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# The effectiveness of cupping therapy on low back pain: A systematic review and meta-analysis of randomized control trials

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ABSTRACT

*Objectives:* This study aims to investigate the effectiveness of cupping therapy on low back pain (LBP).
*Methods:* Medline, Embase, Scopus and WANFANG databases were searched for relevant cupping RCTs on low back pain articles up to 2023. A complementary search was manually made on 27 September for update screening. Full-text English and Chinese articles on all ethnic adults with LBP of cupping management were included in this study. Studies looking at acute low back pain only were excluded. Two independent reviewers screened and extracted data, with any disagreement resolved through consensus by a third reviewer. The methodological quality of the included studies was evaluated independently by two reviewers using an adapted tool. Change-from-baseline outcomes were treated as continuous variables and calculated according to the Cochrane Handbook. Data were extracted and pooled into the meta-analysis by Review Manager software (version 5.4, Nordic Cochrane Centre).
*Results:* Eleven trials involving 921 participants were included. Five studies were assessed as being at low risk of bias, and six studies were of acceptable quality. High-quality evidence demonstrated cupping significantly improves pain at 2–8 weeks endpoint intervention (d=1.09, 95% CI: [0.35–1.83], p = 0.004). There was no continuous pain improvement observed at one month (d=0.11, 95% CI: [−1.02–1.23], p = 0.85) and 3–6 months (d=0.39, 95% CI: [−0.09–0.87], p = 0.11). Dry cupping did not improve pain (d=1.06, 95% CI: [−0.34, 2.45], p = 0.14) compared with wet cupping (d=1.5, 95% CI: [0.39–2.6], p = 0.008) at the endpoint intervention. There was no evidence indicating the association between pain reduction and different types of cupping (p = 0.2). Moderate- to low-quality evidence showed that cupping did not reduce chronic low back pain (d=0.74, 95% CI: [−0.67–2.15], p = 0.30) and non-specific chronic low back pain (d=0.27, 95% CI: [−1.69–2.24], p = 0.78) at the endpoint intervention. Cupping on acupoints showed a significant improvement in pain (d=1.29, 95% CI: [0.63–1.94], p < 0.01) compared with the lower back area (d=0.35, 95% CI: [−0.29–0.99], p = 0.29). A potential association between pain reduction and different cupping locations (p = 0.05) was found. Meta-analysis showed a significant effect on pain improvement compared to medication therapy (n = 8; d=1.8 [95% CI: 1.22 – 2.39], p < 0.001) and usual care (n = 5; d=1.07 [95% CI: 0.21- 1.93], p = 0.01). Two studies demonstrated that cupping significantly mediated sensory and emotional pain immediately, after 24 h, and 2 weeks post-intervention (d= 5.49, 95% CI [4.13–6.84], p < 0.001). Moderate evidence suggested that cupping improved disability at the 1–6 months follow-up (d=0.67, 95% CI: [0.06–1.28], p = 0.03). There was no immediate effect observed at the 2–8 weeks endpoint (d=0.40, 95% CI: [−0.51–1.30], p = 0.39). A high degree of heterogeneity was noted in the subgroup analysis ($I^2$ >50%).

*List of Abbreviations:* **LBP**, low back pain; **CLBP**, chronic low back pain; **NSLBP**, non-specific low back pain; **PNSLBP**, persistent non-specific low back pain; **NSCLBP,**, non-specific chronic low back pain; **TCM**, traditional Chinese medicine; **CAM**, complementary or alternative medicine; **RCTs**, Randomized control trials; **VAS**, VAS-Visual Analogue Scale; **NRS**, Numerical rating scale; **PPI**, Present Pain Intensity Scale of the McGill Pain Questionnaire; **ODI**, Oswestry Pain Disability Index; **ODQ**, Oswestry disability questionnaire; **SMPQ**, **sensory and emotional**: Short-form McGill Pain Questionnaire divided in two parts: sensory and emotional; **NSAIDs**, Non-steroidal anti-inflammatory drugs.

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*Conclusion:* High- to moderate-quality evidence indicates that cupping significantly improves pain and disability. The effectiveness of cupping for LBP varies based on treatment durations, cupping types, treatment locations, and LBP classifications. Cupping demonstrated a superior and sustained effect on pain reduction compared with medication and usual care. The notable heterogeneity among studies raises concerns about the certainty of these findings. Further research should be designed with a standardized cupping manipulation that specifies treatment sessions, frequency, cupping types, and treatment locations. The actual therapeutic effects of cupping could be confirmed by using objective pain assessments. Studies with at least six- to twelve-month follow-ups are needed to investigate the long-term efficacy of cupping in managing LBP.
*Trial registration:* This systematic review was initially registered on PROSPERO with registration code: CRD42021271245 on 08 September 2021.

## 1. Background

Low back pain (LBP) is a group of symptoms characterized by pain, muscle tension, soreness and/or stiffness from the bottom of the rib cage to the buttock folds, sometimes accompanied by sciatic pain [1, 2]The lower back is the most commonly reported complaint area in musculoskeletal conditions, leading to pain, disability, and a reduction in overall life quality [3, 4]A recent systematic review of the global burden of disease study reported that LBP remained as a paramount global issue, and the prevalence of LBP will be increased significantly in the coming decades [5]Temporal LBP classification can be defined as acute (<6 weeks), subacute (6–12 weeks), and chronic (>12 weeks) back pain. Pathological causes of LBP can be identified as specific low back pain and non-specific low back pain (NSLBP) [2]Evidence indicated that patients typically experience at least one reoccurrence of LBP within 12 months [6–9]Approximately 5–10% of acute LBP cases will progress into chronic low back pain (CLBP) [10]Recurrent (i.e., currently defined as lower back pain ranging from 'at least one episode over the past year' to 'pain twice weekly') and chronic symptoms (i.e., pain that lasts for three months or longer) are highly prevalent in patients with LBP [11–13]Evidence indicates that around 90% of LBP cases are not associated with the identified pathoanatomical factors, posing a significant burden on the healthcare system due to the recurring, chronic, and uncertain causes of pain conditions [14].

There is a range of recommended treatment for managing LBP, broadly can be classified into pharmacological, non-pharmacological therapy (e.g., physical therapies, psychological approaches, complementary and alternative therapies, etc.), and surgical treatments [15]However, the decision of whether or when to provide an accurate treatment has no clear-cut answer in existing LBP management [16]A cohort study suggested that surgery may reduce recurrence rates and result in fewer permanent disability occurrences than non-surgical therapy in cost-utility analysis [17]Yet the suitability of surgical intervention varies among patients with LBP, as individuals with mild symptoms or neurological abnormalities may not benefit from invasive procedures [18]Medication-based treatments (e.g., acetaminophen) are recognized as a first-line treatment due to their affordable and efficacy in chronic pain management [19]However, concerns may arise regarding their long-term efficacy and potential side effects such as drowsiness and dizziness, organ damage, and ulcers [20, 21]Physical therapy is also recommended in guidelines for LBP management, but its efficiency tends to be more sufficient at early stages of care [22–24]Notably, a German study emphasized that of 77.4% LBP patients preferred complementary or alternative medicine (CAM) in their treatment decision [25].

Cupping therapy, rooted in traditional Chinese medicine (TCM), is considered as a complementary or alternative medicine (CAM) in Western medicine [26–28]TCM theory believed that cupping can enhance blood flow and alleviate pain intensity caused by blood stasis, thereby improving physical function [29]The application of high negative pressure during cupping can accelerate blood and lymph flow, leading to increased oxygen and metabolism in local tissues, ultimately reducing inflammation and eliminating toxic substances [29, 30]In wet cupping, bloodletting releases toxic substances from the tissue, stimulating an altered central nociceptive processing mechanism (i.e., the way of body responds to pain signals), subsequently reducing pressure pain and lowering pain threshold [31–34]This intervention has been widely used in Asia, the Middle East, and many European countries for managing chronic pain and musculoskeletal disorders [35–37]The technic is generally categorized by two apporaches: dry and wet cupping [38]Dry cupping involves placing cups directly on the painful area or acupoint, using negative pressure suction or heat to create a vacuum environment inside the cup. In contrast, wet cupping involves scarification (making small bleeding cuts on the skin) before applying the cup to the treatment area [39]usually positioned on the acupoint or the most painful muscle region.

With a growing interest in cupping therapy for pain management, researchers have suggested its clinical utility and acceptability in managing LBP [40–43]However, the current evidence on cupping efficacy is limited, and the absence of high-quality RCTs introduces a certain level of bias [44]Considering the variations in cupping protocols and time-to-event outcomes, the effectiveness of cupping on LBP might differ in terms of time efficacy. Moreover, discussions in recent studies have diverged on the efficacy of dry and wet cupping for LBP, and a specific classification for the types of LBP responsive to cupping is lacking [45]Concerns about the validity of cupping effectiveness on LBP have been raised, with some suggesting that the effects may be caused by psychological factors rather than a real therapeutic effect [46, 47]The increased use of novel innovative sham devices in cupping RCTs provides additional evidence for assessing the true therapeutic effect of cupping on LBP [48]As of our knowledge, there is a lack of high-quality evidence investigating cupping therapy for LBP, and the latest review conducted in 2017 did not include sham controls [49]To provide up-to-date evidence, we aim to conduct a comprehensive systematic review with meta-analysis to investigate the effectiveness of cupping on LBP.

## 2. Methods

Study protocol was prospectively registered on PROSPERO (registration code: CRD42021271245) and our findings are reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) checklist [50]as shown in E-Appendix 1. We searched Medline, Embase, Scopus and WANFANG databases from inception to June 2021 and updated the searches on 27th September 2023. The supplementary searching was manually made to track the eligible studies from the journal [51]Searches were based on different keywords including 'cupping therapy', 'low back pain' or 'lumbar region pain' in each database, a detailed search strategy is presented in E-Appendix 2. References were imported to Endnote (version X9, Clarivate Analytics) where duplicates were removed. Two authors (ZX & ZW) independently screened the titles and abstracts on Rayyan [52]and exported to Endnote for eligible full-text screening. Any disagreements were solved by discussion or a third investigator (AN).

The inclusion criteria were (i) all ethnic backgrounds, (ii) adults (≥ 18 years old), (iii) participants with low back pain, including chronic low back pain and/or nonspecific chronic low back pain, (iv) human research with ethical permission, (v) an intervention with cupping

therapy (including dry and/or wet cupping), (vi) randomized controlled trials or randomized clinical trials, and (vii) English and Chinese language articles. The exclusion criteria: (i) were studies of animal design, (ii) no full text available, (iii) no relevant comparator.

Two independent reviewers conducted all quality assessments (ZX & AN), with disagreements resolved by consensus. The risk-of-bias assessment was conducted using the Cochrane Collaboration RoB-2 tool [53]Detailed information in each included study was assessed using the guidelines from Cochrane Handbook [54]The evaluation consists of five domains: 1) risk-of-bias arising from the randomization process; 2) risk-of-bias due to deviations from the intended intervention; 3) risk-of-bias due to missing outcome data; 4) risk-of-bias in the measurement of the outcome; 5) risk-of-bias in the selection of the reported result [54].

An electronic data extraction form was used to collect author, publication year, intervention duration, number of participants, control group, outcome measurement, mean change and standard deviation was collected. Study outcome parameters were treated as continuous variables. Change-from-baseline outcomes were pooled into this study to perform a meta-analysis of the cupping effectiveness on LBP. Meta-analysis could not be carried out when there were fewer than two studies in one comparison [54]The differences in mean change were calculated by subtracting the mean baseline value at the endpoint and follow-up. The change-from-baseline standard deviation was computed with a 95% confidence interval (CI) [54].

$$Change \quad in \quad mean = Mean_{post} - Mean_{baseline}$$

The standard deviation of the difference between sample means (Δ) is approximately equal to [55].

$$SD_{pooled} = \sqrt{\frac{\Delta_1{}^2}{n1} + \frac{\Delta_2{}^2}{n2}}$$

In cases where only the CI was available, the CI was computed for the mean values to calculate the standard deviations [56].

$$SD = \frac{\sqrt{N} \times (upper \quad limit - lower \quad limit)}{3.92}$$

In cases where only the median and interquartile range (IQR) with 95% CI were available, the median and IQR were computed for the mean values and the standard deviations [57].

$$Mean = Median$$

$$SD \approx \frac{q3 - q1}{1.35}$$

Outcome measurements were using the Microsoft Excel software [58]to calculate the values step by step to reduce the chance of mathematical errors. Collected information was completed by the first reviewer (ZX) and shared online with the second independent reviewer (AN) via Microsoft software to verify the outcomes. For the pooled data, RevMan Software [59]conducted a description of analysis by Forrest plots. Continuous data were calculated using the standardized mean difference (SMD) with 95% CI using a random-effect model for the primary and secondary outcomes. Tests for heterogeneity from the pooled data were assessed using $I^2$ statistic with 95% CI. When the heterogeneity test was deemed acceptable ($p > 0.1$, $I^2 \leq 50\%$), which is considered as a low-moderate heterogeneity, a fixed-effects model was performed for meta-analysis [55]If the heterogeneity was significantly present ($p \leq 0.1$, $I^2 > 50\%$), a random-effects model was performed [55]The high level of heterogeneity was considered, as were clinical factors, such as treatment duration and cupping intervention, and methodological factors, such as concealment and blinding in the trial [55]Cohen's d scale (d) determined the magnitude of effect size with a small effect defined as ($\geq 0.2$ and $< 0.5$); a medium effect was defined as ($\geq 0.5$ and $< 0.8$) and significant effect was defined as ($\geq 0.8$) [54]A p-value of $< 0.05$ was considered statistically significant [54].

## 3. Results

### 3.1. Study identification

A total of 183 studies were identified including Medline (n = 40), Embase (n = 70), Scopus (n = 53), WANFANG (n = 22). Duplicates (n = 108) were removed, and 76 papers were 'title and abstract screened' with 41 references excluded at this stage. A supplementary searching was carried out for eligible study without an open access on database (Medline). Hand searching was retrieved one eligible article from the Journal of Journal of Acupuncture and Meridian Studies [60]Seven non-retrieval articles were excluded from the retrieval articles (n = 36). A total of 29 studies were eligible at full paper screening, a further 18 studies were excluded due to not related with the cupping intervention (n = 7) [61–67]not followed the randomization process (n = 5) [68–72]inaccessible full-text reading [73, 74]and unavailable raw data not suitable for data synthesis [75–78]Retrieving 11 eligible studies in this study [60, 79–88]A PRSIMA diagram [50]of the searching process as shown in Fig. 1.

### 3.2. Characteristics of included studies

Data extraction from each individual study is shown in E-Appendix 3. One study was published in Chinese language [79]and ten trials were published in English [60, 80–88]Farhadi et al. recruited participants who had had LBP for at least 4 weeks [80]eight studies recruited participants with LBP more than 12 weeks [60, 81, 83–88]Akbarzadeh et al. recruited participants LBP longer than 6 months [82]and Hong et al. recruited participants with LBP from 1 week to 3 years [79]A total of 1201 participant with low back pain were included to the meta-analysis, 609 participants were involved in the cupping group, and 592 participants were involved in the control group. The control group interventional treatment included: medication [79, 83–85]usual care [80, 82, 87]sham cupping [60, 88]and waiting list with permitted standard exercise and medication [81]Dosage of control medication included maximum 3 tablets of 150 mg dexibuprofen per day, maximum 3 tablets of 500 mg acetaminophen per day, and maximum 4 tablets of 500 mg paracetamol per day. Usual care included NSAIDs, short-duration muscular relaxants, resting, and moderate physical activity.

Six studies used dry cupping as clinical intervention [60, 79, 82, 84, 85, 88]and five used wet cupping [80, 81, 83, 86, 87]All treatment sites covered the lower back area. Three studies selected the same treatment sites at the bilateral acupoint BL23, BL24, BL25 on the lower back (from the inferior bilateral border of the L2 to L5 spinous process) [81, 83, 86]Silva et al. [88]selected bilateral lumbar vertebrae from L1 to L5 spinous process. Akbarzadeh et al. [82]selected one treatment site at acupoint BL23, from L3 to L4 spinous process. Farhadi et al. [80]and Mardani-Kivi et al. [87]chose wet cupping therapy in the interscapular area and the sacrum region. Hong et al. [79]selected the treatment site as from the interscapular area to the sacrum region with dry cupping therapy. Salemi et al. [60]selected treatment sites at the bilateral acupoints with two positions: initial supine position at HT3 (Shaohai), ST36 (Zusanli), then prone position at GV4 (Mingmen), BL23 (Shenshu), BL24 (Qihaishu), BL25 (Dachangshu), BL30 (Baihuanshu), B40 (Weizhong) and BL58 (Feiyang).

A total of seven identical outcome measurements were extracted in this paper: visual analogue scale (VAS), numerical rating scale (NRS), present pain intensity (PPI), Oswestry Pain Disability Index (ODI), Oswestry Disability Questionnaire (ODQ), McGill Pain Questionnaire (SMPQ) sensory, and SMPQ-emotional. All included studies have reported cupping therapy was effective for treating LBP ($p < 0.05$) [60, 79–88]The intervention ranged from a minimum of one session a week to a maximum of four sessions a week. The minimum cupping treatment duration was no less than 8 min in one session, and the maximum treatment duration was 30 min per session. The treatment duration

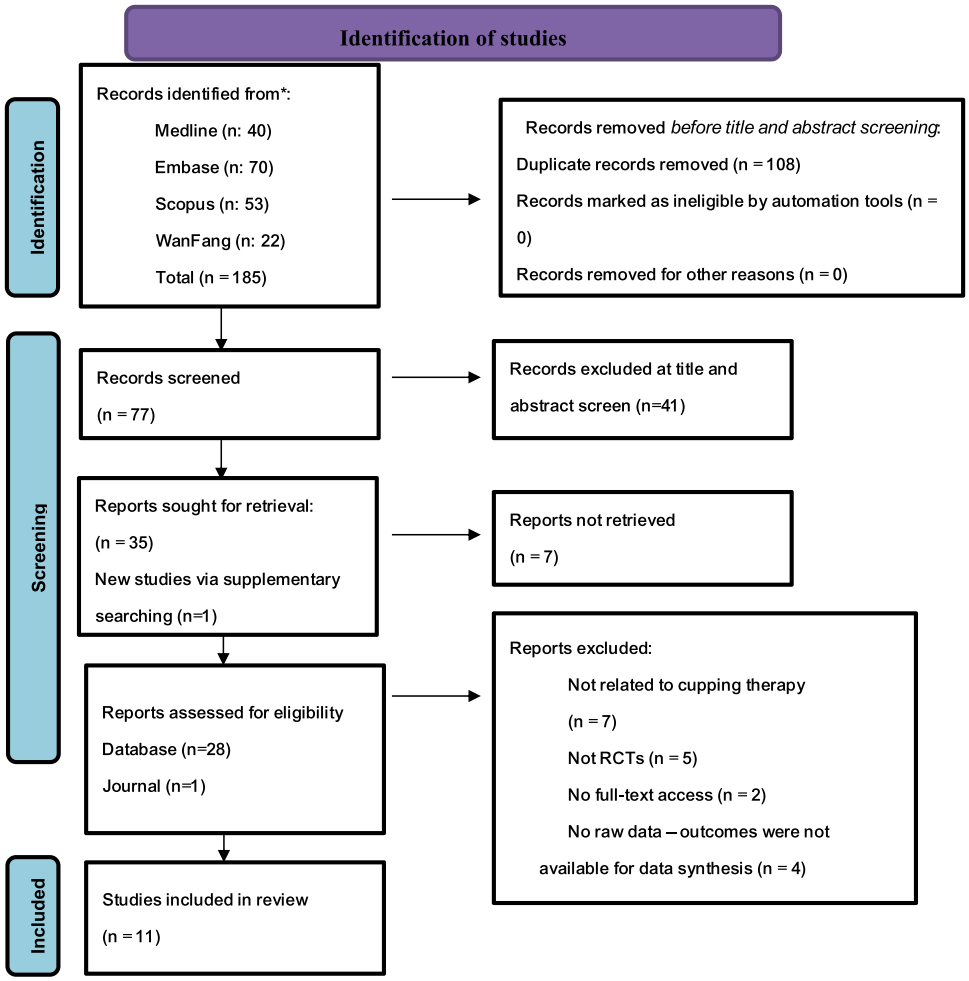


**Fig. 1.** PRISMA diagram of screening process. RCTs: randomized control trials.

period of comparators was same with the intervention group.

The changes in pain score were reported by nine studies. Five studies [60, 79, 82, 85, 87] measured VAS at 12 days to 28 days post intervention. Three studies [81, 83, 86] measured NRS at 2 weeks post-intervention, and one study [88] measured NRS at 4 weeks and 8 weeks post-intervention. Three studies [60, 85, 87] measured VAS in follow up range from 4 weeks to 6 months. Three studies [81, 83, 86] measured ODQ and PPI at 2 weeks post-intervention. Farhadi et al. [80] and Mardani-kivi et al. [87] reported ODI at 3 months follow-up. Salemi et al. [60] measured ODI at three weeks post-intervention and 4 weeks follow-up. Akbarzadeh et al. and Yazdanpanahi et al. reported SMPQ-sensory and SMPQ- emotional at immediate, 24 h post-intervention and 2 weeks follow-up [82,84].

### 3.3. Risk of bias assessment

The risk of bias assessment shows that all 11 included studies [60, 79–88] followed the randomization process and information concealment, but three articles [82, 85, 87] unreported the allocation concealment

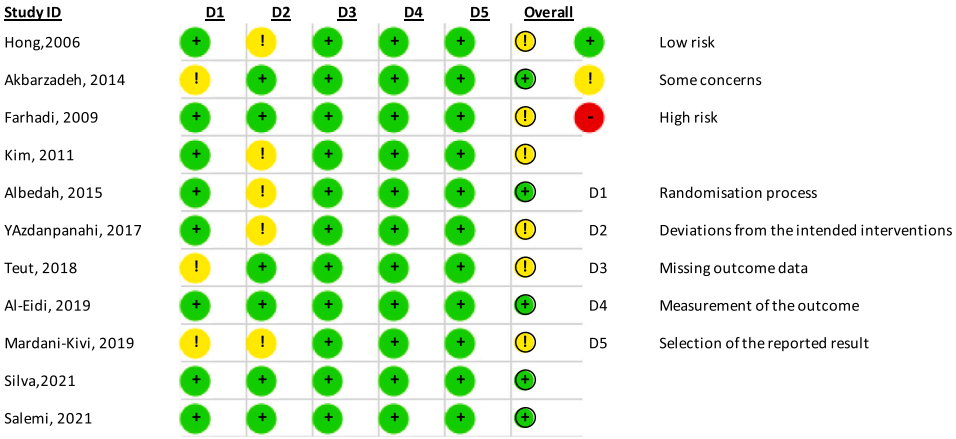


**Fig. 2.** Risk-of-bias assessment.

information, as shown in Fig. 2. Three eligible studies [60, 86, 88]performed blinding for both participants and investigators. Among them, Al-Eidi et al. [86]further blinded coordinators and data analysts in their study. Four studies [80, 81, 83, 85]performed participants blinding by using sealed opaque envelopes. Mardini et al. [87]blinded healthcare providers in their study. Three studies [79, 82, 84]did not provide details on blinding procedures but justified their reasons in the methods section. Given the cupping marks may expose the blinding after the intervention, achieving complete blinding of participants may be challenging [46]We assume that all trials have adhered to rigorous scientific methods to minimize bias in their blinding procedures. It is important to acknowledge the inherent difficulties in blinding participants due to the nature of the cupping. Kim et al. [81]used the allocation block ratio at 2:1 in cupping therapy and a control group in the allocation sequences, suggesting that the effectiveness of the experimental group could be overestimated.

In all included eligible studies (n = 11), outcomes were available for all participants, missing outcome and participants' dropouts were reported in detail. No missing outcome bias was raised from the results—data collection and outcome measurement in a statistical method. Continuous variable data was presented in all included studies. Outcome assessors were blinded to the intervention involvement. There was 45.5% in the concern of the intervention performance bias and 27.3% in the concern of participants' concealment and participants' blinding process, as shown in Fig. 3.

### 3.3.1. Pain reduction

Ten studies [60, 79–81, 83, 85–88]of sixteen outcome parameters (n) were pooled into this meta-analysis. Change-from-baseline outcomes were calculated at the endpoint and follow-up study, with ranged from 12-days to 6-months. The standard mean difference (SMD) of pain score including VAS, NRS, and PPI were evaluated with 95% CI. A random-effects model was conducted for statistical analysis. The pooled effect size was 0.86 [95% CI: 0.35 – 1.38], which is estimated as a significant effect on pain reduction, as shown in Fig. 4. Analysis showed that cupping therapy had a statistically significant effect on pain reduction compared to the control group (p = 0.0009). There was a high degree of heterogeneity between each of the studies ($I^2$ = 95%).

### 3.3.2. Length of cupping efficacy

A subgroup analysis was carried out to identify the cupping efficacy on pain management. The intervention period was clustered as the endpoint group (2–8 weeks post-intervention, n = 13), 1-month follow-up (n = 2), and 3–6 months follow-up (n = 3). Cupping showed a significant effect at 2–8 weeks endpoint intervention (d=1.09, 95% CI: [0.35–1.83], p = 0.004), as shown in Fig. 5. The heterogeneity in the endpoint group showed a statistically significant ($I^2$ =96%, p < 0.001). There was no statistically significant effect in the 1-month follow-up (d=0.11, 95% CI: [−1.02–1.23], p = 0.85) and 3–6 months follow-up (d=0.39, 95% CI: [−0.09–0.87], p = 0.11). It is noted that 2–8 weeks endpoint intervention has a lager weight in terms of sample size compared to the 1-month and 3–6 months groups. The subgroup differences showed a low level of heterogeneity ($I^2$ =34.3%, p = 0.22).

### 3.3.3. Different types of cupping on low back pain

A subgroup analysis (n = 13) was carried out to investigate the high heterogeneity in the endpoint group. Dry and wet cupping were clustered to determine whether different types of cupping had independent effects to LBP. Dry cupping (n = 6) showed no statistical effect on pain reduction (d=1.06, 95% CI: [−0.34, 2.45], p = 0.14), and wet cupping (n = 7) showed significant pain reduction at the endpoint of intervention (d=1.5, 95% CI: [0.39–2.6], p = 0.008), as shown in Fig. 6. The test suggested the different effectiveness on LBP was not dependent on the different types of cupping manipulation ($I^2$ =0%, p = 0.65). However, there was high level of heterogeneity between each individual study ($I^2$ >90%).

### 3.3.4. Cupping on different low back pain classifications

A subgroup analysis (n = 13) was carried out to investigate whether cupping have independent impact on different LBP diagnosis. Pain reduction in different LBP diagnosis at the endpoint of cupping intervention was carried out. NSLBP (d=2.43, 95% CI: [0.91–3.95], p = 0.002) and persistent nonspecific low back pain (PNSLBP) (d=1.66, 95% CI: [0.76–2.55], p = 0.0003) has a statistically significant effect on pain reduction, as shown in Fig. 7. There was no statistical significance have been founded in CLBP group (d=0.74, 95% CI: [−0.67–2.15], p = 0.30) and non-specific chronic low back pain (NSCLBP) group (d=0.27, 95% CI: [−1.69–2.24], p = 0.78). Subgroup differences reported low heterogeneity between each individual study ($I^2$ =27.7%).

### 3.3.5. Acupoint vs. lower back area

A subgroup analysis was carried out to investigate the cupping pain effectiveness compared with different treatment locations (n = 18). The treatment duration ranged from 2 weeks post-intervention to 6-month follow-up. The standard mean difference with 95% CI was used as the mode of analysis. Acupoint group showed a significant effect on pain reduction (p = 0.0001) with a considerable effect size at 1.29 [95% CI: 0.63- 1.94], as shown in Fig. 8. Whereas cupping on lower back area was not statistically significant on pain reduction (d=0.35 [95% CI: −0.29–0.99], p = 0.29). The subgroup difference was considered as a high level of heterogeneity ($I^2$ = 75.1%, p = 0.05).

### 3.3.6. Comparison of cupping vs medication therapy

A meta-analysis was carried out to compare the cupping with medication therapy in pain reduction (n = 8). The treatment duration ranges from 2 weeks to 12 weeks in both cupping group and control group. The pooled effect size is considered as statistically significant

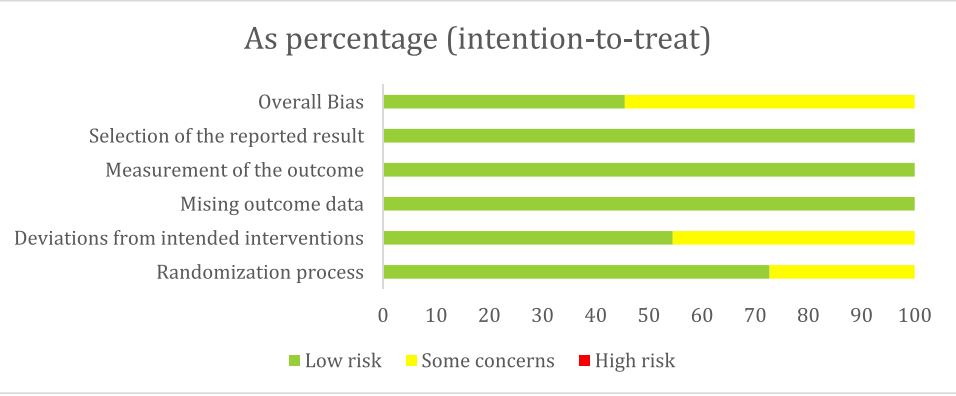


**Fig. 3.** Overall bias for RCTs assessment.

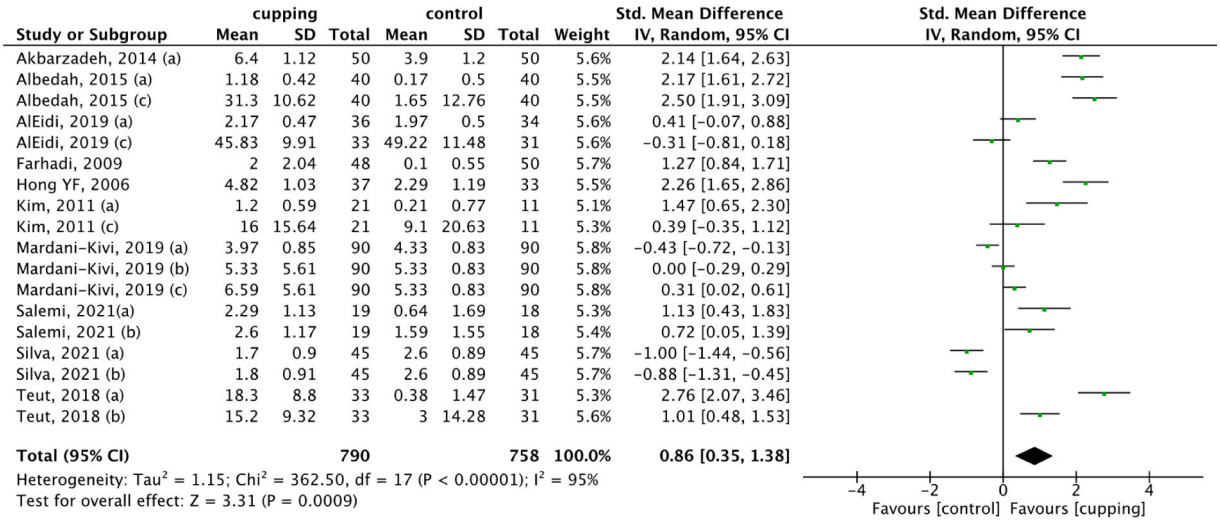


**Fig. 4.** The cupping effectiveness on pain reduction from pain score analysis. A random-effect model with 95% CI. Letters (a), (b), and (c) for the same study represent different pain reduction outcomes. Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score.

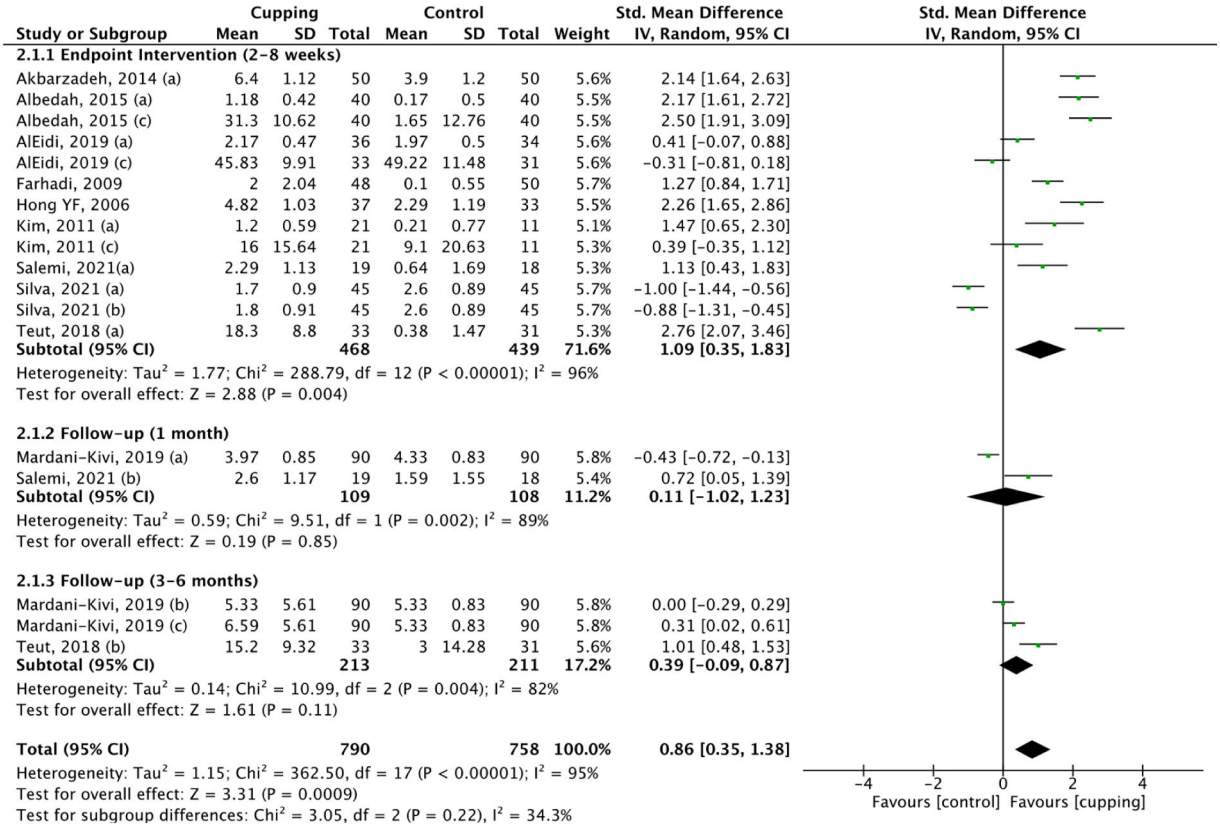


**Fig. 5.** Pain relief at endpoint intervention (2–8 weeks), follow-up (1 month), and follow-up (3–6 months). A random-effect model with 95% CI. Letters (a), (b), and (c) represent different pain reduction outcomes. Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score, Cohens' d value (d): effect size.

(d=1.8 [95% CI: 1.22 – 2.39], $p < 0.001$), as shown in Fig. 9. There was a high degree of statistical heterogeneity between each of the studies ($I^2 = 86\%$, $p < 0.00001$).

### 3.3.7. *Comparison of cupping vs usual care*

A meta-analysis was carried out to investigate the cupping pain effectiveness compared with usual care (n = 5). The treatment duration ranged from one-week post-intervention to 6-months follow-up in both groups. The standard mean difference with 95% CI was used as the mode of analysis. The overall effect showed that cupping therapy has a superior effect compared with the usual care on pain reduction ($p = 0.01$) with considerable effect size at 1.29 [95% CI: 0.3- 2.29], as shown in Fig. 10. There was a significant heterogeneity between each of the studies ($I^2 = 97\%$, $p < 0.0001$).

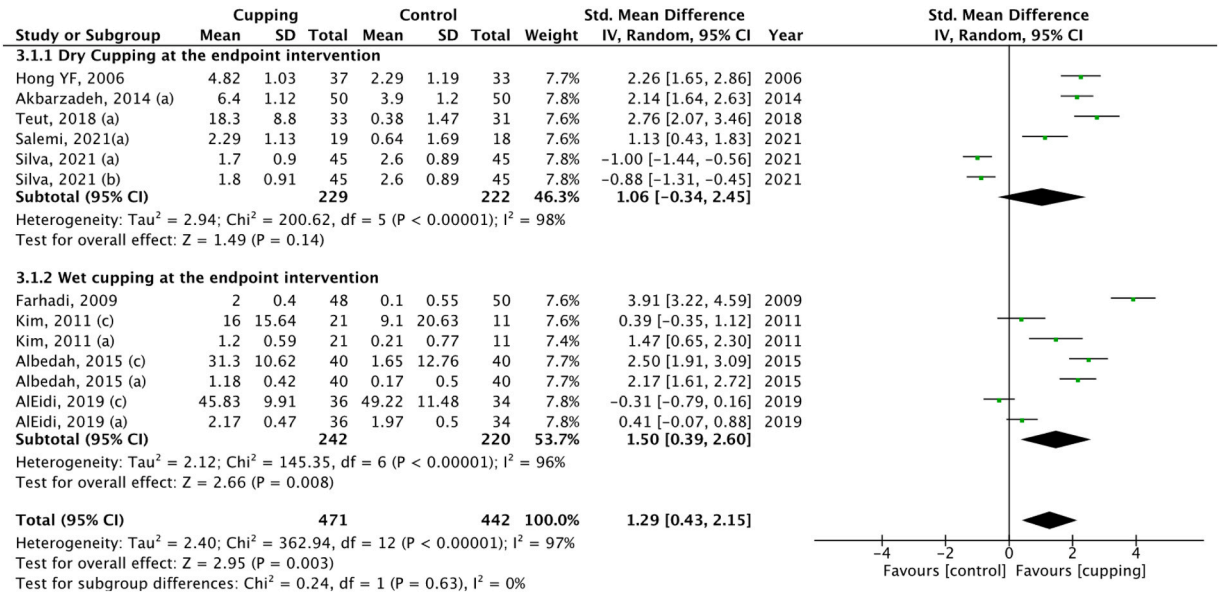


**Fig. 6.** The effectiveness of wet cupping and dry cupping at 2–8 weeks post-intervention. A random-effect model with 95% CI. Letters (a), (b), and (c) represent different pain reduction outcomes. Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score; Cohens' d value (d): effect size.

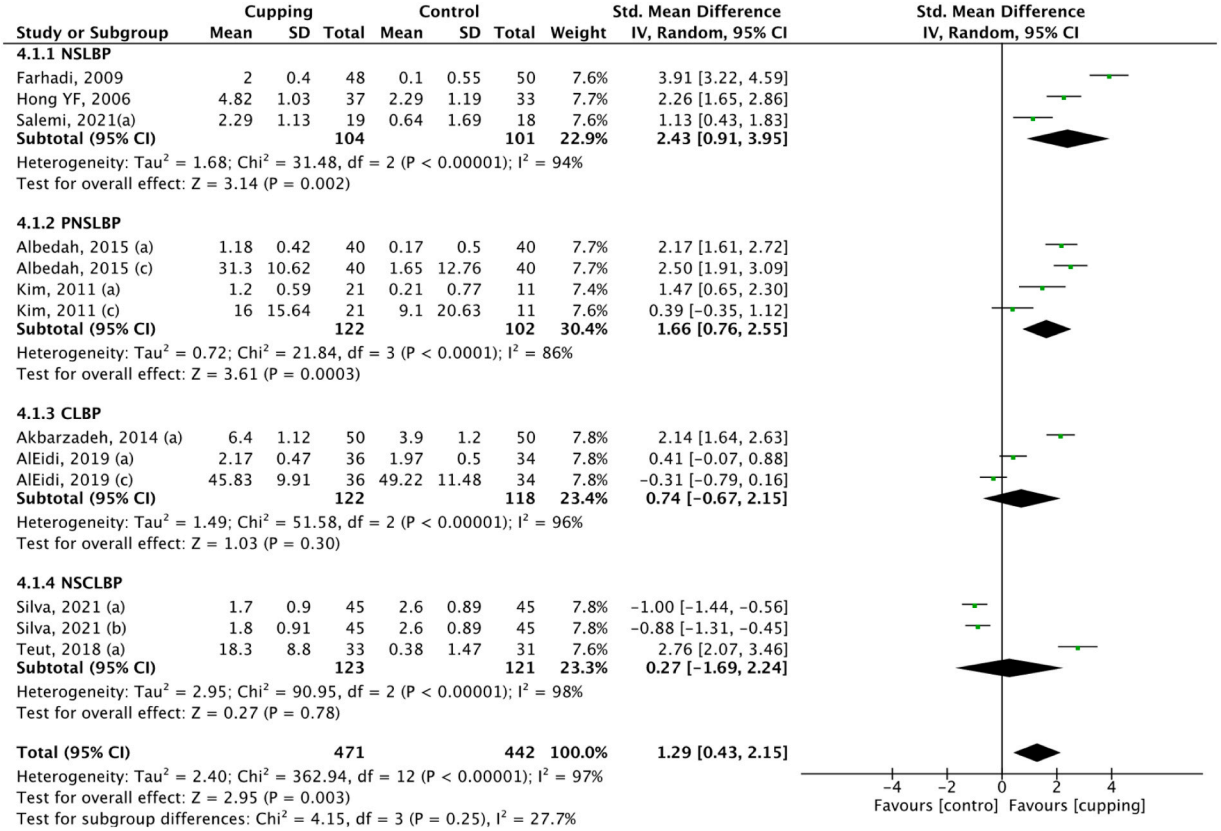


**Fig. 7.** A subgroup analysis (random-effect model with 95% CI) on different type of LBP. NSLBP: non-specific low back pain (n = 2); PNSLBP: persistent nonspecific low back pain (n = 4); CLBP: chronic low back pain (n = 3); NSCLBP: non-specific chronic low back pain (n = 3); Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score; Cohens' d value (d): effect size.

### *3.3.8. Sensory and emotional pain*

A meta-analysis assessed cupping effectiveness on SMPQ-sensory and emotional pain changes at the immediate (n = 4), 24-hour (n = 4), 2-week post-intervention (n = 4). The results suggested cupping has a significant effect at immediate (d=4.81, 95% CI [3.07–6.55], p < 0.00001), 24 h (d= 5.95, 95% CI [4.80–7.11]), and 2-week post-intervention (d= 5.71, 95% CI [2.47–8.95]), as shown in Fig. 11. The overall effect was statistically significant (p < 0.00001). There was no subgroup heterogeneity between each of the groups (p = 5.6, $I^2$ = 0%). The heterogeneity from each of the individual studies

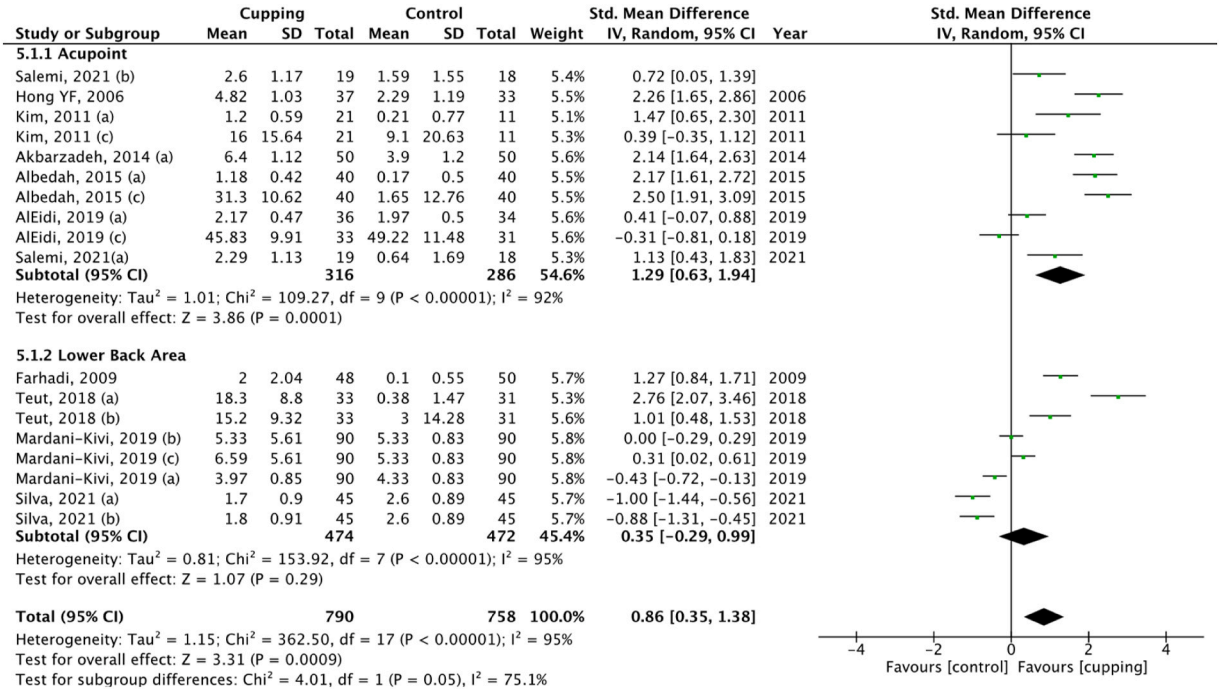


**Fig. 8.** Acupoint vs Lower Back Area, VAS and NRS of change-from-baseline outcomes at 2 weeks endpoint intervention to 6-month follow-up. Forest plot of pain score, random-effects mode with 95% CI. Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score; Cohens' d value (d): effect size.

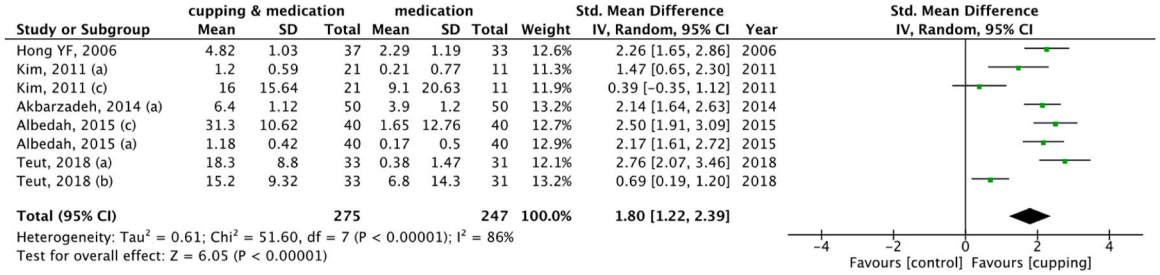


**Fig. 9.** Cupping with medication therapy vs medication therapy (control) alone. Forest plot of pain score, a random-effect model (95% CI). Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score; Cohens' d value (d): effect size.

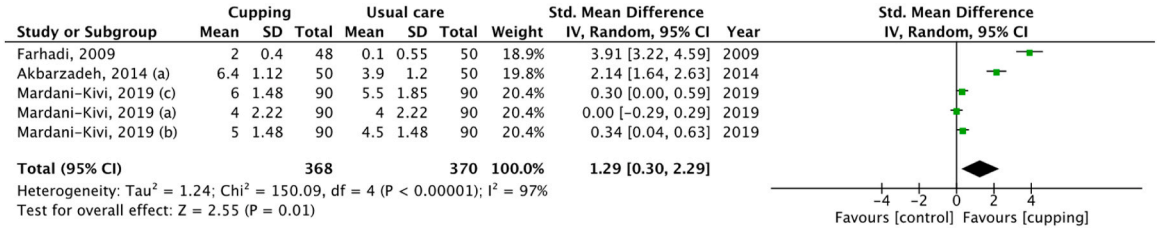


**Fig. 10.** Cupping vs usual care. Forest plot of pain score, a random-effect model (95% CI). Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score.

was considerably high ($p < 0.05$, $I^2 > 80\%$).

### 3.3.9. *Disability*

A meta-analysis was carried out to investigated cupping effectiveness on disability. Change-from-baseline outcomes including ODI and ODQ from seven studies. The treatment duration ranged from 2–8 weeks post-intervention (n = 5) to 1–6 months follow-up (n = 5). Cupping showed a medium effect in the improvement of disability (d=0.67, 95% CI: [0.06–1.28], p = 0.03), as shown in Fig. 12. A subgroup analysis further conducted to explore the high heterogeneity between studies. Continuous improvement could be observed with statistically significant in the 1–6 months follow-up group (d=0.94, 95% CI: [0.05–1.83], p = 0.04). The endpoint intervention group showed no statistically significant effect on disability improvement (d=0.40, 95% CI: [−0.51–1.3], p = 0.39). The heterogeneity from each of the individual studies was considerably high ($I^2$ = 95%, $p < 0.001$).

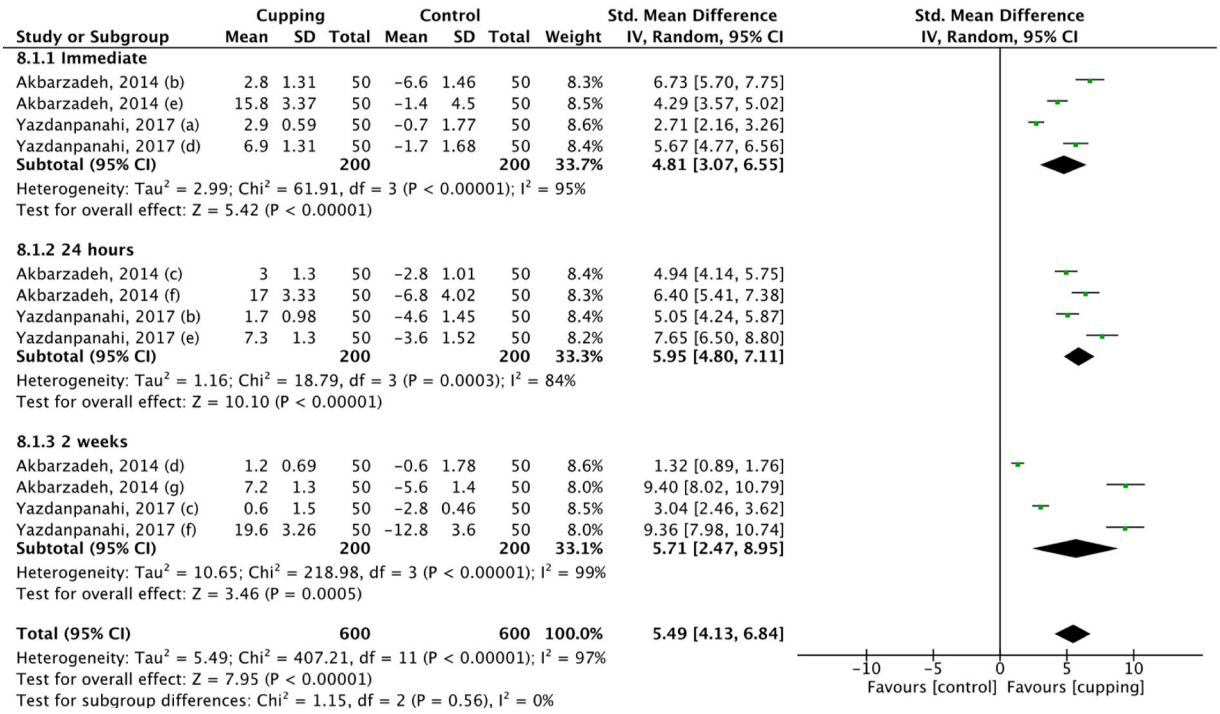


**Fig. 11.** SMPQ-sensory and emotional outcomes at immediate, 24-hour, 2-week post-intervention time points. Forest plot of pain score, random-effects mode with 95% CI. Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score; Cohens' d value (d): effect size.

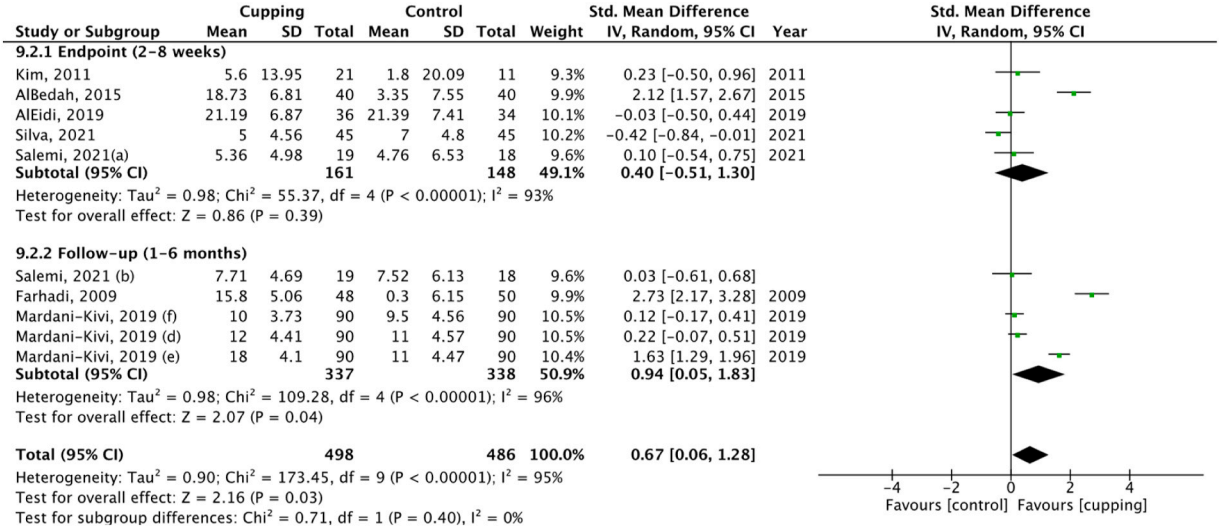


**Fig. 12.** Forrest plot of ODI and ODQ of change-from-baseline outcomes, at 2–8 weeks endpoint intervention and 1–6 months follow-up. A random-effect model with 95% CI. Letters (d), (e), and (f) represent different 1-month, 3-month, and 6-month follow-up outcomes. ODI - Oswestry Pain Disability Index; ODQ – Oswestry disability questionnaire; Std. Mean Difference: standard mean difference (SMD); 95% CI: 95% confidence interval; $I^2$: heterogeneity score; Cohens' d value (d): effect size.

## 4. Discussion

Cupping has a significant effect on pain reduction, sensory and emotional pain, and disability improvement. Our study investigated cupping effectiveness based on the treatment period, different manipulations (i.e., cupping types and treatment locations), and LBP classification. We found that cupping was effective at the endpoint intervention for pain reduction, but has no continuous improvement after the treatment sessions. Dry and wet cupping have different effects on pain improvement at the endpoint intervention, but this divergence was not caused by the different types of cupping. Our findings also suggested the effectiveness of cupping on pain was related with the different LBP classifications and the different locations of cupping (acupoints vs. lower back area). In the management of LBP, cupping may have a superior and sustainable effect compared to medication and usual care. Evidence found that cupping progressively reduces functional disability in the follow-ups, but could not improves pain immediately at the early-stage of intervention. Subgroup analysis cannot distinguish the high degree of heterogeneity in this study, further studies with sufficient sample size are warranted.

Our study included ten eligible studies [60, 79–83, 85–88]demonstrated cupping can significantly improve pain for LBP(d=0.86, $p < 0.01$). A

subgroup analysis was further conducted to investigate high heterogeneity based on the intervention period (i.e., endpoint and follow-up). Evidence showed that cupping has a significant effect on pain improvement at 2-8 weeks endpoint intervention (d=1.09, p = 0.004), but did not exhibit ongoing improvement at 1 month (d=0.11, p = 0.85) and 3–6 months follow-up (d=0.39, p = 0.11). This finding conflicts with the previous studies regarding the long-term cupping efficacy on LBP. Mardini-Kivi et al. indicated the cupping effectiveness on pain intensity is equivalent to the usual care in the 1-month follow-up, but it will surpass the usual care at 3 to 6 months follow-up [87]While some researchers stated that long-term cupping efficacy may only exist in a specific outcome such as health-related life quality and physical function [85, 89]Thus, further study should be conducted with adequate follow-ups to investigate the length of cupping efficacy on LBP.

Different cupping manipulations have different effects on LBP. A subgroup analysis assessed eight studies [79–83, 85, 86, 88] based on the different types of cupping (i.e., wet and dry cupping) to explore high heterogeneity at the endpoint intervention. Only wet cupping showed a statistically significant improvement at the end of treatment (p = 0.008), dry cupping did not showed a significant pain improvement (p = 0.14). This finding differs from the existing research, as all eligible studies have suggested both dry cupping [60, 79, 82, 84, 85, 88]and wet cupping [80, 81, 83, 86, 87]were effective for LBP. Another subgroup analysis was carried out based on the different cupping locations (i.e., acupoints vs. lower back area). Evidence found that cupping had a statistically pain improvement when applying on the acupoints (d=1.29, p < 0.001). But there was no pain improvement observed in the lower back area (d=0.35, p = 0.29). The degree of heterogeneity ($I^2$ =75.1%, p = 0.05) indicated the different cupping effectiveness may driven by the different cupping locations. It is possible that acupoints may have better pain improvement compared with the lower back area for LBP. Further investigation should be carried to distinguish the effectiveness of different cupping manipulations.

Moreover, Silva et al. [88]applied sham cupping in the control group (i.e., dry cupping vs sham cupping) and reported dry cupping did not result in superior pain reduction in LBP. Sham cupping was introduced as a novel intervention by Lauche et al. in 2016 [48]They designed a sham device with lower pressure to successfully implement blinding procedure and reduce the outcome bias in cupping RCTs. However, some researchers suggested pain improvement was related to the negative pressure from the cupping. The mechanism of negative pressure involves blocking pain signal to the spinal cord (pain-gate theory), moderating metabolic acidosis (blood detoxification theory), improving microcirculation and vasodilatation (nitric oxide theory), and increasing blood flow (muscle relaxation), all contributing to achieving pain relief [27, 90]Evidence found that 90% of participants who received sham cupping could sense the suction feelings after the intervention [85, 88] There is no valid evidence supporting the use of sham cupping/negative pressure would not influence the pain results. Further investigation is needed to distinguish the effects of using sham cupping and the negative pressure for LBP management.

In the subgroup analysis of cupping on different LBP classification, a statistically significant pain reduction was observed in NSLBP (p < 0.01) and PNSLBP (p < 0.01). There was no statistically significant effect observed in CLBP (p = 0.30) and NSCLBP (p = 0.78). This finding was conflicted with previous research regarding the cupping effect on CLBP and NSCLBP [82, 85, 86, 88]We noticed that included studies of NSLBP and PNSLBP patients mostly received wet cupping, whereas CLBP and NSCLBP patients received dry cupping. Considering the fact that the chronicity of pain is associated with a higher range of tissue acidosis [91]The characteristic of wet cupping, involving bloodletting, may react more quickly than dry cupping to release the toxic substances, potentially leading a better effect on diffuse noxious inhibitory controls for LBP. [92]Additionally, a recent study on dry and wet cupping indicated that the frequency of cupping sessions can influence the treatment effectiveness [45] AlEidi et al. [86]and Silva et al. [88]who favored control groups, treated participants with one session a week rather than other studies that treated at least twice a week. We believed that consecutive intervention could contribute to better cupping effectiveness in pain management. Further studies should explore the various effects between dry and wet cupping, treatment sessions, and their impact on different LBP classifications.

To establish the superior efficacy of cupping effectiveness compared to non-cupping therapy. A meta-analysis was conducted by comparing cupping with medication and usual care for LBP management. Our study indicated that cupping was more effective than medication therapy (d=1.8, p < 0.001) and usual care (d=1.29, p = 0.01) in pain reduction at the endpoint intervention and follow-up. The timeline ranges from 12 weeks to 6 months did not change the outcomes of pain reduction. This finding is different from the existing literature that cupping showed advantages only at the end of the intervention compared with conventional therapy in pain improvement [93] In fact, researchers have advocated cupping therapy as an effective and safe intervention for LBP management [23,28] Oral drugs were not recommended to LBP patients for long-term use, and usual care was hard to prevent the recurrence of back pain symptoms [94]Further research is needed to investigate which specific aspects of cupping are superior than medication and usual care for LBP management.

Our study suggested that cupping therapy improved sensory and emotional pain immediately (p < 0.001) and sustained after 24 h (p < 0.001) and 2 weeks post-intervention (p < 0.001). To our knowledge, this meta-analysis was the first to investigate the effectiveness of cupping on emotional pain experience. However, this finding may not fully explain the true therapeutic effect on pain reduction, as pain is related to the central nervous system and emotional reflection [95] Patients can experience pain by their own perspective without any structural impairment [96]Using a simulated pain threshold may not fully explain the cupping effectiveness, considering the pain measurement will be influenced by the subjective experience and feelings [80]Cupping marks after the intervention may introduce potential psychological implication that could influence the subjective outcome meausrements [46]In addition, cupping may induce the perception of nociceptive stimulation and trigger a defensive system of pain and fear [97]Cupping therapy, especially wet cupping, might use another pain stimulus to modulate the actual perception of pain [81]Given the high heterogeneity in each study, future research should considerse using objective assessments to evaluate the real therapeutic cupping effect on LBP.

Our study assessed ODI and ODQ changes from baseline to follow-up to evaluate the effectiveness of cupping on disability. The meta-analysis showed that cupping was more effective than the control group in the disability improvement (d=0.67, p = 0.03). In the subgroup analysis, evidence indicated that cupping had no immediate effect on physical function at 2–8 weeks endpoint intervention (p = 0.39), but a significant effect was observed at 1–6 months follow-up (p = 0.04). . There is a controversy regarding the effectiveness of cupping on disability at the endpoint of intervention. AlBedah et al. [83]and Salemi et al.[60] reported cupping has a statistically significant improvement in the endpoint of intervention, while three studies [81, 86, 88]reported no functional improvement at the end of the intervention. We acknowledged that this diverse outcome could be influenced by multiple factors, including demographic characteristics, pain status, and cognitive function [98] However, due to the limited literatures, this study could not assess whether those factors are associated with the different effects of cupping on disability . Further study should carry out to explore this field in detail.

### 4.1. Strength and limitation

This study has several strengths. This study followed the Cochrane Handbook protocol to conduct a thorough and detailed systematic review and meta-analysis. Screening text identified original English and Chinese articles to supplement evidence on cupping effectiveness on LBP. This research included studies with low to moderate risk of bias to

quantify the efficacy of cupping therapy on LBP through meta-analysis. All significant outcomes were observed with a considerable effect size (d > 0.5- 1.0), which was considered strong evidence of this research findings. This study has assessed cupping effectiveness on pain changes, emotional and sensory pain, and physical function in patients with LBP. This study was the first article to investigate the cupping effectiveness from intervention period, cupping manipulation, and LBP classifications. This systematic review and meta-analysis conducted several classifications to minimize the differences between the intervention and control groups. The study emphasized that standardized manipulation protocol, sham device, and objective assessment for cupping on low back pain would ultimately improve the quality of cupping research.

This study has several limitations. Various conditions contributed to infeasible analysis in the subgroup analysis and meta-regression. The absence of a standard protocol and high-quality RCTs result in poor evidence to support the cupping effectiveness on LBP. Existing subgroup analyses did not adequately address the concern of high heterogeneity in the included studies. Different outcomes have yet to be addressed due to the lack of relevant variables. All included outcome measurements were self-reported assessments, which cannot fully explain the reliability and credibility of cupping effectiveness, given the potential influence of psychological factors. The nature of the cupping characteristic may affect the potential for intervention exposure in clinical trials. Insufficient blinding design introduces bias to the outcome, thereby affecting the validity and accuracy of the cupping effectiveness. Furthermore, it is challenging to investigate the real therapeutic cupping effect with inadequate research on the effectiveness of sham cupping.

### 4.2. Future perspectives

In future clinical research, we recommended a well-designed clinical trial and standardized cupping protocol to explore the effectiveness of cupping on LBP. Multiple-armed trials should be conducted and focused on using sham devices to determine the true therapeutic effect of cupping on LBP. Cupping manipulations (i.e., wet or dry cupping, acupoint or lower back area) should be further investigated to determine which type of cupping manipulation is more effective for managing LBP. High-quality RCTs with adequate blinding procedures should be conducted to explore the prognosis and superior effectiveness of cupping on different classification of LBP. It is necessary to conduct cohort studies with a follow-up of at least a six-month to twelve-month to investigate the long-term efficacy of cupping therapy on LBP. Treatment sessions and frequency should be standardized at least twice a week for 15 min. To determine the imapct of psychological factors in cupping therapy, neuroimaging techniques should be used in cupping trials to minize the influence of patient perspectives and treatment expectations [99]Objective pain assessment (e.g., electroencephalography and functional magnetic resonance imaging) can be used in cupping trials to investigate the actual therapeutic effect of cupping on LBP [100].

## 5. Conclusions

This systematic review and meta-analysis contribute to the body of existing literature, providing evidence for the effectiveness of cupping therapy in managing LBP. This review is the first to investigate the immediate and sustained effects of cupping, compares wet and dry cupping by time efficacy, evaluate pain improvement based on different LBP classifications and treatment locations, assess the effectiveness of cupping on sensory and emotional pain, and measure the effect on disability. The study emphasized that cupping surpasses medication and usual care in reducing pain. Future research should incorporate sham cupping and objective measurement to distinguish the effectiveness of negative pressure and the actual therapeutic effect on LBP. It is important to standardize cupping protocol and establish a consensus on the cupping intervention of LBP management.

## CRediT authorship contribution statement

**Pasapula Mahesh:** Writing – review & editing. **Zhang Zixin:** Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Edwards Kimberley:** Writing – review & editing, Supervision, Project administration. **Wang Zelu:** Data curation. **Norrish Alan:** Writing – review & editing, Supervision, Project administration, Methodology, Data curation. ZX was responsible for study design, data collection, analysis and interpretation, publication screening, writing, and manuscript revision. ZW was involved in data screening. MP was involved in the initial manuscript editing. KE was involved in reviewing and proofreading. AN was responsible for the study design, data collection, publication screening, and manuscript revision. All authors read and approved the final manuscript.

## Declaration of Competing Interest

All authors have no conflicts of interest to declare.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ctim.2024.103013.

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