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REVIEW

Acupuncture for obesity: a systematic review and meta-analysis

S-H Cho[1], J-S Lee[2], L Thabane[3,4] and J Lee[2,4]

[1]*Hospital of Korean Medicine, Kyung Hee University Medical Center, Seoul, Korea;* [2]*Department of Biostatistics, College of Medicine, Korea University, Seoul, Korea;* [3]*Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada and* [4]*Biostatistics Unit, FSORC, St. Joseph's Hospital Hamilton, Hamilton, Ontario, Canada*

Background and Objective: Acupuncture is widely used in complementary and alternative medicine to reduce body weight. However, a systematic review and meta-analysis to assess an effect of acupuncture has not yet been performed. Aim of this study is to critically assess evidence for reduction of body weight and to evaluate adverse events of acupuncture therapy based on the results of randomized controlled trials (RCTs) that evaluate the effect of various types of acupuncture therapies.
Data sources: A total of 19 electronic databases, including English, Korean, Japanese and Chinese databases, were systematically searched for RCTs of acupuncture for reduction of body weight or improvement in obesity up to March 2008 with no language restrictions.
Methods: RCTs for acupuncture compared either with placebo controlled or with comparator intervention were considered. Studies' methodological qualities were assessed using the Jadad scale. If no evidence of heterogeneity existed across study results, statistical pooling of data was performed using a fixed effects model; otherwise, a random effects model was used. Publication bias was assessed using funnel plots. Subgroup analyses were performed according to types of acupuncture.
Results: A total of 31 studies, which comprised a total of 3013 individual cases, were systematically reviewed. Owing to insufficient data in 2 RCTs, 29 RCTs were used for meta-analysis. About two-thirds of the trials (20 out of 31) showed the lowest score of the Jadad. Compared to control of lifestyle, acupuncture was associated with a significant reduction of average body weight (95% confidence interval, CI) of 1.72 kg (0.50–2.93 kg) and associated with an improvement in obesity (relative risk = 2.57; 95% CI, 1.98–3.34). Acupuncture significantly reduced a body weight of 1.56 kg (0.74–2.38 kg), on average, compared to placebo or sham treatments. Acupuncture also showed more improved outcomes for body weight (mean difference = 1.90 kg; 1.66–2.13 kg), as well as for obesity (relative risk = 1.13; 1.04–1.22), than conventional medication. Only four RCTs reported acupuncture-related adverse events, which were mostly minimal.
Conclusions: Our review suggests that acupuncture is an effective treatment for obesity. However, the amount of evidence is not fully convincing because of the poor methodological quality of trials reviewed. In conclusion, there is an urgent need for well-planned, long-term studies to address the effectiveness of acupuncture for treating obesity.
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Keywords: acupuncture; weight management; systematic review; meta-analysis

Introduction

Obesity is an increasingly prevalent chronic condition that is associated with serious morbidity and mortality. Excess bodyweight is the sixth most important risk factor contributing to the overall burden of disease worldwide. Indeed, a total of 1.1 billion adults and 10% of children are now classified as overweight or obese.[1] Obesity may be defined as the degree of fat storage associated with clearly elevated health risks.[2] The graded classification of obesity and overweight status according to body mass index (BMI) is accepted by many countries. According to the World Health Organization guidelines, a BMI of over 25.00 kg m^{-2} is defined as overweight, 25.00–29.99 kg m^{-2} as preobese, and over 30.00 kg m^{-2} as obese; the normal range is 18.50–24.99 kg m^{-2}.[3]

There is a growing tendency for people to turn to complementary and alternative medicine. Combined with this tendency, the increasing prevalence of obesity creates an expanding market for alternative modes of therapy to aid

Correspondence: Professor J Lee, Department of Biostatistics, College of Medicine, Korea University, 126-1, 5-Ka, Anam-Dong, Sungbuk-Gu, Seoul 136-705, Korea.
E-mail: jyleeuf@korea.ac.kr
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weight management.[4] Among current modalities of complementary and alternative medicine, acupuncture is one of the most widely used therapies.[5] Acupuncture appears to be effective for control of postoperative or chemotherapy-related nausea and vomiting, as well as for postoperative dental pain.[6,7] It also can improve appetite, intestinal motility, metabolism, as well as emotional factors such as stress. Further, researches show that the application of acupuncture can cause increases in neural activity associated with the ventromedial nuclei of the hypothalamus, the tone of the smooth muscle of the stomach, and levels of enkephalin, β-endorphin and serotonin in plasma and brain tissue.[8,9]

Despite the above results, the effectiveness of acupuncture on obesity has not been fully understood. Lacey *et al*.[10] reviewed seven randomized controlled trials (RCTs) and reported a modest positive effect of acupuncture for weight loss, although his review was nonsystematic. Meanwhile, Ernst[11] reported an inconclusive result regarding the efficacy of acupuncture on weight loss based on a systematic review, but without a meta-analysis, of four RCTs. Further, with an overview of seven RCTs including the four trials reviewed by Ernst,[11] Ernst and White[12] conclusively reported that acupuncture for weight loss was not effective. On the basis of these studies, other researchers have suggested that acupuncture is not an effective weight loss treatment modality.[13–15] A recently conducted systematic review of Pittler and Ernst[16] reported that there was insufficient, but not conclusive evidence to support the efficacy of acupuncture and acupressure for weight loss. However, Pittler and Ernst's[16] review was based on four RCTs, which consisted of three articles published in Western journals and one in a Chinese journal. Therefore, a systematic review of RCTs, using a meta-analysis, having more detailed search without language restriction is necessary to rigorously and quantitatively evaluate the efficacy of acupuncture for treating obesity, and to reconcile the different conclusions reached by previous reviews.

Recently several RCTs of acupuncture for reducing weight have been published; however, no meta-analysis examining the efficacy of acupuncture for reducing weight has been performed. Thus, as the first review without restricting the language of publication, this systematic review was conducted to critically assess evidence from RCTs regarding the efficacy of various types of acupuncture therapy for reducing body weight.

Methods

Objectives

The primary objective of this review was to assess whether acupuncture therapies—which include classical acupuncture, electroacupuncture, laser acupuncture, acupressure, auricular acupuncture, auricular acupressure, auricular electroacupuncture and acupoint—are not only more effective than placebo but also as effective as conventional therapies to treat obesity. The secondary objective was to describe the frequency and types of adverse events or adverse reactions of acupuncture reported in clinical trials.

Data sources

The following sources were searched up to March 2008: the Cochrane Library, including the Cochrane Central Register of Controlled Trials (CENTRAL, 2008), MEDLINE, EMBASE, Allied and Complementary Medicine Database (AMED), CINAHL, PsycInfo, Korean medical databases (which include the National Assembly Library,[17] KoreaMed,[18] Korean Studies Information Service System,[19] DBpia,[20] and Korea Institute of Science Technology Information and Research Information Service System[21]), Japanese database (Japan Science and Technology Information Aggregator Electronic)[22] and Chinese database (which include the China Academic Journal, Century Journal Project, China Doctor/Master Dissertation Full Text DB and China Proceedings Conference Full Text DB).[23] We also searched the databases of clinical trials such as Current Controlled Trials (http://www.controlled-trial.com), the National Centre for Complementary and Alternative Medicine (NCCAM) at the National Institutes of Health (NIH) (http://nccam.nih.gov/), and the Complementary and Alternative Medicine Specialist Library at the NHS National Library for Health (http://www.library.nhs.uk/cam/).

Key words used to search RCTs were ('acupuncture' OR 'electroacupuncture' OR 'acupressure' OR 'meridian' OR 'acupoint') AND ('obesity' OR 'weight loss' OR 'weight control' OR 'weight reduction' OR 'weight increase' OR 'weight decrease' OR 'weight watch' OR 'overweight' OR 'overeat' OR 'overfeed' OR 'slim'). As all of the various databases utilized for this study possessed their own subject headings, each database was searched independently.

Study selection (inclusion and exclusion criteria)

Types of studies. Our review was restricted to RCTs that compared acupuncture or its variants with a control group, which included no treatment, placebo treatment, pharmacological or nonpharmacological treatments, to assess the efficacy of acupuncture on obesity and weight loss. No restriction was imposed on studies with respect to blinding and the type of design such as parallel or crossover. Also, no language restriction was made for selecting studies.

Types of participants. We included all ages of participant, including children, defined as overweight/obese at baseline to assess effects of acupuncture on obesity or bodyweight loss. In defining overweight or obese status, criteria using either BMI cutoff points or percentage of weight excess compared with ideal weight/height tables were accepted.

Pregnant women and patients with serious medical conditions, such as drug-induced obesity, were excluded.

Types of intervention. Clinical trials evaluating all forms of acupuncture treatments, specifically, classical acupuncture, electroacupuncture, laser acupuncture, acupressure and acupoint, were included. Both traditional acupuncture (classical meridian points) and contemporary acupuncture (nonmeridian or trigger points) were included if the points of stimulation were acupuncture-related (for example, hand, needle, laser or electrical stimulation excluding moxibustion). Studies that assessed the combined effect of acupuncture with other therapies (for example, acupuncture and massage therapy or acupuncture and moxibustion therapy) were excluded because the purpose of our review was to assess the effects of acupuncture alone on obesity or weight loss. Trials that compared different forms of acupuncture to each other were also excluded. Types of control interventions considered in this review included no treatment (wait-listed or treatment as usual), placebo-controlled (sham acupuncture, minimal acupuncture or non-invasively controlled), pharmacological treatment (standard medication to treat obesity) or nonpharmacological interventions (such as dietary or physical activity interventions).

Types of outcome measures. The primary outcome was change in weight (absolute or percentage scales) or change of BMI in terms of body weight content. Secondary outcomes assessed were frequency of adverse events which included bleeding in ears, mild ecchymosis, abdominal discomfort and other mild effects such as dry mouth, headaches, sleepiness, hypertension, palpitations and dizziness.

Data abstraction and quality assessment

Information was abstracted independently by two reviewers (SHC and JSL) who were blinded to each other's coding but not to treatment group. Interrater agreement for data extraction was 98% in general. Data extraction was conducted according to predefined criteria using standard data extraction forms. These reviewers also independently evaluated the quality of the methodology of the RCTs using the Jadad scoring system.[24] Interrater agreement for quality scores was 70%, the low percentage mainly due to discrepancy of evaluating randomization of trials that merely state the phrase without further mentioning its process such as a concealment of allocation. A study that stated the phrase 'randomization' in its text was regarded as a randomized trial after discussion between two reviewers. Agreement for quality scores was also reached between two reviewers. Other disagreements were resolved by discussion with other two reviewers (JL and LT).

Quantitative data synthesis

Weighted mean difference (MD) for changes in body weight or in BMI as a degree of reduction in severity of obesity or pooled risk ratio (RR) for a remission of obesity as a measure of improvement in obesity, with their 95% confidence intervals (CIs), respectively, were calculated using Review Manager (RevMan) software (version 5.8 for Windows; The Nordic Cochrane Centre, Copenhagen, Denmark). Degree of reduction in severity of obesity between treatment and control groups was calculated by subtracting mean changes in body weight or in BMI for the treatment group from that for the control group, so that a positive value of MD for the changes indicated greater reduction in severity of obesity in the treatment than in the control, whereas a negative value indicated greater reduction in the control group. A value of RR for a remission of obesity larger than one indicated more improvement in the treatment group than the control group. For trials reporting only pre- and postintervention values, mean change was obtained by subtracting pre- from postmeasurements. Accordingly, standard deviation (s.d.) for changes was estimated using the following formula:

$$\sqrt{\text{s.d.}_{\text{pre}}^2 + \text{s.d.}_{\text{post}}^2 - 2\times r_{\text{pre,post}}\times \text{s.d.}_{\text{pre}}\times \text{s.d.}_{\text{post}}},$$

where the correlation between pre- and postmeasurements ($r_{\text{pre,post}}$) was assumed to be 0.5.[25,26] Average estimates of the effect of acupuncture were calculated using either fixed or random effects model depending on the result of the assessment of statistical heterogeneity between the studies.

Assessment of heterogeneity and subgroup analysis

Clinical heterogeneity was assessed by noting the difference in the distribution of participants' characteristics among trials (age, gender, specific diagnosis/diagnostic subtypes, duration of disorder and associated diseases). Methodological heterogeneity was assessed by comparing trial design factors (randomization concealment, blinding, follow-up loss, treatment type and co-interventions). Studies were combined to assess the net effect of all types of acupuncture treatments on weight loss only if statistical heterogeneity was not evident. Heterogeneity was examined with Cochran's χ^2-test for heterogeneity as well as with the I^2-test, where I^2 values of 50% or more were considered to be indicators of a substantial level of heterogeneity.[27,28] To maximize the similarities among studies that would be combined, data were further stratified where possible into subgroups based on types of acupuncture.

Assessment of publication bias and other related biases

Assessment of publication bias. Funnel plots of effect estimates against standard error were generated if sufficient studies for each treatment regimen were available. It should be noted that asymmetry of a funnel plot may have arisen not only because of publication bias, but also from the

relationship between trial size and effect size. As Egger *et al*.[29] suggest, in the event that such a relationship is found, clinical diversity of the studies should be examined. However, in this review, the use of funnel plots was limited due to the small number of studies evaluated.

Dealing with missing data. We tried to acquire any missing or unpublished data by contacting the authors of identified studies through electronic mail. Evaluation of important numerical information such as screened, eligible and randomized subjects as well as intention-to-treat and per-protocol populations, was carefully performed.

Dealing with duplicate publications. In the case of duplicated publications and companion papers of a primary study, the yield of information was maximized by simultaneously evaluating all available data. Whenever doubtful (for example, clinical trials performed in the same hospital during the same period), the original publication (usually the oldest version) was given priority whereas all others were excluded.

Sensitivity analysis. Owing to a limited number of trials, sensitivity analysis to examine pooled results could not be performed.

Results

Study description

An initial search identified 99 potentially relevant articles, of which 31 studies met our inclusion criteria and thus were subjected to our systematic review. The total number of subjects evaluated was 3013. A total of 60 articles were initially excluded because they did not meet our inclusion criteria. Among them, 14 studies used combined therapy other than acupuncture alone, for example, acupuncture and moxibustion,[30] as an intervention, whereas 26 studies compared different forms of acupuncture to each other. The remaining 39 studies were further evaluated regarding randomization, and eight were found to be nonrandomized trials. A total of 2 RCTs[31,32] provided insufficient information so that 29 RCTs were used for our meta-analysis. Of 31, 24 RCTs were published during 2005–2007. Figure 1 summarizes the search results based on the Quality of Reporting of Meta-analyses (QUOROM) flow diagram.[33]

Methodological quality

The methodological quality of the trials varied substantially. Using the quality criteria set forth by Jadad and his colleagues, the scores varied from 1 to 5. A total of 5 studies (16%)

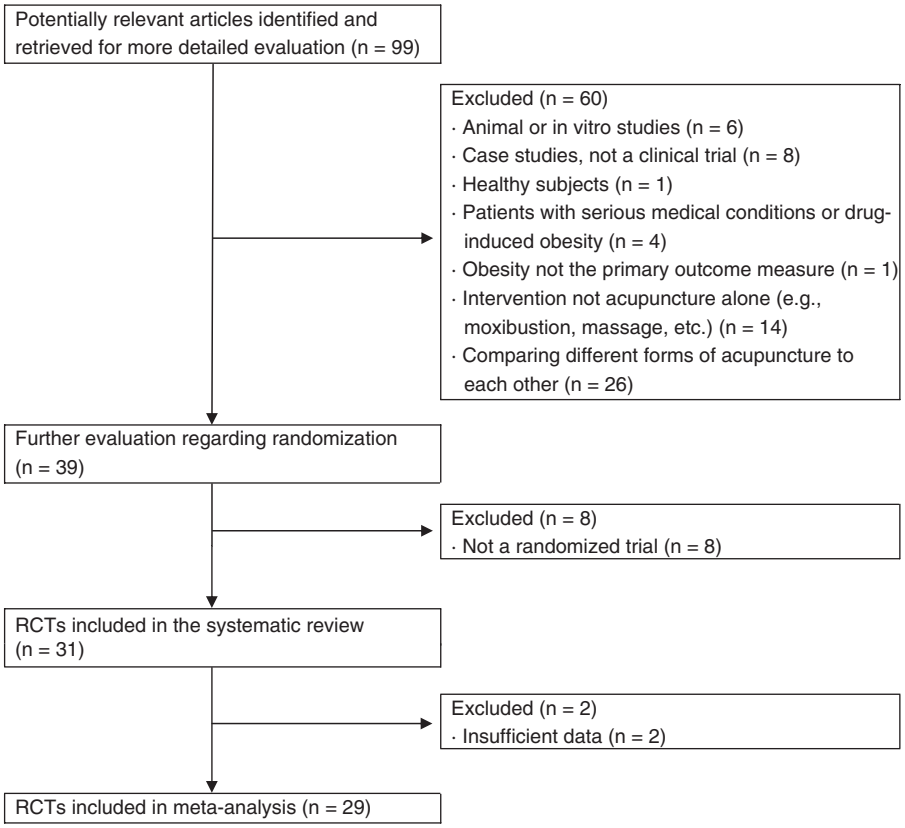


Figure 1 Flow diagram showing the number of studies included in and excluded from the systematic review and the meta-analysis. RCT, randomized controlled trial.

described their randomization procedure,[34–38] whereas information of dropout or withdrawal was described in 10 trials (32%). Among 26 trials that did not report the randomization procedure, 20 trials (77%) scored the lowest with respect to methodological quality (Table 1). Two trials were double-blinded[34,35] and six trials were single-blinded.[31,36,39–42]

Acupuncture versus control of lifestyle

Reduction in severity of obesity measured by a mean difference for changes in body weight or in BMI. With respect to reduction in severity of obesity, combining five studies (237 participants) that provided data on body weight (kg) using a fixed effects model produced a weighted MD in favor of acupuncture compared to control of lifestyle such as diet, exercise or qigong (pooled MD = 1.72 kg, 95% CI = 0.50–2.93) (Figure 2). Statistical heterogeneity was not found among studies ($I^2 = 0\%$). Comparisons made with lifestyle controls were classical acupuncture,[35,37] electroacupuncture,[38,54] or acupressure approaches.[36] In the meta-analysis of acupuncture style, no significant difference was found for groups of electroacupuncture (pooled MD = 1.2 kg, 95% CI = −0.65–3.05). Similarly, no significant difference was found in the trial using acupressure (MD = 1.6 kg, 95% CI = −4.19–7.39). However, a significant mean reduction was observed among subjects who received classical acupuncture treatment (pooled MD = 2.16 kg, 95% CI = 0.47–3.84). There was no perceptible asymmetry in funnel plots of these five studies (Figure 3).

Improvement in obesity measured by a relative risk for a remission of obesity. Five trials compared acupuncture treatment with diet versus diet alone (Figure 4). Combining these trials for evaluation of improvement in obesity using a fixed effects model provided a risk ratio of improving obesity in favor of acupuncture (pooled RR = 2.57, 95% CI = 1.98–3.34). One study compared acupuncture plus diet versus diet alone (RR = 2.77, 95% CI = 1.65–4.65),[44] whereas another study compared Catgut implantation electroacupuncture and auricular acupressure plus diet versus diet alone (RR = 1.91, 95% CI = 1.19–3.07), which exhibited statistically significant differences between the treatment and control groups.[56] The other three studies also reported a significant improvement for the treatment group using electroacupuncture plus diet versus diet alone (pooled RR = 3.03, 95% CI = 2.04–4.49; $P = 0.64$, $I^2 = 0\%$) (Figure 4).[47,51,52] No heterogeneity was found between the styles of acupuncture ($I^2 = 0\%$). However, funnel plot indicated that there was a lack of smaller sized studies with a relatively small effect size (Figure 5). Meanwhile, comparing acupuncture alone with diet, Fan *et al*.[57] reported no significant difference between groups (RR = 1.16, 95% CI = 0.95–1.42).

Acupuncture versus placebo or sham treatments

Reduction in severity of obesity. Three studies reported a reduction in severity of obesity in terms of weight changes for acupuncture treatment compared to placebo or sham treatment. The combined result, based on a fixed effects model, showed statistically significant reduction in severity of obesity (pooled MD = 1.56 kg, 95% CI = 0.74–2.38) with no heterogeneity among styles of acupuncture ($I^2 = 28\%$) (Figure 6). Specifically, a study for auricular acupuncture[39] reported significantly better results than the placebo group (MD = 2.20 kg, 95% CI = 1.05–3.35), whereas an auricular acupressure study[40] and an acupuncture study[35] showed no significant reduction in severity of obesity (MD = 0.65 kg, 95% CI = −0.77–2.07; MD = 1.42 kg, 95% CI = −0.66–3.51, respectively) compared to the placebo group or sham control group (Figure 6). There were two additional studies that reported a reduction in severity of obesity;[41,42] however, these studies used measures other than body weight. Mok *et al*.[42] reported no significant difference for auricular acupressure compared to placebo using percentages above ideal body weight (MD = 0.90, 95% CI = −0.29 to 2.09). Tong *et al*.[41] reported a significant effect for acupuncture, compared to sham acupuncture and diet, based on BMI changes (MD = 2.01 kg m^{-2}, 95% CI = 0.45–3.57).

Improvement in obesity. One study reported a significant improvement in obesity with auricular electroacupuncture compared to placebo (RR = 7.46, 95% CI = 2.95–18.69).[34]

Acupuncture versus medication

Reduction in severity of obesity. By combining two trials that examined the reduction in severity of obesity with acupuncture versus sibutramine, using a fixed effects model, a pooled MD of 1.90 kg (95% CI = 1.67–2.13) was produced in favor of acupuncture ($I^2 = 0\%$) (Figure 7).[43,49]

Improvement in obesity. Four studies reported improved outcomes for obesity by comparing acupuncture treatments with medication. The combined result reached statistical significance using a fixed effects model (pooled RR = 1.13, 95% CI = 1.04–1.22), and the style of acupuncture did not explain statistical heterogeneity ($I^2 = 0\%$) (Figure 7). Specifically, although two trials with electroacupuncture plus auricular acupressure provided a statistically insignificant pooled RR of 1.10 (95% CI = 0.94–1.28),[46,55] two other trials with acupuncture alone produced a marginally significant pooled RR of 1.14 (95% CI = 1.04–1.25) (Figure 7).[53,59]

Acupuncture versus herbal supplement

Reduction in severity of obesity. Wang[62] showed that the reduction of BMI was significantly better in an acupuncture treatment group than in an herbal tea group (MD = 1.41 kg m^{-2}, 95% CI = 1.23–1.59). Sun and Yu[63] also reported that the change of body weight was significantly better in an acupuncture plus auricular acupressure treatment group than in an herbal treatment group (MD = 2.96 kg, 95% CI = 2.89–3.03).

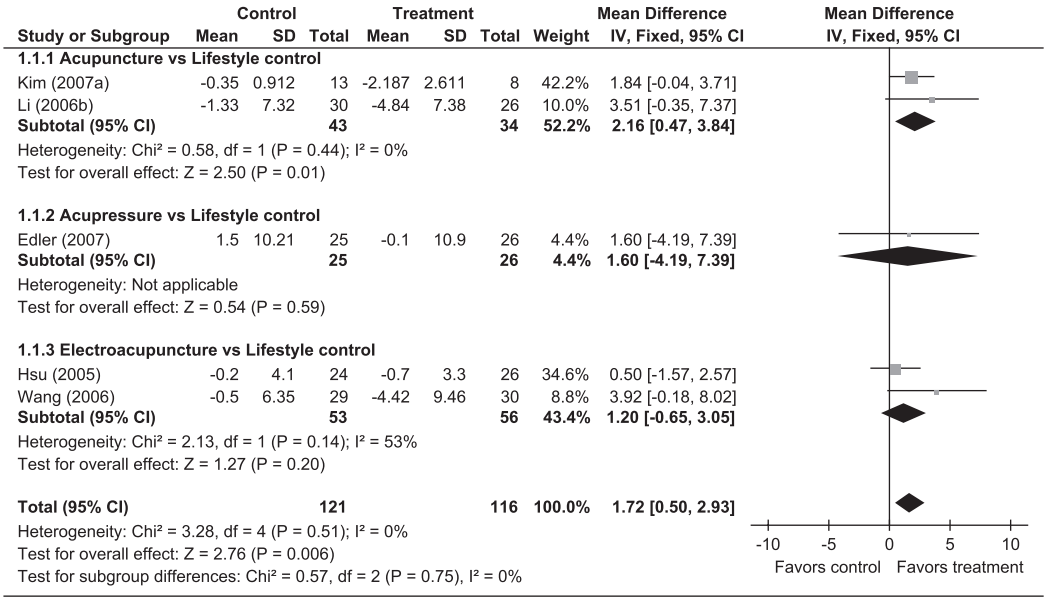
Table 1 Characteristics of RCTs of acupuncture for obesity

First Author (pub. year, location)	*Subjects' mean age (s.d.)*	*Number of patients randomized/ analyzed*	*Type of design; blinding*	*Jadad score*[a]	*Intervention type*	*Treatment frequency (treatment period)*	*Treated acupoints*	*Type of control group*	*Outcome measure, reported* P-*value*	*Adverse events reported* (n)
Richards and Marley (Australia)[34]	44.1 (11.7)	60/60	Parallel; DB	5	Auricular electroacupoint stimulation	2 per day (4 wks)	Shenmen, stomach	Placebo (on thumb no acupuncture points)	IO, <0.05	Intercurrent illness (1)
Kim (Korea)[39]	38.6 (5.7)	60/33	Parallel; DB	4	Acupuncture	3 per wk (12 se.)	LR1, SP1, LU8, SP5	(1) Kim sham plus diet (2) Diet	BW, 0.093	NR
Edler *et al.* (USA)[36]	47.6 (10.6)	92/81	Balanced; SB	3	Acupressure	1 per day (24 wks)	GB21, BL1, YingTang	(1) Qigong (2) Self-directed support	BW, 0.09	NS
Li and Wang (China)[37]	16.0 (1.38)	90/85	Parallel; open	3	Electroacupuncture plus diet	1 per day (60 se.)	SP6, ST36, ST25	(1) Auricular electroacupuncture (acupressure) plus diet (2) Diet	BW, BMI, <0.05	NR
Hsu *et al.* (Taiwan)[38]	41.5 (11.2)	54/46	Crossover; open	3	Electroacupuncture	2 per wk (6 wks)	REN6, REN9, ST28, K14, ST26, ST40, SP6	Sit up exercise	BW, 0.001 BMI, 0.003	Ecchymosis (2) Abdominal discomfort (1)
Hsieh (2007, Taiwan)[31]	18–20 (NR)	70/55	Parallel; SB	2	Auricular acupressure	1 per wk (8 wks)	Shenmen, mouth, stomach, endocrine, small intestine	Placebo (adhesive tape)	BMI, <0.001	NR
Kim *et al.* (Korea)[35]	34.7 (11.9)	91/58	Parallel; SB	2	Auricular acupuncture	Retained (8 wks)	Shenmen, stomach, spleen, hunger, endocrine	(1) Auricular: hunger (2) Placebo	BW, 0.003 BMI, 0.002	NR
Dong (China)[43]	35 (NR)	60/58	Parallel; open	2	Acupuncture	1 per day (40 se.)	ST22, SP10, BL20, BL21, CV12	Sibutramine 10 mg/qd	BW, NS	Control, 42.9% Intervention, 16.7%
Mi (China)[44]	38.4 (NR)	120/120	Parallel; open	2	Acupuncture plus diet	1 per 2 days (3 mths)	ST10, ST6, ST44, ST34, ST37, ST39, ST25, SP15, CV12, BL20, BL21, LR13, PC6, CV6, ST40, CV4, KI3, TE6	Diet (2520 kJ per day)	IO, <0.05	NR
Allison *et al.* (USA)[40]	44.5 (12.7)	96/69	Parallel; SB	2	Auricular acupressure	Placed (12 wks)	Six strategically placed points	Placebo (wrist acupress device)	BW, 0.37	Mild redness, pain, discomfort, bleeding in ears
Steiner *et al.* (USA)[32]	42.7 (12.6)	78/57	Parallel; open	2	Acupuncture	1 per wk (8 wks)	LI4, ST45, SP5, GB34/lung, stomach, hunger, mouth, endocrine, shenmen	(1) Sham acupuncture (2) Waiting list (3) Behavior modification	BW, <0.05 compared to (2)	None
Gao *et al.* (China)[46]	30.31 (5.50)	50/50	Parallel; open	1	Electroacupuncture, auricular acupressure	1 per 2 days (2 mths)	ST40, CV4, SP6, ST40, ST36 and adjunctive points/ endocrine, spleen , stomach, triple energy, large intestine	Sibutramine 10 mg/qd	IO, NS	NR
Luo (China)[47]	44 (NR)	60/60	Parallel; open	1	Electroacupuncture plus diet	1 per 2 days (2 mths)	CV12, ST36, ST37 ST25, CV4, SP6 and adjunctive points	Diet (2520 kJ per day)	IO, <0.05	NR
Luo and Li (China)[48]	34.10 (8.89)	60/60	Parallel; open	1	Acupuncture	1 per 2 days (27 se.)	ST35, SP14, ST34, SP10, SP4, ST44 and so on	(1) Electroacupuncture (2) Waiting list	IO, <0.01	NR
Nie *et al.* (China)[49]	35 (NR)	150/150	Parallel; open	1	Acupuncture	1 per 2 days (30 se.)	CV8, CV4 and adjunctive points	Sibutramine 10 mg/qd	BW, 0.097 BMI, 0.07 IO, 0.608	NR
Su *et al.* (China)[50]	16–56 (NR)	240/240	Parallel; open	1	Acupuncture, auricular acupressure	1 per 2 days (30days)	CV4, SP6 and adjunctive points/shenmen, spleen, endocrine and adjunctive points	TCM forment	IO, <0.01	NR
Zhang and Cui (China)[51]	32.52 (4.28)	64/64	Parallel; open	1	Electroacupuncture plus diet	5 per wk (2 mths)	CV4, CV12, LI25, CV9, CV7, KI16, ST36, SP10, BL15, BL17, BL20 and adjunctive points	Diet	IO, <0.01	NR
Li and Wu (China)[52]	30.5 (8.97)	160/160	Parallel; open	1	Acupuncture plus auricular acupressure	2–4 per wk (90 days)	ST25, SP15, CV12, CV10, CV6, CV4, ST23, ST27, GB26, SP9, SP40 and adjunctive points/sympathy, abdomen, brian, subcortex, hunger, large intestine, spleen, stomach, mouth	Waiting list	BW, BMI, <0.01	NR
Tong *et al.* (China)[41]	32 (NR)	41/41	Parallel; SB	1	Acupuncture plus diet	1 per 2 days (40 se.)	Abdominal 8 points, ST36, SP9	Sham acupuncture plus diet	BMI, <0.01	NR
Ma *et al.* (China)[53]	33.76 (1.30)	150/150	Parallel; open	1	Acupuncture	1 per 2 days (90 days)	LI11, ST25, ST29, ST36, ST41, CV12 and adjunctive points	Sibutramine 5 mg/bid	IO, <0.01	NR

Table 1 (continued)

First Author (pub. year, location)	*Subjects' mean age (s.d.)*	*Number of patients randomized/ analyzed*	*Type of design; blinding*	*Jadad score*[a]	*Intervention type*	*Treatment frequency (treatment period)*	*Treated acupoints*	*Type of control group*	*Outcome measure, reported P-value*	*Adverse events reported (n)*
Wang and Cheng (China)[54]	25–60 (NR)	59/59	Parallel; open	1	Electroacupuncture plus Exercise plus benazepril 10 mg	1 per 2 days (8 wks)	GV20, LI11, LR4, ST36	Exercise plus benazepril 10 mg	BW, BMI, <0.01	NR
Yang *et al.* (China)[55]	18–50 (NR)	50/50	Parallel; open	1	Electroacupuncture, auricular acupressure	1 per 2 days (2 mths)	ST25, CV4, ST40, ST36 and adjunctive points/endocrine, large intestine, triple energy (Tri-jiao), stomach, spleen, brain	Sibutramine 10 mg/qd	IO, NS	NR
Zeng and Nie (China)[56]	18–50 (NR)	50/50	Parallel; open	1	Catgut implantation, electroacupuncture, auricular acupressure plus diet	1 per 2 days (2 mths)	ST25, CV12, CR6, SP14, SP15, SP6, ST40, ST36 and adjunctive points/shenmen, endocrine, spleen, stomach, trienergy, large intestine, brain and adjuvant acupoints	Diet	IO, <0.05	NR
Fan *et al.* (China)[57]	47 (NR)	100/100	Parallel; open	1	Acupuncture	1 per 2 days (30 days)	SP10, SP6, ST25, ST36, LI4 and adjunctive points	Diet	IO, <0.05	NR
Lee (Korea)[58]	36.63 (5.42)	24/24	Parallel; open	1	Electroacupuncture	2 per wk (6 wks)	12 points on abdomen	(1) Ultrasound therapy (2) ultrasound plus electroacupuncture	BW, NS	NR
Wang (China)[59]	34.3 (12.4)	149/149	Parallel; open	1	Acupuncture, auricular acupressure plus diet	2 per wk (8 wks)	CV12, CV6, ST24, ST26, ST36, ST40, SP6, SP9, ST34, LI11, LI3, KI3/shenmen, endocrine, spleen, kidney, hunger, constipation, esophagus, thyroid gland, brain stem, tri-energy	Fenfluramine 20 mg/qd plus diet	IO, <0.05	NR
Xy (China)[60]	13–62 (NR)	307/307	Parallel; open	1	Electroacupuncture plus auricular acupressure	1 per day (60 se.)	SP6 and adjunctive points/ endocrine and adjunctive points	TCM ferment	IO, <0.01	NR
Li and Deng (China)[61]	38.18 (NR)	123/123	Parallel; open	1	Electroacupuncture plus auricular acupressure	1 per 2 days (20 se.)	BL20, BL21, BL22, ST25, ST28, CV12, CV6, SP15, ST36, ST40, SP9, SP6/lung, spleen, kidney, endocrine, abdomen, tri-energy	TENS	IO, <0.05	NR
Wang (China)[62]	13–52 (NR)	120/120	Parallel; open	1	Acupuncture	1 per 2 days (15 se.)	ST25, ST24, ST26, CV10, GW5 and adjuvant points	Kang Er Shou diet tea plus noncarbohydrate food	BMI, <0.05 IO, <0.01	NR
Sun and Xu (China)[63]	34.0 (9.3)	161/161	Parallel; open	1	Acupuncture, acupressure	1 per 3–5 days (90 days)	ST25, ST36, ST40, SP6, mouth, stomach, esophagus, abdomen, hunger, lung, shenmen, endocrine	Herbal supplement (oenothera erythrosepalae oil)	BW, <0.01	NR
Mok *et al.* (USA)[42]	NR (NR)	24/24	Crossover; SB	1	Auricular acupuncture	Retained (9 wks)	Mouth, stomach (bilateral points)	(1) Auricular acupuncture (mouth, stomach unilateral points), (2) placebo	% above ideal BW, 0.24	None

Abbreviations: BMI, body mass index; BW, body weight; DB, double blind; IO, Improvement in obesity; mths, months; NR, not reported; NS, not significant; SB, single blind; se., sessions; wks, weeks.
[a]Quality score; based on the Jadad scale (with maximum points of 5).



The blocks represent the point estimates for each trial and the horizontal lines the 95% CI. The size of each block is approximately proportional to the statistical weight of the trial in the meta-analysis. The diamond represents the pooled estimate and its 95% CI. The solid vertical line represents no difference in its effect between the treatment group and the control group. SD, standard deviation; IV, inverse-variance; CI, confidence interval.

Figure 2 A forest plot with a combined result of meta-analysis for mean difference (MD) of body weight changes between acupuncture treatment and control of lifestyle groups ($n = 237$).

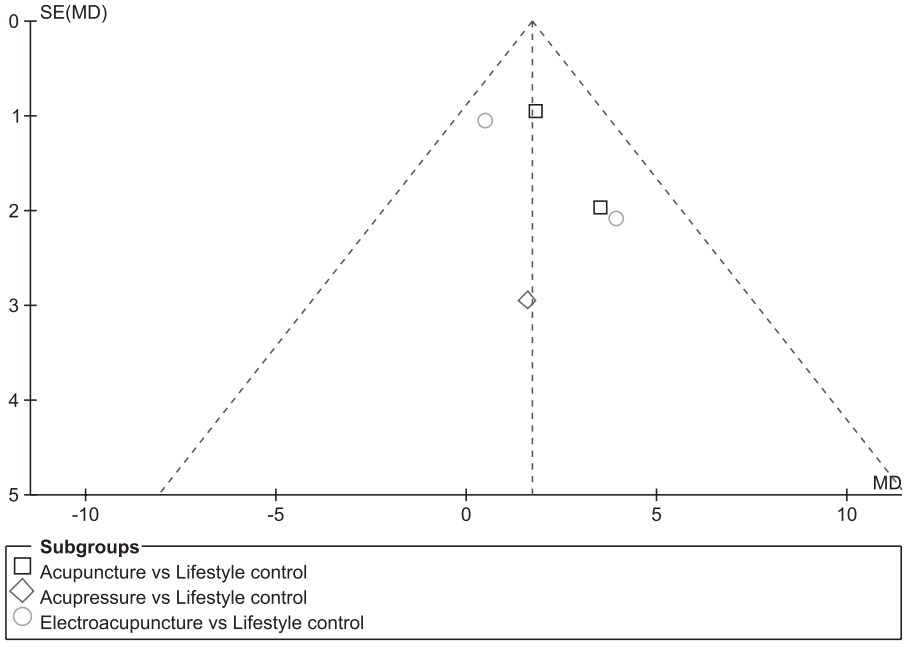
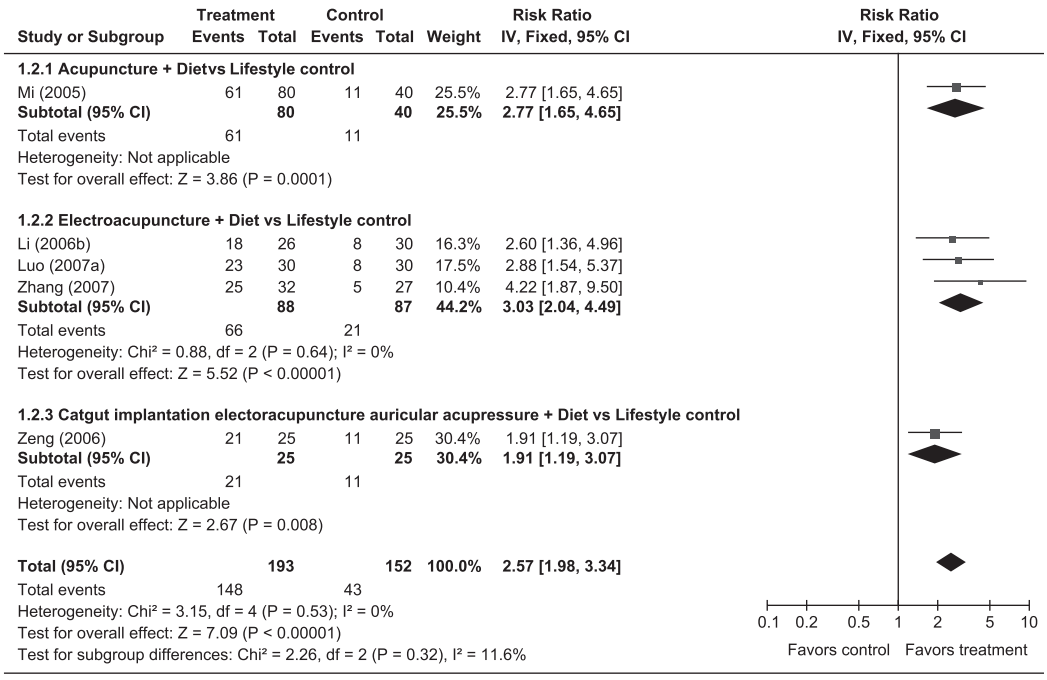


Figure 3 A funnel plot of mean difference (MD) of body weight changes between acupuncture treatment and control of lifestyle groups versus its standard error (s.e.).

Improvement in obesity. According to the comparison made by Wang[62] between acupuncture and herbal treatment, a significant improvement in the former group was found (RR = 1.59, 95% CI = 1.25–2.01). Su *et al*.[50] also reported a significant difference between acupuncture plus auricular acupressure group versus a herbal treatment (RR = 1.09, 95%



The RRs are displayed on a logarithmic scale so that the differences in the CIs can be easily seen. Other symbols are explained in Figure 2. IV, inverse-variance; CI, confidence interval.

Figure 4 A forest plot with a combined result of meta-analysis for risk ratio (RR) of a remission of obesity between acupuncture treatment and control of lifestyle groups ($n = 345$).

CI = 1.02–1.16). Xy[60] reported significant improvement in the treatment of electroacupuncture plus auricular acupressure compared to herbal treatment (RR = 1.33, 95% CI = 1.18–1.51). The results of these three studies were not combined in a meta-analysis because of their evidence of statistical heterogeneity ($I^2 = 87\%$).

Acupuncture versus wait-list control

Two studies reported a significant difference between acupuncture and wait-list controls.[48,52] A significant mean reduction in obesity was found among participants receiving both acupuncture and auricular acupressure compared with a wait-list group (MD = 3.66 kg, 95% CI = 3.05–4.27).[52] Significant improvement in obesity was also found for the acupuncture group compared with the wait-list group (RR = 17.0, 95% CI = 2.49–115.86).[48]

Acupuncture versus other interventions

One study showed no significant difference between electroacupuncture treatment and ultrasound stimulation therapy (MD = 0.16 kg, 95% CI = −0.56–0.88).[58] Another study, however, reported significant improvement for a group receiving electroacupuncture and auricular acupressure compared with a group receiving transcutaneous electrical nerve stimulation treatment (RR = 1.61, 95% CI = 1.20–2.17).[61]

Adverse events

Among studies observing adverse events, four RCTs reported minimal adverse events,[34,38,40,43] whereas two RCTs reported no adverse events,[32,42] compared to appropriate control groups. Allison *et al*.[40] reported three adverse events, namely, redness, pain or discomfort, and bleeding in ears in auricular acupuncture group compared to none in placebo group, although their frequencies were not statistically different. Hsu *et al*.[38] reported no major adverse event; however, mild ecchymosis ($n = 2$) and abdominal discomfort after electroacupuncture treatment ($n = 1$) was observed. Richards and Marley[34] reported a case of intercurrent illness and discomfort in a placebo group, whereas Dong[43] reported mild adverse effects, such as dry mouth, headaches, sleepiness, hypertension, palpitations and dizziness, up to 16.7% in the acupuncture group, compared with 42.9% in a group of receiving medication.

Discussion

To the best of our knowledge, this is the first systematic review and meta-analysis of acupuncture RCTs for treatment of obesity that did not restrict studies for analysis due to

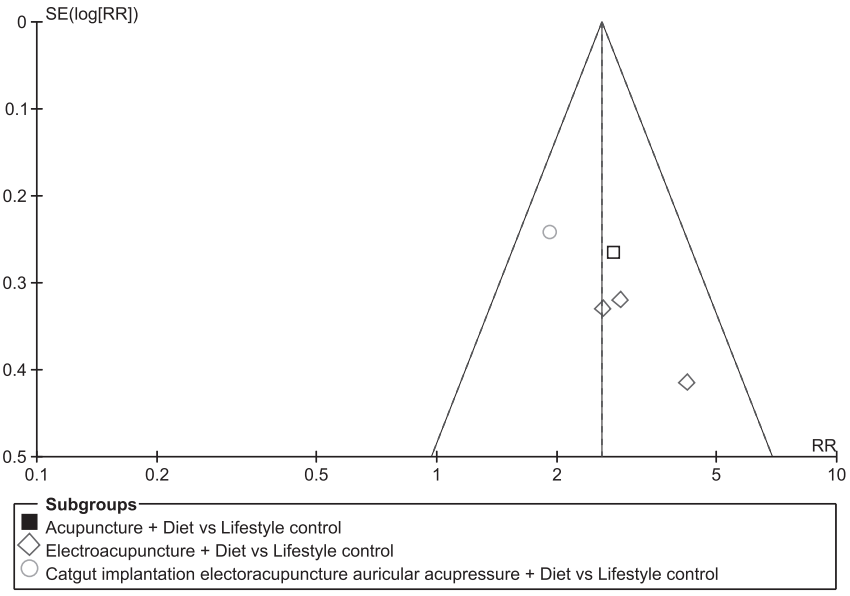
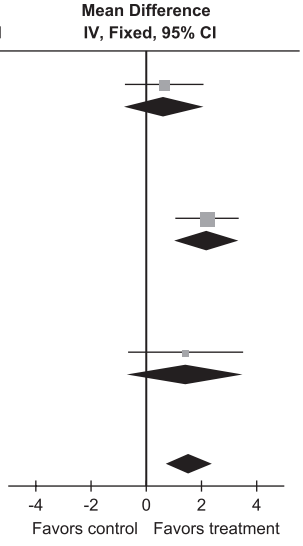


Figure 5 A funnel plot of risk ratio (RR) of a remission of obesity between acupuncture treatment and control of lifestyle groups versus the standard error (s.e.) of its logarithm.

Study or Subgroup	Control Mean	Control SD	Control Total	Treatment Mean	Treatment SD	Treatment Total	Weight	Mean Difference IV, Fixed, 95% CI
2.1.1 Auricular acupress vs Placebo or sham control								
Allison (1995)	-0.63	3.26	34	-1.28	2.74	35	33.3%	0.65 [-0.77, 2.07]
Subtotal (95% CI)			**34**			**35**	**33.3%**	**0.65 [-0.77, 2.07]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.90 (P = 0.37)								
2.1.2 Auricular acupuncture vs Placebo or sham control								
Kim (2007b)	-2.2	1.9	15	-4.4	1.5	22	51.2%	2.20 [1.05, 3.35]
Subtotal (95% CI)			**15**			**22**	**51.2%**	**2.20 [1.05, 3.35]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.76 (P = 0.0002)								
2.1.3 Acupuncture vs Placebo or sham control								
Kim (2007a)	-0.762	1.826	12	-2.187	2.611	8	15.5%	1.42 [-0.66, 3.51]
Subtotal (95% CI)			**12**			**8**	**15.5%**	**1.42 [-0.66, 3.51]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.34 (P = 0.18)								
Total (95% CI)			**61**			**65**	**100.0%**	**1.56 [0.74, 2.38]**
Heterogeneity: Chi² = 2.78, df = 2 (P = 0.25); I² = 28%								
Test for overall effect: Z = 3.73 (P = 0.0002)								
Test for subgroup differences: Chi² = 2.78, df = 2 (P = 0.25), I² = 28.1%								



Details of symbols are explained in Figure 2. SD, standard deviation; IV, inverse-variance; CI, confidence interval.

Figure 6 A forest plot with a combined result of meta-analysis for mean difference (MD) of body weight changes between acupuncture treatment and placebo or sham control groups ($n = 126$).

the language of publication. This review suggests that the existing evidence supports the value of acupuncture for the treatment of obesity; however, the limitations of the trials and hence the degree of evidence do not allow us to definitively conclude that acupuncture does in fact reduce obesity.

Analysis of the outcomes of the trials that compared acupuncture with sham treatment or lifestyle control for treating obesity subjects favored acupuncture. These results are limited, however, because the number of trials is small, and thus should be interpreted with caution. There is insufficient evidence as to whether acupuncture is more

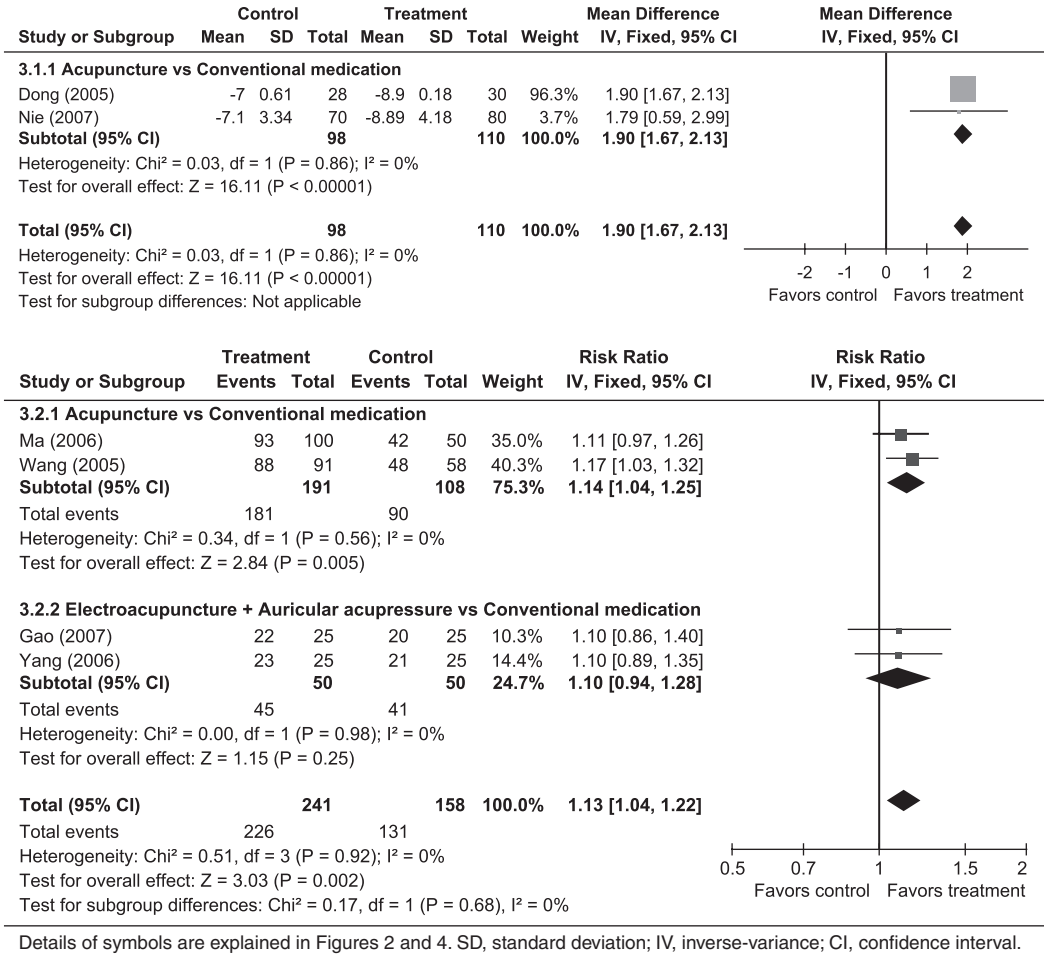


Figure 7 Forest plots with a combined result of meta-analysis for mean difference (MD) of body weight changes and for risk ratio (RR) of a remission of obesity between acupuncture treatment and medication control groups.

effective than other modalities of treatment such as medication, which might be because of the small number of trials as well as inadequate reporting or methodological flaws in some studies. Styles of acupuncture were explored with prespecified subgroup analysis; however, due to the small number of trials, conclusions from the subgroup analysis were also limited. Therefore, the types of acupuncture intervention that have the most positive outcome on obesity could not be determined.

Among widely used quality scoring systems, the objective of the Jadad scale is to provide an overall quantitative estimate of study quality with focusing on three dimensions of internal validity of a study, namely, randomization, blinding and withdrawals.[24] However, the scale was not shown to necessarily outperform other similar scales.[64] One of the limitations of the Jadad scale is that it is weighted using the quality of trial reporting rather than actual methodological quality.[65] It emphasizes generation of allocation sequences but does not assess allocation concealment, which has clearly been shown to be related with exaggerated treatment effects.[64] Therefore, trials with low scores of this scale tend to exaggerate treatment effects compared with those having high scores.[66,67] It also addresses the importance of blinding, which is hard to apply, for example, in a trial studying the effect of acupuncture. Nonetheless, this scale is one of the most widely advocated scoring systems and has the strength that it is the only tool among those published that was constructed based on psychometric principles.[68]

Using the Jadad scale, we found that the quality of the analyzed RCTs regarding acupuncture therapy were unsatisfactory. Details of randomization were unclear, power analyses were seldom reported, and details of the acupuncture were not fully provided. Concealment of allocation and

blinding methods were rarely described, and reporting of dropouts and withdrawals was often incomplete. Indeed, a total of 20 out of the 31 trials systematically reviewed in this study had the lowest methodological quality (that is, a score of 1 on the Jadad scale). Considering that low-quality trials are more likely to overestimate efficacy, it is not surprising that 75% of the 20 RCTs, which we identified as poor in our review, generated positive results, as compared with 63.6% in the other 11 higher-quality trials (that is, whose quality score was larger than 2). Even the trials that scored the highest on the Jadad scale were not devoid of flaws; two trials had high dropout rates (>30%), and a small number of treatment sessions.[35,39] Considering that most of the reviewed trials were of poor quality, the use of scale-based assessment to assess trial quality is unlikely to influence our findings.

Among the six RCTs that reported adverse events, none were serious enough to warrant concern. This finding supports the contention that acupuncture is as safe for treating obesity as has been found for other conditions. Though acupuncture therapy is not risk-free, it is relatively safe when performed by qualified practitioners.[7,69] Indeed, it should also be noted that, in a prospective survey with 34 407 acupuncture treatments, no serious adverse events had been reported.[70]

Nevertheless, the findings of our review and analyses are of clinical importance in that the results support the possibility that acupuncture may aid weight loss. We would like to note that, although acupuncture is being utilized to treat a variety of important health problems, its clinical usefulness in obesity management had not yet been fully evaluated. Our review reveals that acupuncture is a viable option for treating obesity. The question that needs to be addressed in the future includes which particular type of acupuncture should be offered. It is worthwhile to note that overweight and obese patients who refuse not only taking pharmacotherapy or a very low calorie diet but also receiving bariatric surgery, should not be discouraged from acupuncture. In addition, existing literature on acupuncture in patients with obesity as well as with a variety of other conditions have indicated that acupuncture is a treatment modality that obviates the side effects of pharmacotherapy. Nevertheless, because excessive pressure applied to skin for a long period might result in redness or ecchymosis of the ear, it is important that any form of acupuncture should be performed by a well-trained and experienced practitioner who understands the theories behind acupuncture.

This systematic review had several limitations: the number of RCTs was small. The trials satisfying the inclusion criteria were clinically as well as methodologically heterogeneous with respect to age of patients, severity of obesity, type of acupuncture variants, control groups used and outcomes examined. Many of the reviewed studies were of low quality and had methodological shortcomings such as an inadequate level of blinding. Although blinding of the therapist who applies acupuncture would be difficult, blinding of patients and other care providers, as well as outcome assessors should be attempted to minimize the performance and assessment bias of trials. We also emphasize that trials with acupuncture should be randomized, double blinded (including assessor blinding), controlled for placebo effects, have adequately concealed allocation, and utilize an appropriate level of power through sample size determinations. As the quality of trials and the reporting of trial methodologies reviewed in this study were generally weak, further high quality trials are needed to assess the effectiveness of acupuncture in treating obesity. In this respect, future trials should adhere to rigorous trial designs that are suitable for the research questions being addressed. To improve the trial design quality, level of performance, and the degree of reporting of clinical trials on acupuncture, future researchers should follow not only the basic guidelines for reporting clinical trials such as the CONSORT statement,[71] but also the STRICTA recommendations, which provide specific guidelines for the reporting of acupuncture trials.[72]

Most studies to date have been of short duration, varying from 4 to 12 weeks. Noting that obesity is a chronic condition, it is likely to require longer periods of acupuncture treatment. Moreover, obesity may wax and wane with or without treatment, and thus a longer follow-up period with serial measurements of outcomes is suggested to determine the genuine effect of acupuncture as well as its long-term efficacy. Acupuncture may also be considered during the maintenance phase of weight loss programs to prevent relapse.

In summary, the number of RCTs included in our review was too small, and their methodological qualities were too limited, to allow us to generate reliable conclusions about the efficacy of acupuncture. Conclusive evidence as to the efficacy of acupuncture for weight loss requires more rigorous RCTs to be performed.

Conclusions

Our review indicates that acupuncture for obesity has some beneficial effect compared to placebo or lifestyle control, although the results are of limited value due to the clinical heterogeneity and poor methodological quality of the included studies which prevent us from drawing a definitive conclusion for the effectiveness of acupuncture. However, acupuncture therapy for obesity is a relatively safe treatment modality, and thus obese patients who want to try acupuncture should not be discouraged.

Questions that cannot be conclusively answered at present include whether acupuncture should be widely recommended and what the most effective form of acupuncture is. More research and well-designed, rigorous clinical trials are necessary to address these issues.

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Disclosure/Conflict of interest

None.

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