03 ± 5.23	0/0	79.52 ± 5.41/77.73 ± 5.33	30.30 ± 2.31/30.06 ± 2.06	Yunfu Tongjing Tuina (15 min each time, once a day) + Metformin, 8 weeks	Metformin, 8 weeks	BW, BMI, WC, HC, WHR, LP, TNF-α, IL-6
Ni YP, 2017	45/45	41.4 ± 7.5/ 40.3 ± 6.7	29/30	NR	27.1 ± 1.5/ 27.6 ± 1.1	Tuina + Diet and exercise, 5 months	Diet and exercise, 5 months	BMI, SSS, FAI
Wang L, 2015	211/214	37.58 ± 11.67/36.21 ± 10.84	67/77	NR	NR	TuiNa for strengthening the spleen and dispelling dampness (40 min each time, 3 times a week) + Balanced diet and exercise, 8 weeks	Balanced diet and exercise, 8 weeks	Therapeutic efficacy, Total Symptom Score, Total Signs Score
Jiang SC, 2014	12/12	28.4 ± 3.9/ 29.5 ± 5.4	0/0	77.3 ± 3.6/ 77.7 ± 4.0	29.9 ± 1.1/ 29.7 ± 0.9	Acupressure massage (25 min each time, once a day, 6 times a week) + Aerobic exercise and Diet control, 12 weeks	Aerobic exercise and Diet control, 12 weeks	BW, BMI, TG, TC, Fat Weight, PBF, Muscle mass, HDL-C, LDL-C
Yan BH, 2014	30/30	30–55/ 25–53	2/4	75.3 ± 12.3/ 74.9 ± 11.7	27.89 ± 1.76/27.77 ± 1.65	Meridian massage (3 times a week) + Diet and exercise, 8 weeks	Diet and exercise, 8 weeks	BW, BMI, WC, HC, therapeutic efficacy
Huang JJ, 2013	50/50	37.04 ± 9.14/36.52 ± 8.77	13/14	NR	NR	TuiNa for soothing liver and invigorating spleen massage (Once a day for the first 5 days, then once every other day, 20 times for a course of treatment, rest for 5 days and then the next course of treatment), 2 course of treatment	Orlistat Capsules, 3 months	Therapeutic efficacy
Li HM, 2010	33/34	19–64/ 19–62	12/8	93.3 ± 4.1/ 91.3 ± 4.9	33.7 ± 0.9/ 34.4 ± 1.4	Tuina (40 min each time, 3 times a week) + Balanced diet and exercise, 8 weeks	Balanced diet and exercise, 8 weeks	BW, BMI, WC, HC, therapeutic efficacy, PBF
Wang BL, 2010	30/30	18–65	NR	NR	NR	Viscera and Meridian Acupoint Tuina (40 min each time, 3 times a week) + Balanced diet and exercise, 8 weeks	Balanced diet and exercise, 8 weeks	TG, TC, HDL-C, LDL-C
Guo X, 2008	50/50	21.24 ± 5.78/22.36 ± 7.58	19/22	25.25 ± 3.59/24.78 ± 4.87	NR	Meridian Tuina (Once a day for the first 5 days, then once every other day, 20 times for a course of treatment, rest for 5 days and then the next course of treatment), 2 course of treatment	Sibutramine Tablets, 2 course of treatment	TG, therapeutic efficacy, Ins
Shao XN, 2007	100/100	21.24 ± 5.78/22.36 ± 7.58	15/28	NR	NR	Meridian Tuina (Once a day for the first 5 days, then once every other day, 20 times for a course of treatment, rest for 5 days and then the next course of treatment), 2 course of treatment	Sibutramine Tablets, 2 course of treatment	Therapeutic efficacy, Ins
Shao XN, 2006	30/30	28.98/30.12	8/9	NR	NR	Meridian Tuina (Once a day for the first 5 days, then once every other day, 20 times for a course of treatment, rest for 5 days and then the next course of treatment), 2 course of treatment	Sibutramine Tablets, 2 course of treatment	Therapeutic efficacy
Che XD, 2005	30/30	36.12 ± 9.76/35.86 ± 10.24	12/14	78.64 ± 7.22/78.56 ± 8.34	29.46 ± 3.26/28.36 ± 4.68	Abdominal Tuina (30 min each time, 3 times a week), 12 weeks	Sibutramine Hydrochloride Capsules, 12 weeks	BW, WC, therapeutic efficacy, TCM syndrome curative effect

E: Experimental intervention group, C: Control intervention group, y: years, m: months, w: weeks, NR: Not reported. Follow up refers to follow up duration after the end of the treatment. BW: body weight, BMI: body mass index, WC: waist circumference, HC: hip circumference, WHR: waist-to-hip ratio, LP: leptin, TNF-α: tumor necrosis factor-α, IL-6: interleukins-6, TG: triglycerides, TC: total cholesterol, SSS: Self-Rating Scale for Somatization Symptoms, FAI: Fatigue Assessment Instrument, PBF: body fat percentage HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol, Ins: insulin.

finally mapped by the Cochrane Collaboration's "Risk of Bias Assessment" tool, RevMan5.4, for study content bias.

2.5. Statistical analysis

Meta-analysis of the outcome indicators was performed by RevMan5.4. The statistics were first combined using mean difference (MD) or standardized mean difference (SMD) for continuous variables. Heterogeneity among the studies was assessed the using the I^2 statistic. I^2 values of 25%, 50% and 75% as cut-off points represented low, moderate and high degrees of heterogeneity, respectively. The random-effect model was used because there was great heterogeneity in massage intervention. We planned to perform publication bias by funnel plots if the number of the included RCTs were no less than ten. However, we did not perform publication bias because of the limited included trials. Lastly, for results with considerable heterogeneity (I^2), we conducted sensitivity analysis by systematically

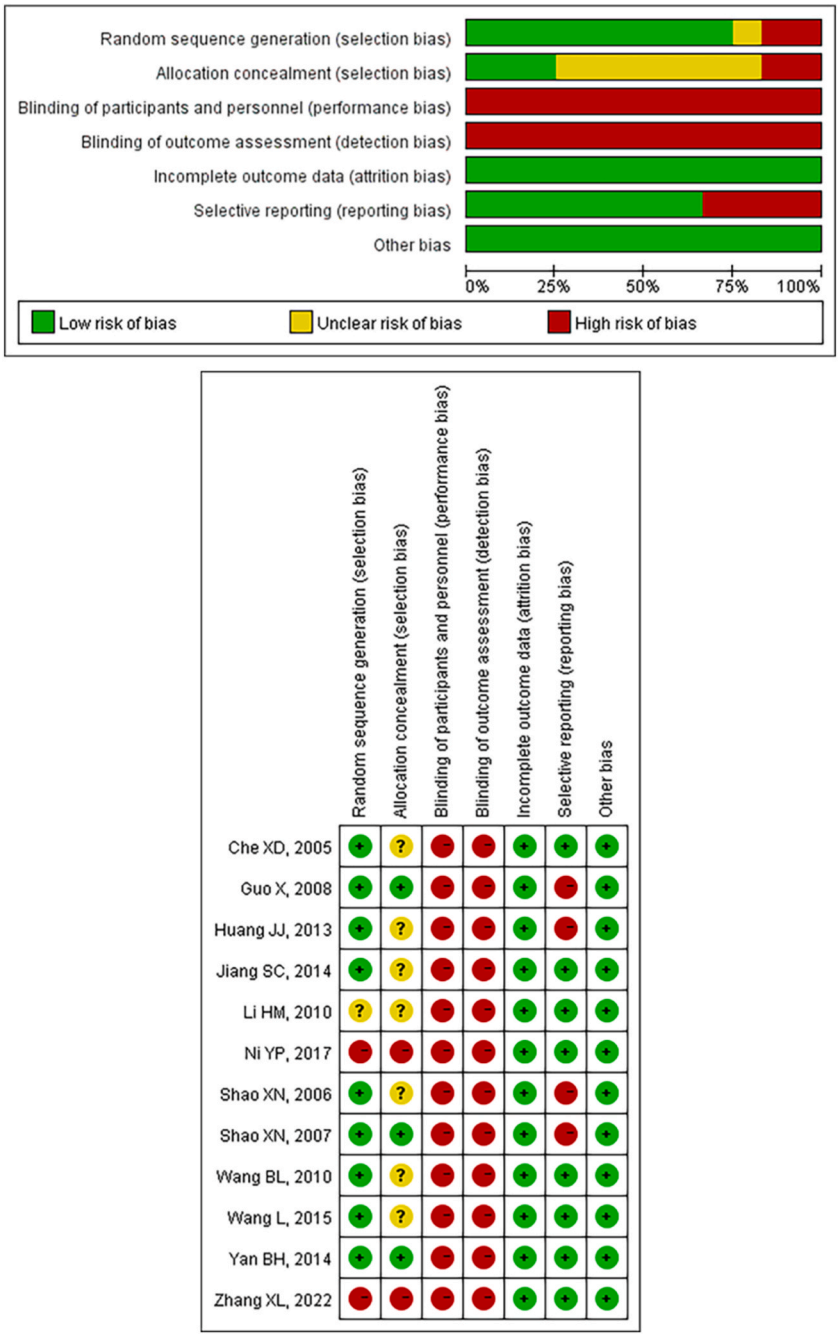

Fig. 2. Overall quality assessment of included studies.

omitting one study at a time and examining the impact of each individual study on the overall effect size. Sensitivity analysis was done with R software by means of meta package.

3. Results

3.1. Literature search results

A comprehensive search summary was conducted according to the developed search strategy, and a total of 2909 potentially related studies were retrieved, and 1764 studies were excluded by reviewing titles and abstracts. Then, 85 studies were identified and retrieved for full-text screening. Finally, 12 studies [11–22] were included in systematic review and 8 studies [15–22] in meta-analysis. The specific screening process is detailed in Fig. 1.

3.2. Basic characteristics of the included literature

The characteristics of 12 randomized controlled trails, which included 1306 participants and were published between 2005 and 2022, were shown in Table 1. Two studies explored the effect only in females, nine studies in males and females, and one studies did not mention gender composition. Five studies reported the baseline weight, and average weight of all studies were higher than 70 kg. The average baseline BMI was reported in seven studies, two of which were greater than 30 kg/m^2, and 5 were less than 30 kg/m^2. There were three types of experimental intervention used in experimental groups, including the use of massage alone (n = 5), the use of massage and healthy lifestyle (n = 6), and the use of massage and metformin (n = 1). In addition, the control intervention used in control groups include healthy lifestyle (n = 6) and medicine (n = 6). The primary outcomes of the included studies included therapeutic efficacy, BMI, BW, WC, HC, WHR, TC, TG, and so on.

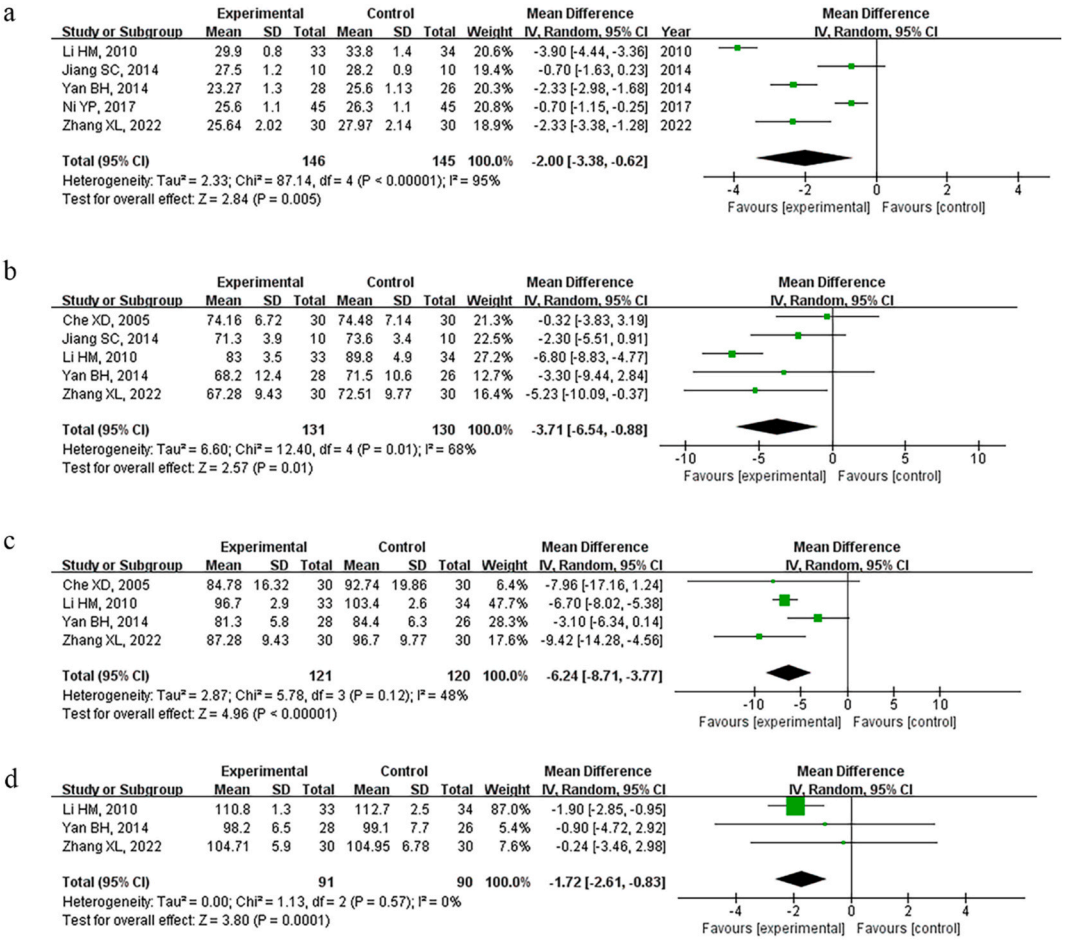

Fig. 3. Effect of massage on obesity status in simple obesity. a) BMI, b) BW, c) WC, d) HC.

3.3. Evaluation of literature bias

The risk of bias of included studies was assessed using the Cochrane risk of bias assessment tool. Blinding of participants and personnel, blinding of outcome assessment, and selective reporting were showing a high risk of bias. Whereas, the incomplete outcome data and other bias were showing a low risk of bias in all the included RCTs. The detailed information is summarized in Fig. 2.

3.4. Meta-analysis results

A total of five eligible RCTs (n = 291) were included in the meta-analysis to examine massage effectiveness on BMI (Fig. 3a). Massage was significantly more effective than controls in reducing BMI for simple obesity (MD = −2.00; 95%CI: 3.38, −0.62; $I^2 = 95\%$; P = 0.005). Five RCTs (n = 261) investigated the effect of massage on BW (Fig. 3b). Massage was significantly more effective in reducing BW compared to control with moderate heterogeneity (MD = −3.71; 95%CI: 6.54, −0.88; $I^2 = 68\%$; P = 0.010). In addition, four RCTs (n = 241) investigated the effect of massage on WC (Fig. 3c). Massage significantly reduced WC of simple obesity with small heterogeneity (MD = −6.24; 95%CI: 8.71, −3.77; $I^2 = 48\%$; P < 0.001). Furthermore, three studies (n = 181) investigated the therapeutic effects of massage on HC of simple obesity (Fig. 3d). The pooled estimate of RCTs of the effect of massage on HC has shown a significant reduction (MD = −1.72; 95%CI: 2.61, −0.83; $I^2 = 0\%$; P < 0.001) when compared to the control group in simple obesity patients.

Three studies (n = 180) focused the effects of massage on TG (Fig. 4a). The summary estimate showed that the effect of massage on TG has shown a significant reduction (MD = −0.92; 95%CI: 1.37, −0.47; $I^2 = 71\%$; P < 0.001) than the control group in simple obesity patients. Finally, two RCTs (n = 80) reported the effect of massage on TC (Fig. 4b). The pooled estimate showed that massage significantly reduced TC of simple obesity with no heterogeneity (MD = −0.65; 95%CI: 1.08, −0.22; $I^2 = 0\%$; P = 0.003).

The sensitivity analysis results for BMI, BW, and TG were presented in Fig. 5. All sensitivity analysis results demonstrated the robustness of our study findings. After excluding the study by Li HM et al., the heterogeneity in the meta-analysis of BW significantly decreased ($I^2 = 0\%$), indicating that it may be the source of heterogeneity (Fig. 5b). In addition, the heterogeneity in the meta-analysis of TG significantly decreased ($I^2 = 0\%$) after excluding the study by Jiang SC et al., indicating that it may be the source of heterogeneity (Fig. 5c). However, our quantitative analysis results did not identify any potential sources of heterogeneity regarding BMI (Fig. 5a).

4. Discussion

Obesity is not an independent single disease, it is the external manifestation of the body's endocrine metabolism disorder, while more terrible is that it will cause a variety of chronic diseases including diabetes, cardiovascular disease, etc., and these diseases will seriously affect people's quality of life, increase the medical and economic burden, and even accelerate death. Chinese medicine believes that obesity is due to excess nutrition, physical weakness, aging, low exercise and other factors, resulting in excessive phlegm and dampness in the body, long-term stagnation and formation. The main mechanism of action of Massage in treating simple obesity is to stimulate the acupuncture points and meridians of human body through external treatment techniques, so as to harmonize the internal organs, dredge the meridians and promote the metabolism of qi, blood and fluid, and achieve the effect of tonifying qi and strengthening spleen, dispelling dampness and resolving phlegm. Modern medicine believes that the effect of Massage on the body's muscle surface can effectively stimulate the blood circulation system, thus increasing the body's metabolism and consuming excess sugar and fat through circulatory metabolism. At the same time, current molecular biology studies suggest that the insulin/IGF axis and adipokines (adiponectin, leptin and resistin) are the main causes of obesity development. Not only that, we have also made some new discoveries in the field of genomics, genetic markers, proteomics, metabolomics, microbiota and other studies [23]. For example, appetite suppression can be achieved by modulating the levels of the neurohormones ghrelin, GAS, and NPY through Massage [9]. By

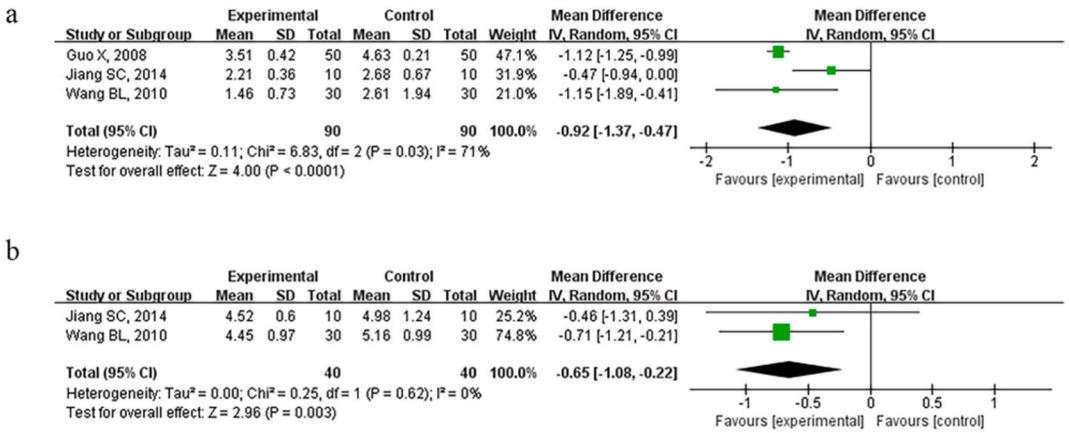

Fig. 4. Effect of massage on lipid levels in simple obesity. a) TG and b) TC.

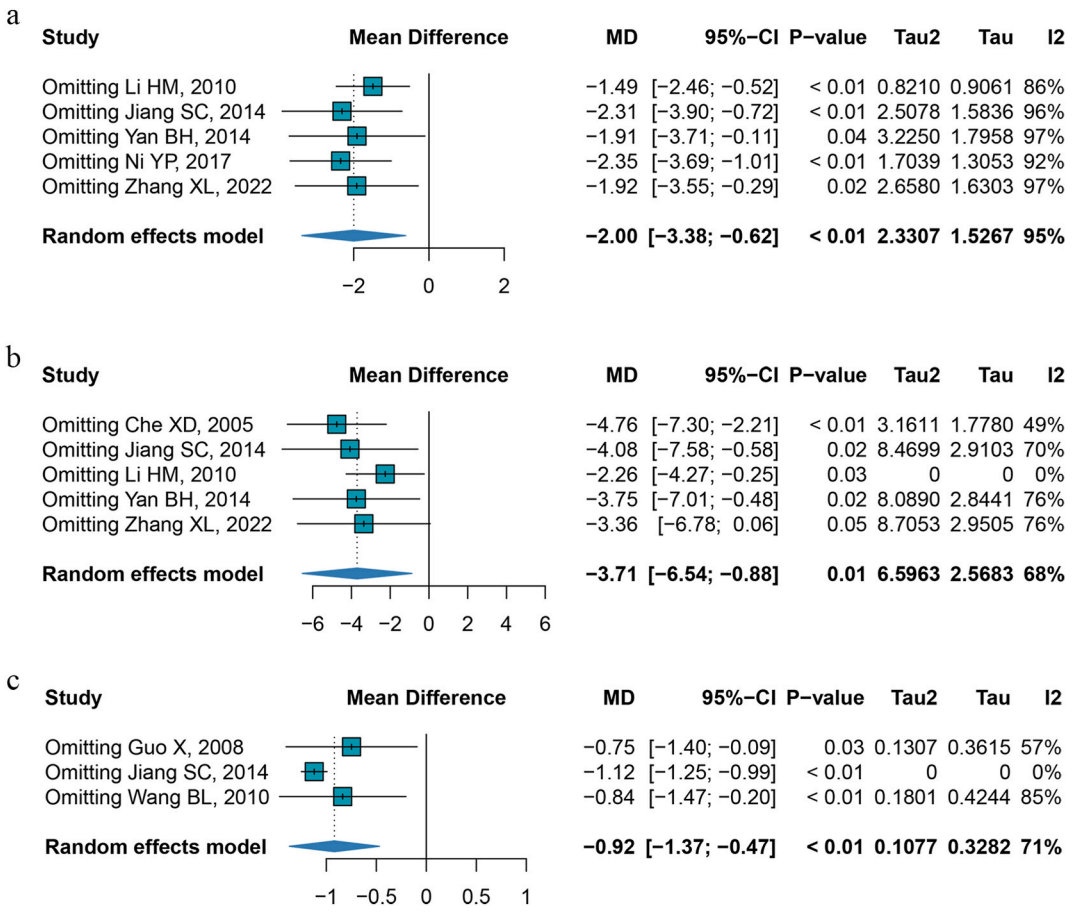

Fig. 5. The sensitivity analysis results for a) BMI, b)BW, and c)TG.

stimulating TLR4 signaling pathway through pushing, the mRNA and protein expression levels of MyD88 and NF-κB signaling pathway were inhibited, which effectively inhibited adipose inflammatory cytokine secretion and controlled the morphological changes of adipocytes thus playing a role in fat reduction [24]. Research on the treatment of obesity by Massage is being enriched and improved from clinical to experimental, providing new ideas for the treatment of obesity.

This study is the first systematic evaluation for the efficacy of Massage manipulation on obsess patients, which will fill the research gap. By conducting meta-analysis and organizing and re-analyzing the existing clinical observation data, it will provide higher quality evidence and guidance for clinical treatment of obesity. The results of meta-analysis showed that massage significantly improved metabolic outcomes in patients with obesity compared to conventional treatment. We also found some issues that need to be elucidated and clarified. First, the methodological quality of the RCTs included in this meta-analysis was low, which may have led to a reduction in the strength of our conclusions. In addition, the whole study population is from China, which makes the extrapolation of our research conclusions weak. Future studies on the effects of massage intervention in patients with obesity of other ethnicities are necessary. Second, our results were susceptible to heterogeneity. Sources of heterogeneity may include differences in the definition of obesity, differences in massage interventions (e.g., manipulation, location and duration of massage), and differences in comparisons. However, due to the smaller number into the literature we failed to carry out further subgroup analysis and meta-regression. Our conclusions need to be interpreted with caution, taking into account the effect of potential heterogeneity. Although results are subject to heterogeneity, most studies have concluded that massage is beneficial for patients with obesity. Our findings provide a potential direction for non-drug treatment of patients with obesity. Future international multicenter studies need to confirm our findings with larger samples. Third, considering the large differences in the definition of subjective indicators, we only considered objective outcome indicators in the subsequent meta-analysis. A smaller sample size may result in lower statistical power.

Through this Meta-analysis, we found that TCM Massage can effectively improve metabolic outcomes among patients with obesity, which will provide more options for clinical treatment. At the same time, it is expected that more high-quality clinical trial studies will be conducted in the future to exclude as much as possible the influence of various factors such as ethnicity, age, massage treatment method, treatment duration, and definition of obesity on the experimental results. Standardize trial design, realize double-blind trials as much as possible, and do follow-up. Improve the rigor and meticulousness of clinical research, and provide more accurate, detailed and in-depth reporting of clinical research results. At the same time, we will accelerate the establishment and improvement of

international standard evaluation of research indicators for simple patients with obesity. To provide more high-quality and high-level evidence-based evidence for clinical Massage manipulation in the treatment of simple obesity, to promote the rapid development of Chinese medicine, and to provide more powerful medical protection for the majority of patients.

Registration and protocol

This study has been registered on the PROSPERO platform (www.crd.york.ac.uk/prospero/): Registration number, CRD42023400132.

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Data availability

All data in this study are included in the article.

Ethics declarations

Review and/or approval by an ethics committee was not needed for this study because it was a statistical analysis of available reports, no patient privacy issues were involved.

CRediT authorship contribution statement

Zhengri Cong: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Yuxing Tai:** Visualization, Validation, Supervision. **Tianjiao Gao:** Writing – review & editing, Validation. **Long Zhang:** Investigation, Data curation. **Rongsheng Jiang:** Investigation, Data curation. **Peizhe Li:** Investigation, Data curation. **Mingjun Liu:** Writing – review & editing, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e28791.

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