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Review article

The effects of reflexology on symptoms in pregnancy: A systematic review of randomized controlled trials

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ABSTRACT

Objective: This review assessed the effects of reflexology on symptoms in pregnancy.
Methods and analysis: PubMed, Embase, Springer, Web of Science, the Cochrane Library, and reference lists of previous systematic reviews were searched for the eligible randomized controlled trials (RCT) from the inception date of each predefined database up to May 31st, 2023. Data were extracted, and methodological quality was evaluated by the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2). The efficacy of treatment was assessed using pooled effect sizes (Hedges' g) and 95% confidence intervals (CI). Meta-analysis was performed using the RevMan 5.4 manager, and publication bias was evaluated by Begg's test.
Results: The included a total of 13 RCTs in this review, of eleven was high risk of bias and two were low, reported the effects of reflexology on low back and/or pelvic pain (LBPP), labor pain, duration of labor, anxiety, fatigue, sleep quality, constipation symptoms, and ankle and foot edema in pregnancy. The effect sizes (Hedges' g) for reflexology in labor pain, duration of labor, anxiety, fatigue, and sleep quality showed statistical significance, which the meta-analysis also confirmed except for fatigue and sleep quality due to insufficient studies.
Conclusion: Reflexology is probably effective and safe for labor pain, duration of labor, and anxiety in pregnancy, while the evidences for reflexology in LBPP, fatigue, sleep quality, constipation symptoms, and ankle and foot edema during pregnancy were insufficient. Based on the low to high quality of included studies, strong supportive evidence is not yet available. Rigorous-design and large-scale clinical trials should be conducted to provide higher-quality, reliable evidence.

1. Introduction

Pregnancy is considered a challenging experience presenting both psychological and physiological challenges for women. Along with the physical and mental change, many women suffer from a series of symptoms, such as edema [1], low back and/or pelvic pain (LBPP) [2], sleep problem and fatigue [3]. And as labor is approaching, tension, anxiety, and fear can be increased, which are

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considered to exacerbate labor pain and affect the birth experience [4]. Many pregnant women seek Complementary and Alternative Medicine (CAM) to manage a range of symptoms, because they believe that non-invasive treatments offer a safer alternative therapy than pharmacological or invasive treatments [5,6].

Reflexology, as a complementary therapy, was first introduced into the field of modern medicine by Dr. William Fitzgerald [7] as "zone therapy", and was defined as "the science of relieving pain and curing disease by pressures in the various 'zones' affected by pain or disease". Later in the 1930s and 1940s, it was modified and renamed "reflexology" by Eunice Ingham [8]. Based on Ingham's work, the International Institute of Reflexology [9] defined: "Reflexology is a science which deals with the principle that there are reflex areas in the feet and hands which correspond to all of the glands, organs, and parts of the body. Stimulating these reflexes properly can help many health problems in a natural way, a type of preventative maintenance." The reflex areas, also called "reflex zones", have been claimed to correspond to the internal organs, glands, and other body parts [10]. Reflex zones in the feet, hands, and ears [11,12] are studied and used by many reflexologists. And reflex zones in the feet are a preference since feet are larger, more sensitive, and easily accessible [10]. In a Cochrane review [5], reflexology is defined as "gentle manipulation or pressing on certain parts of the foot to produce an effect elsewhere in the body".

According to nerve impulse theory, it has been proposed that reflexology stimulation can affect the autonomic nervous system and enhance nervous connections to corresponding body parts, which may reduce stress and tension and maintain balance or homeostasis [13]. And some scholars tend to believe reflexology increases blood flow to the related organs and body parts or restores the proper flow of the bloodstream, which raises a sense of relaxation and improves the healing ability [13,14].

With the popularity of reflexology, the way of reabsorbing and eliminating energy blocks or disturbances by applying pressure to reflex zones [10,15] is used to manage pregnancy symptoms. To enable women and therapists to make informed decisions and offer evidence for clinical practice, this study was to evaluate the efficacy and safety of reflexology in pregnant women.

2. Methods

2.1. Search strategy

This systematic review consisted of an electronic and manual search for all randomized controlled trials (RCT) conducted in pregnant women treated by reflexology. PubMed, Embase, Springer, Web of Science, and the Cochrane Library were searched from the inception date up to May 31st, 2023. The reference lists of previous systematic reviews were searched for citations of potentially eligible trials. The search strategy for the PubMed database is shown in Table 1 as an example.

2.2. Eligibility criteria

Studies published in English, reporting RCT conducted with pregnant women, were included in this review. Articles were included when reflexology was the sole or main intervention in one group during pregnancy (including the first stage of labor). Duplicate publications of the same study were excluded, and the most recent paper incorporating the results of the entire study was included incorporating the results of the entire study.

Table 1
Search strategy used in PubMed.

Number	Search terms
1	Randomized controlled trial [MeSH Terms]
2	Controlled clinical trial [MeSH Terms]
3	Randomized [Title/Abstract]
4	Randomly [Title/Abstract]
5	1 or 2-4
6	Reflexotherapy [MeSH Terms]
7	Reflexology [Title/Abstract]
8	reflection therapy [Title/Abstract]
9	reflective therapeutics [Title/Abstract]
10	reflexological therapy [Title/Abstract]
11	reflexogenic therapy [Title/Abstract]
12	reflex therapy [Title/Abstract]
13	zone therapy [Title/Abstract]
14	6 or 7-13
15	pregnancy [Mesh Term]
16	pregnant [Title/Abstract]
17	gestation [Title/Abstract]
18	gestational [Title/Abstract]
19	maternal [Title/Abstract]
20	prenatal [Title/Abstract]
21	antenatal [Title/Abstract]
22	15 or 16-21
23	5 and 14 and 22

Table 2
Summary characteristics of the included studies.

Author First author, Year	Location	Duration	Sample	Sample Size (n)		Sample Age	Sample Gestational Week	Main Outcome Measures
Mollart 2003 [20]	Australia	Sep 1999 to Aug 2001	Pregnancy with ankle and foot edema	n = 55	Control Group (n = 10) Reflexology Group (n = 45)	27 ± 5.66	35.9 ± 1.79	Measurements of ankle and foot circumference
Dolatian 2011 [21]	Iran	In 2018	Pregnancy	n = 120	Control Group (n = 40) Reflexology Group (n = 40) Support Group (n = 40)	22.9 ± 3.85	39 ± 1.24	VAS Duration of three stages
Close 2015 [22]	UK	Jul 2012 to Sep 2013	Pregnancy	n = 64	Control Group (n = 25) Placebo Group (n = 15) Reflexology Group (n = 24)	30.1 ± 5.65	32.04 ± 1.26	VAS RMDQ STAI TX-1
Mccullough 2017 [23]	UK	Jul 2012 to Nov 2013	Pregnancy with LBPP	n = 64	Control Group (n = 25) Reflexology Group (n = 24) Placebo Group (n = 15)	30.3 ± 5.5	21.7 ± 0.9	Labour time of onset and duration of the second stage
Shobeiri 2017 [24]	Iran	Jan 2016 to Mar 2016	Pregnancy	n = 126	Control group (n = 42) Reflexology Group (n = 84)	25.85 ± 7.28	25.16 ± 4.73	30-question standard checklist for fatigue assessment
Mccullough 2018 [25]	UK	Jul 2012 to Dec 2013	Pregnancy with LBPP	n = 61	Control group (n = 23) Reflexology Group (n = 23) Placebo Group (n = 15)	30.4 ± 5.8	27.1 ± 5.9	VAS Beta-endorphin STAI TX-1 Cortisol
Erkek 2018 [26]	Turkey	Not reported	Pregnancy with anxiety	n = 154	Control Group (n = 77) Reflexology Group (n = 77)	Not reported	40	STAI TX-1
Nasir 2019 [27]	Iran	Mar to Jun 2018	Pregnancy with gestational diabetes and high blood pressure	n = 72	Control Group (n = 36) Reflexology Group (n = 36)	27.5 ± 6.2	28–32	SCI
Navaee 2019 [28]	Iran	in 2019	Pregnancy with anxiety	n = 60	Control Group (n = 30) Reflexology Group (n = 30)	26 ± 4	38	STAI TX-1
Sehhatti 2020 [29]	Iran	2017 to 2018	Pregnancy with constipation diagnosis	n = 72	Control Group (n = 36) Reflexology Group (n = 36)	25.4 ± 4.6	23–28	CAS STAI TX-1
Semra 2020 [30]	Turkey	1 Jul 2017 to 7 Jul 2018	Pregnancy	n = 60	Control Group (n = 30) Reflexology Group (n = 30)	Not reported	Not reported	VAS Duration of three stages Birth Satisfaction Scale STAI TX-1
Jameei-Moghaddam 2021 [31]	Iran	Jan 2020 to Oct 2020	pregnancy	n = 60	Control Group (n = 28) Reflexology Group (n = 32)	26 ± 6.2	39.9 ± 0.9	VAS Duration of three stages
Kaplan 2021 [32]	Turkey	15 Jun 2019 to 15 Mar 2020	Pregnancy	n = 120	Control Group (n = 40) Reflexology Group (n = 40) Guided Imagery Group (n = 40)	23.6 ± 3.8	Not reported	VAS Duration of the active phase, transition phase, and 2nd stage

Note. VAS: Visual Analogue Scale; RMDQ: Roland Morris Disability Questionnaire; STAI TX-1: S-subscale of State Trait Anxiety Inventory; CAS: Constipation Assessment Scale; SCI: Sleep Condition Indicator.

Table 3
Reflexology groups of the included studies.

Study	n	Intervention Reflexology	Reflex Zone	Reflexology Tool	Reflexology Time	Reflexology Frequency	Reflexology Period
Mollart 2003 [20]	20	Reflexology	Foot reflex zones for chest, abdomen, spine, pelvis, and head and related to the lymphatic system, liver, gastrointestinal tract, and kidneys	Finger + grapeseed oil	15 min	1–4 times	Not reported
Dolatian 2011 [21]	40	Reflexology	Foot reflex points	Finger	40 min	Once	At a dilation of 4–5 cm
Close 2015 [22]	24	Reflexology	Foot reflex points for the back or pelvis	Finger	30 min	Once a week	Six weeks
Mccullough 2017 [23]	24	Reflexology#	Foot reflex points for the bones and musculature of the back and pelvic girdles and related organs and structures that impact the functioning of the spine and pelvic girdle	Finger	30 min	Six times a week	Six weeks
Shobeiri 2017 [24]	84	Reflexology#	Foot	Finger	30 min	Twice a week	Five weeks
Mccullough 2018 [25]	23	Reflexology	Foot reflex points for the bones and musculature of the back and pelvic girdles and related organs and structures that impact the functioning of the spine and pelvic girdle	Finger	30 min	Once a week	Six weeks
Erkek 2018 [26]	77	Reflexology#	Foot anxiety reflex points	Finger	30 min	Once	During the active phase (3–4 cm) of labor
Nasir 2019 [27]	36	Reflexology#	Foot reflex points correspond to every organ	Finger + olive oil	30 min	Twice a week	Four weeks
Navaee 2019 [28]	30	Reflexology#	Foot	Finger + body oil	30 min	Once	One day
Semra 2020 [30]	30	Reflexology#	Foot reflex points	Finger	50 min	Once	During the active phase (4 cm) of labor
Sehhatti 2020 [29]	36	Reflexology#	Foot using the "Metatarsal kneading" method and on the intestine and colon area on the right sole	Finger	12 min	Once a week	Six weeks
Jameei-Moghaddam 2021 [31]	32	Reflexology	Foot reflex points for the pituitary gland, solar plexus, uterine, and spinal cord	Finger + olive oil	40 min	Twice	At a dilation of 4 cm and 7 cm, respectively
Kaplan 2021 [32]	40	Reflexology	Foot	Finger	30 min	Once	At a dilation of 4 cm

Note. # treated based on the control group.

2.3. Study selection and data extraction

Two review authors (FJY and XYL) independently screened the titles, abstracts, and keywords of all retrieved trials and determined which trials met the above inclusion criteria. The other two review authors (SPW and XHW) strictly screened the full text of all relevant trials and potentially eligible full-text articles according to the eligibility criteria, recorded and explained excluded trials. Disagreement at this stage was resolved by bilateral discussion or the third review author (KL) if necessary.

Once study selection was completed, data were extracted into Microsoft Excel 2013 from each included article. The extracted data are listed as follows: authors' name, publication year, sample size, sample age and gestational week, intervention details, and outcome measures.

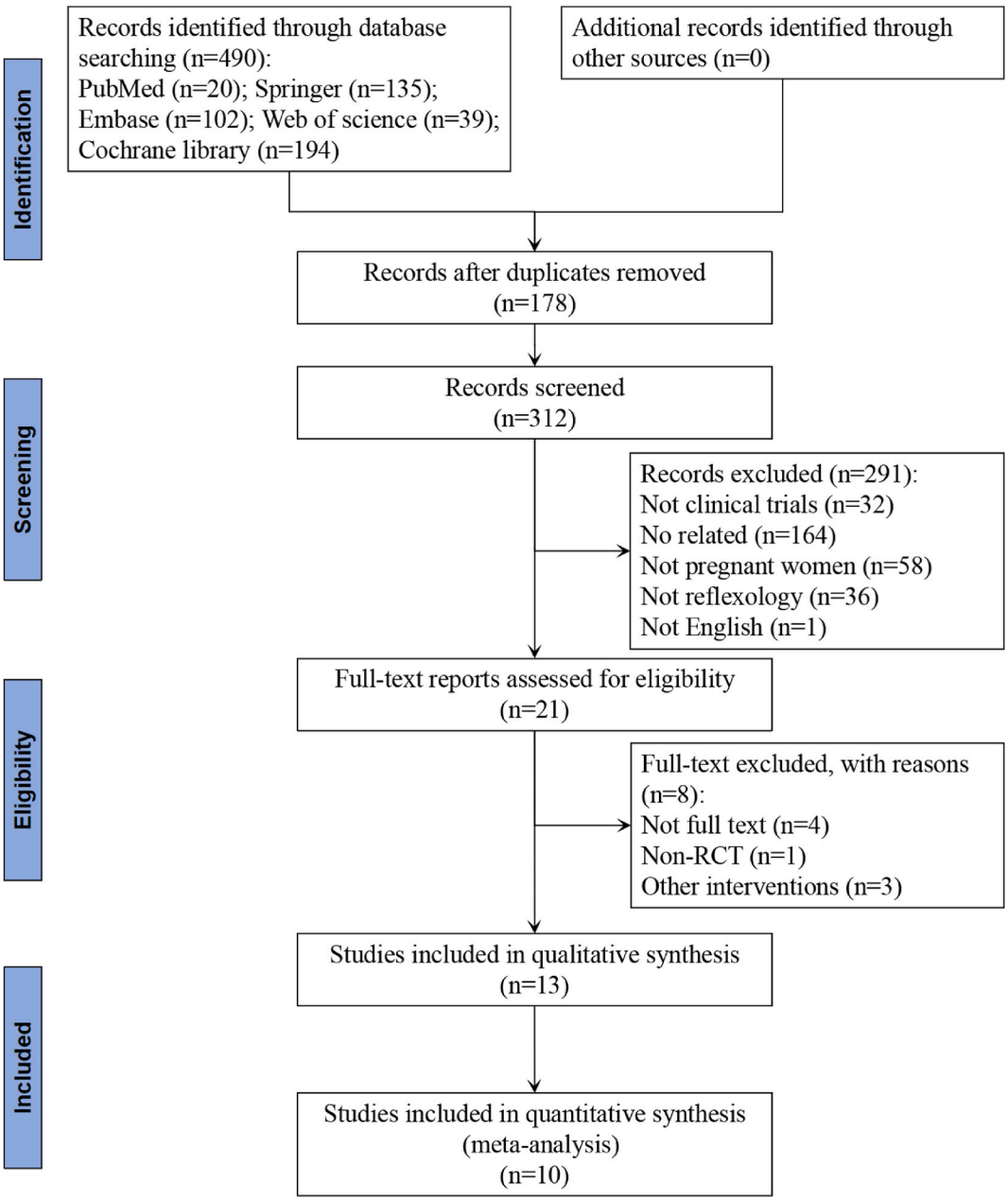


Fig. 1. The flowchart for study search and study selection.

2.4. Quality assessment

The quality of all included RCTs was independently evaluated by two review authors (XYL and SPW) using the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2) [16]. The risk of bias was assessed as "low risk of bias", "some concerns", or "high risk of bias" in five domains: randomization process, deviations from the intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. An overall bias was calculated based on bias in the five domains. For each study, the assessment result in at least one domain showing "high risk" or multiple domains showing "some concerns" would result in overall high risk of bias; in all domains showing "low risk" would result in overall low risk of bias in the assessed outcome. Disagreement between assessments was resolved by the third review author (KL).

2.5. Data management and analysis

Efficacy of the interventions was assessed by 95% confidence interval (CI) and effect sizes (Hedges' g) [17] for all continuous data. For each RCT, effect size and 95%CI were calculated according to the provided statistics of the reflexology group and the control or placebo group. If pre-intervention data was provided, it was also used, together with the post-data, to calculate the effect size and 95% CI for the reflexology group. Based on benchmarks proposed by Cohen [18], the experimental intervention was regarded as effective if 95%CI of the effect size did not cross 0, and the effect size was referred to large effect (Hedges' $g > 0.8$), moderate effect (Hedges' $g = 0.5–0.8$) and small effect (Hedges' $g = 0.2–0.5$). And efficacy of the intervention was evaluated by its effect size, along with its P value.

If two or more trials provided the same outcome measure and available data, meta-analysis for individual outcomes was conducted by software RevMan 5.4 and presented in this review, otherwise descriptive analysis was conducted. Mean differences (MDs) with 95% CI were calculated for continuous data in meta-analysis. Heterogeneity of the results was assessed by Cochrane's Q test, with $P < 0.10$ proving significant heterogeneity, and quantified by I-square test (I^2) [19]. A random-effect model was used if $P < 0.10$ and $I^2 > 50\%$, otherwise a fixed-effect model was used. Sensitivity analysis was conducted to evaluate the robustness of results and explore heterogeneity sources by removing the included studies one by one. Begg's test was used to evaluate publication bias, and P value and the 95%CI was considered as statistically significant. If the number of included RCTs for meta-analysis was 2 or less, only according to the P value to define the publication bias. Studies with $P > 0.05$ were considered as no publication bias.

3. Results

3.1. Included studies search

A total of 490 articles were identified during the initial electronic search and no eligible study was obtained from reviewing the reference lists. 178 articles were retained after removing duplicates. After screening titles and abstracts, 291 articles were retained for further evaluation. 21 articles were further excluded by screening the full text of all remaining relevant trials. Therefore, 13 articles were included and assessed for qualitative analysis (Tables 2 and 3), of which 10 RCTs involving 835 pregnant women were selected for the meta-analysis. The selection process is shown in Fig. 1.

3.2. Characteristics of studies

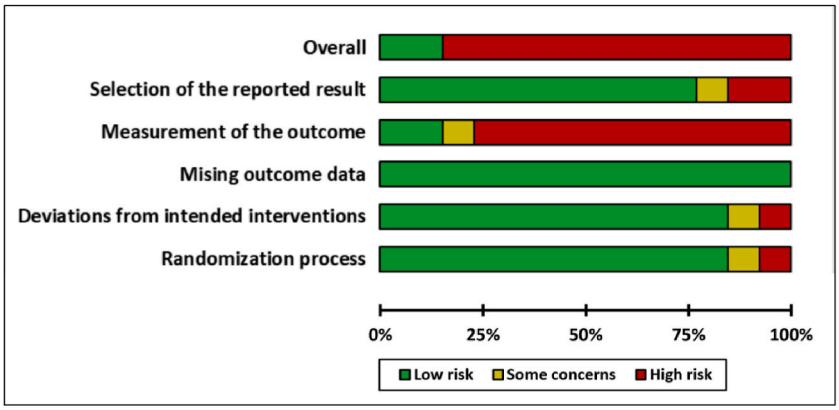
The main characteristics of the included studies are summarized in Tables 2 and 3.

13 articles published in English between 2003 and 2020 were analyzed, including six articles from Iran [21,24,27–29,31], three from the United Kingdom (UK) [22,23,25], three from Turkey [26,30,32], and one from Australia [20]. A total of 1088 pregnant women, ranged from 55 to 154 in each RCT, were enrolled, and the number in each Reflexology Group ranged from 23 to 77.

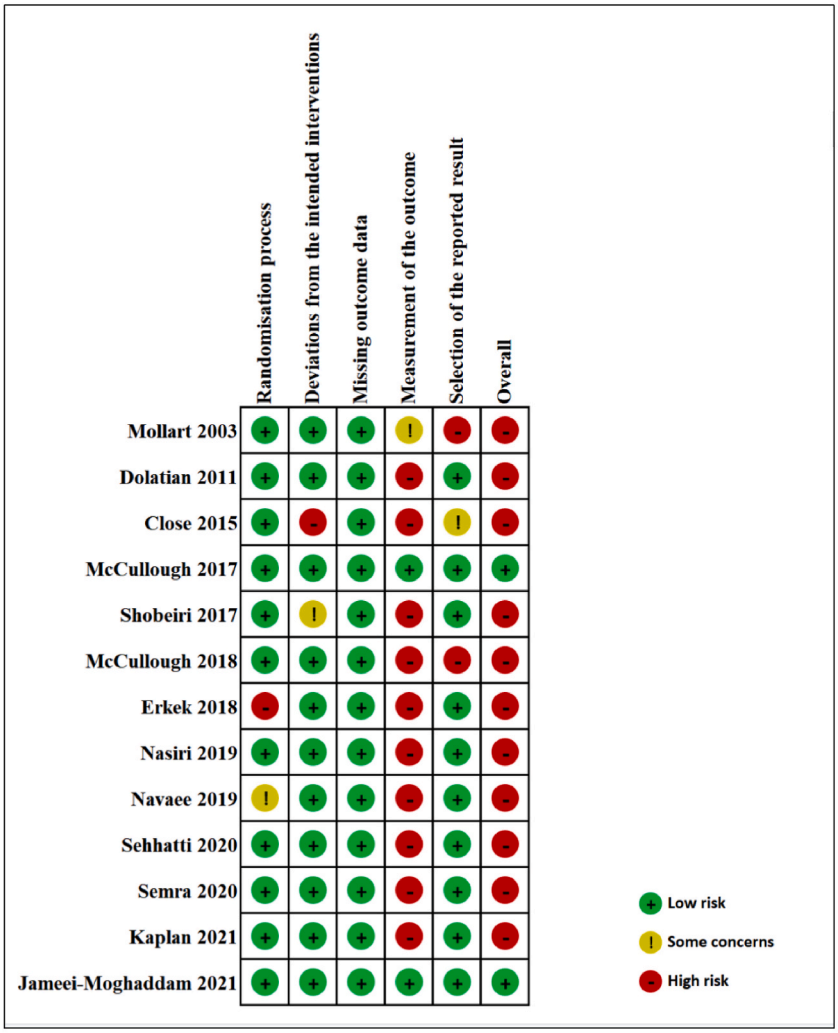
All studies used control group as comparator. Most control groups used no intervention [26,20] or routine care [21,24,22,23,25,27,29,30,32], and 2 control groups underwent massage [28,31]. 7 reflexology groups [24,28,29,27,23,26,30] of included RCTs were treated based on the control group, and the rest adopted reflexology alone. The placebo groups in 3 RCTs [22,23,25] adopted foot bath intervention.

According to symptoms managed and outcome measures in included studies, the clinical application of reflexology in pregnancy was summarized into low back and/or pelvic pain (LBPP), labor pain, labor quality, anxiety, fatigue, ankle and foot edema, sleep quality, and constipation. And the reflexology treatments were all applied on foot and varied in reflex zone selection, time, frequency, and course of treatment.

To measure the efficacy of reflexology on LBPP, outcome measures included the Visual Analogue Scale (VAS) for pain intensity and frequency [22,25], the Roland Morris Disability Questionnaire (RMDQ) [22], and the level of beta-endorphin [25]. VAS was also used to measure labor pain [21,31,30,32]. To measure the efficacy of reflexology on anxiety, outcome measures included S-subscale of State Trait Anxiety Inventory (STAI TX-1) [28,29,22,25,26,30] and the level of cortisol [25], while one study [25] failed to report the result of STAI TX-1. Five RCTs [21,31,23,30,32] measured the efficacy of reflexology on duration of labor. A fatigue assessment standard checklist [24] was used to measure the efficacy of reflexology on fatigue. One study [29] used the Constipation Assessment Scale (CAS) to evaluate the effect of reflexology on constipation symptoms during pregnancy, and one [27] adopted Sleep Condition Indicator (SCI) to sleep quality among high risk pregnant women. One study [20] used ankle and foot circumference as the outcome measure for ankle and foot edema, but the result was reported incompletely.



(A)



(B)

Fig. 2. The results of risk of bias assessment. (A) Risk of bias graph: percentage of each risk of bias item across all included studies; (B) Risk of bias summary.

Table 4
Effect size evaluation for studies in the review.

Study	Measures	Reflexology				Mean	SD	n	Effect Size	95% CI	*P*
		Mean	SD	n							
Low Back and/or Pelvic Pain											
Close 2015	Frequency in VAS	5.41	2.8	24	**Pre**	7.05	2.36	24	0.75	[0.16,1.34]	= 0.03
					Control	5.5	2.8	25	0.03	[-0.53,0.59]	= 0.91
					Placebo	6.13	2.85	15	0.25	[-0.40,0.90]	= 0.44
	Intensity in VAS	5.14	2.65	24	**Pre**	5.81	2.02	24	0.28	[-0.29,0.85]	= 0.32
					Control	5.33	2.69	25	0.07	[-0.49,0.63]	= 0.80
					Placebo	5.63	2.26	15	0.19	[-0.46,0.84]	= 0.54
	RMDQ	8.29	5.23	24	**Pre**	9.67	3.91	24	0.29	[-0.28,0.86]	= 0.30
					Control	10.21	5.28	25	0.36	[-0.21,0.92]	= 0.20
					Placebo	11.13	5.13	15	0.54	[-0.12,1.19]	= 0.10
Mccullough 2018	Frequency in VAS	5.42	2.8	23	**Pre**	7.05	2.36	23	0.62	[0.03,1.21]	= 0.03
					Control	5.5	2.81	23	0.03	[-0.55,0.61]	= 0.92
					Placebo	6.13	2.86	15	0.25	[-0.41,0.90]	= 0.45
	Intensity in VAS	5.14	2.65	23	**Pre**	5.81	2.02	23	0.28	[-0.30,0.86]	= 0.33
					Control	5.33	2.69	23	0.07	[-0.51,0.65]	= 0.81
					Placebo	5.63	2.27	15	0.19	[-0.46,0.84]	= 0.54
	Beta-endorphin	4.19	2.99	23	**Control**	4.72	3.28	23	0.17	[-0.41,0.75]	= 0.57
					Placebo	4.13	3.3	15	−0.02	[-0.67,0.63]	= 0.95
Labor Pain											
Dolatian 2011	VAS in cervical dilation 4–5 cm	4.5	1.06	40	**Control**	7.23	0.83	40	2.84	[2.21,3.47]	<0.00001
					Support	6.25	0.84	40	1.81	[1.29,2.34]	<0.00001
Semra 2020	VAS in cervical dilation 4–7 cm	4.3	0.7	30	**Control**	6.7	1.1	30	2.57	[1.88,3.26]	<0.00001
	VAS in cervical dilation 8–10 cm	9.1	0.9	30	**Control**	9.8	0.3	30	1.03	[0.49,1.57]	<0.0001
Kaplan 2021	VAS	4.1	1.69	40	**Pre**	6.65	1.52	40	1.57	[1.07,2.08]	<0.00001
					Control	6.7	0.6	40	2.03	[1.49,2.57]	<0.00001
					Guided Imagery	4.02	2.2	40	−0.04	[-0.48,0.40]	= 0.86
Jameei-Moghaddam 2021	VAS	6.3	1.6	32	**Pre**	6.3	2.8	32	0.00	[-0.49,0.49]	= 1.00
					Control	7.9	1.6	28	0.99	[0.45,1.53]	= 0.0001
Duration of labor											
Dolatian 2011	Duration of the first stage	166.88	42.02	40	**Control**	229.13	51.52	40	1.31	[0.83,1.80]	<0.00001
					Support	207.13	64.41	40	0.73	[0.28,1.19]	= 0.0009
	Duration of the second stage	25.18	17.24	40	**Control**	55.63	27.29	40	1.32	[0.84,1.81]	<0.00001
					Support	47.63	2.087	40	1.81	[1.29,2.33]	<0.00001
	Duration of the third stage	3.33	1.34	40	**Control**	7.93	12.15	40	0.53	[0.08,0.97]	= 0.02
					Support	7.55	6.29	40	0.92	[0.46,1.38]	<0.0001
Mccullough 2017	Duration of the second stage	73.56	53.78	16	**Control**	117.92	56.51	16	0.78	[0.06,1.51]	= 0.02
					Placebo	117.4	68.54	10	0.71	[-0.11,1.53]	= 0.09
Semra 2020	Duration of the first stage	426.8	236.4	30	**Control**	413.1	214.1	30	−0.06	[-0.57,0.45]	= 0.81
	Duration of the second stage	27.3	16.4	30	**Control**	30.8	6.9	30	0.27	[-0.23,0.78]	= 0.28
	Duration of the third stage	8.8	2.5	30	**Control**	11.6	4.4	30	0.77	[0.25,1.30]	= 0.002
Jameei-Moghaddam 2021	Duration of the active phase	448.8	189.3	32	**Control**	530.6	192.8	28	0.42	[-0.09,0.94]	= 0.10
	Duration of the second stage	17.5	10.7	32	**Control**	22	8.6	28	0.69	[0.17,1.22]	= 0.07
	Duration of the third stage	7.67	3.5	32	**Control**	9.6	4.4	28	0.48	[-0.03,1.00]	= 0.06
Kaplan 2021	Duration of the active phase	385.37	212.03	40	**Control**	668.25	90.39	40	1.72	[1.20,2.23]	<0.00001
					Guided Imagery	330.75	203.91	40	−0.26	[-0.70,0.18]	= 0.24
	Duration of the transition phase	31.07	16.44	40	**Control**	64.87	12	40	2.33	[1.75,2.90]	<0.00001
					Guided Imagery	44.25	87.11	10	0.21	[-0.23,0.65]	= 0.63
	Duration of the second stage	14.5	4.05	40	**Control**	34.87	4	40	5.01	[4.10,5.92]	<0.00001
					Guided Imagery	17.39	2.52	40	0.84	[0.38,1.30]	= 0.0001
Anxiety											
Close 2015	STAI TX-1	44.92	4.12	24	**Pre**	43.46	5.18	24	0.33	[-0.24,0.90]	= 0.28
					Control	45.72	4.09	25	0.18	[-0.38,0.74]	= 0.09
					Placebo	45.07	3.33	15	0.04	[-0.61,0.68]	= 0.90
Mccullough 2018	Cortisol	0.202	0.081	23	**Control**	0.297	0.38	23	0.34	[-0.24,0.92]	= 0.24
					Placebo	0.17	0.073	15	−0.40	[-1.06,0.26]	= 0.21

(*continued on next page*)

Table 4 (*continued*)

Study	Measures	Reflexology				Mean	SD	n	Effect Size	95% CI	*P*
		Mean	SD	n							
Erkek 2018	STAI TX-1 in latent phase (3–4 cm)	47.77	9.38	77	**Pre**	47.57	9.68	77	−0.02	[-0.34,0.30]	= 0.90
					Control	51.72	9.99	77	0.41	[0.09,0.72]	= 0.01
	STAI TX-1 in active phase (6–8 cm)	54.64	9.45	77	**Control**	60.32	8.14	77	0.64	[0.32,0.96]	<0.0001
	STAI TX-1 in the early postpartum period	33.89	7.37	77	**Control**	35.92	7.23	77	0.28	[-0.04,0.59]	= 0.08
	Mean scores of STAI TX-1	45.97	6.43	77	**Control**	48.94	6.05	77	0.47	[0.15,0.79]	= 0.003
Navaee 2019	STAI TX-1	40	7	30	**Pre**	55	8	30	1.97	[1.35,2.59]	<0.00001
					Control	47	7	30	0.99	[0.45,1.52]	= 0.0001
Semra 2020	STAI TX-1 in cervical dilation 4–7 cm	24.9	4.1	30	**Control**	50.3	9.5	30	3.43	[2.62,4.24]	<0.00001
	STAI TX-1 in cervical dilation 8–10 cm	49.2	9.2	30	**Control**	62.8	5.1	30	1.80	[1.20,2.41]	<0.00001
Sehhatti 2020	STAI TX-1	38.8	8.5	36	**Pre**	42.4	7.3	36	0.51	[0.04,0.98]	= 0.05
					Control	41.2	8	36	0.34	[-0.12,0.81]	= 0.22
Fatigue											
Shobeiri 2017	30-question standard checklist for fatigue assessment	0.72	0.47	84	**Pre**	1.23	0.63	84	0.91	[0.60,1.23]	<0.00001
					Control	1.15	0.54	42	0.86	[0.48,1.25]	<0.0001
Sleep quality											
Nasir 2019	SCI	21.3	3.6	36	**Pre**	15.6	9.8	36	0.76	[0.28,1.24]	= 0.001
					Control	12.5	5.7	36	1.82	[1.27,2.38]	<0.00001

Note. VAS: Visual Analogue Scale; RMDQ: Roland Morris Disability Questionnaire; STAI TX-1: S-subscale of State Trait Anxiety Inventory; CAS: Constipation Assessment Scale; SCI: Sleep Condition Indicator.

3.3. Risk of bias assessment

13 RCTs were assessed for the primary outcomes by the RoB2 tool [16], and the results were visualized in Fig. 2A and B. For some studies with more than one outcome, assessments for Measure of outcome and Selection of the reported result could have multiple assessments, and Fig. 2 only presented the worst assessment for each trial. Overall risk of bias was high in eleven RCTs [21,24,28,22,27,29,20,25,26,30,32] and low in two [31,23].

In the Randomization process, most studies presented low risk of bias. One study [26] presented high risk of bias due to inappropriate random method on admission date, and another [28] presented some concerns due to lack of information on allocation concealment. Considering the intention-to-treat effect, one study [22] presented high risk on Deviation from intended interventions because participants in the study sought other interventions to manage their symptoms and the deviation was unbalanced between groups, and another one [24] was considered some concerns because of insufficient information. There was low risk of bias from Missing outcome data in all papers. Most of the studies presented high risk of bias [21,24,28,22,27,29,25,26,30,32] or some concerns [20] on Measurement of the outcome, which the reason of was the use of self-report methods, such as VAS for pain. Our opinion upon viewing the papers was that self-report methods were acceptable and reasonable since the objects of the studies were to evaluate symptom management and there was no better alternative. Some studies using high risk self-report outcomes also provided objective outcome measurement evaluated as low risk (i.e., labor time), and the reason why low risk was not presented in Fig. 2 because only the worst assessment for each study was presented. Furthermore, the risk of bias on Selection of the reported result presented high risk of bias in two studies [25,20] due to incomplete report of the result, and another study [22] reported some concerns since its analysis intention was not available without providing protocol.

3.4. Low back and/or pelvic pain (LBPP)

Two studies [22,25] reported the efficacy of reflexology on LBPP mainly using VAS for pain frequency and intensity as measurement, but probably came from the same team and shared part of the relevant data of VAS. Both studies from Close [22] (Hedges' g = 0.75, 95%CI [0.16, 1.34], $P = 0.03$) (Table 4) and Mccullough [25] (Hedges' g = 0.62, 95%CI [0.03, 1.21], $P = 0.03$) (Table 4) demonstrated a significant difference and moderate effect on LBPP frequency between pre-post groups, from which meta-analysis results also showed statistical significance and no statistical heterogeneity with fixed-effect model (MD -1.64, 95%CI [−2.68, −0.59], $P = 0.002$, $I^2 = 0\%$) as shown in Fig. 3A. Compared with other groups, the data of the LBPP frequency and intensity in the reflexology group decreased but with no significant difference and effect because effect size 95%CI did cross zero. The meta-analysis results from the two studies also showed no significant difference between the reflexology group and the other groups, and no statistical heterogeneity ($I^2 = 0\%$) (Fig. 3B–F).

The results of beta-endorphin in the study from Mccullough [25] and the Roland Morris Disability Questionnaire (RMDQ) in the study from Close [22] were the same as the above, which had no significant difference and effect.

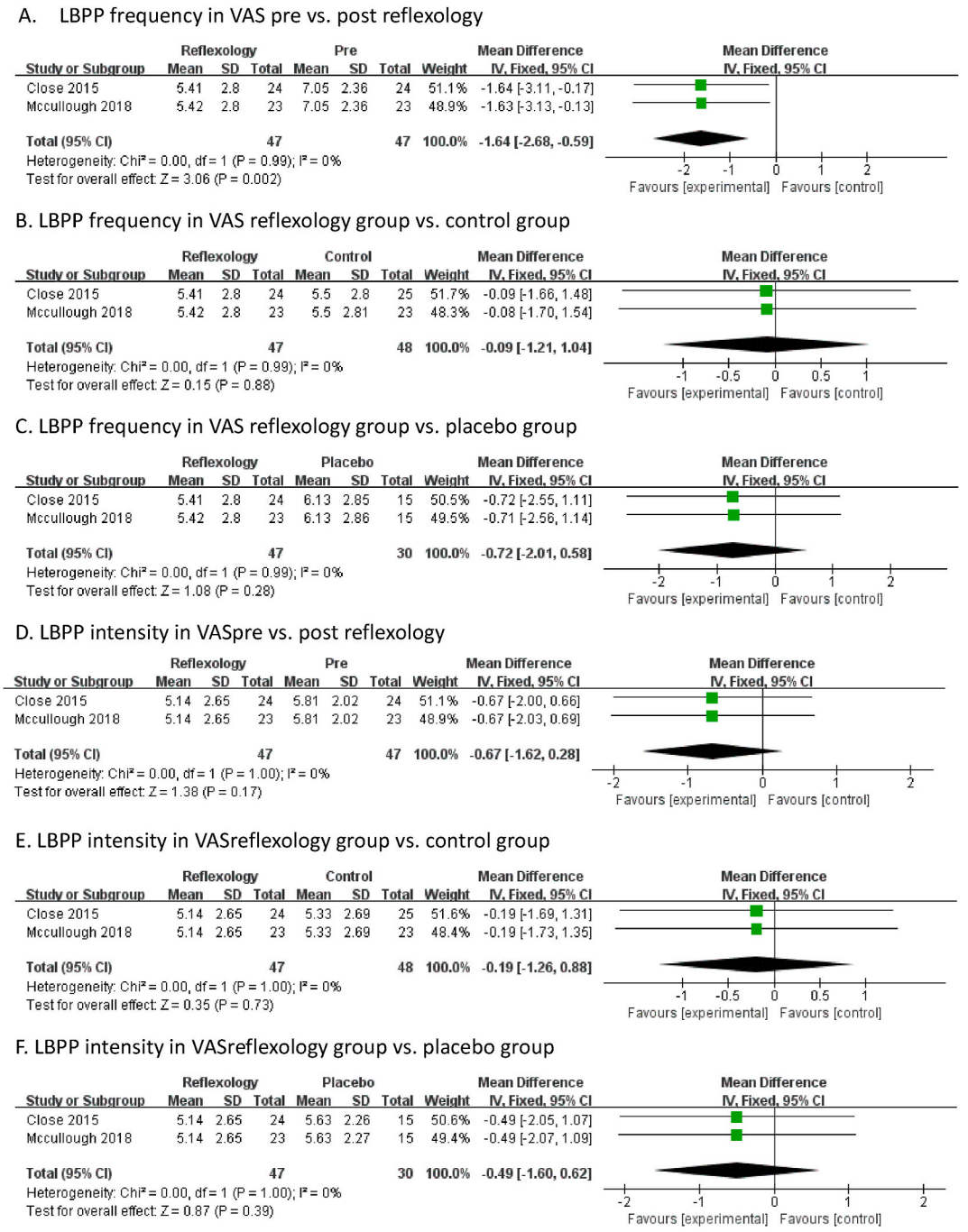


Fig. 3. Meta-analysis for the effect of reflexology on LBPP.
Note. LBPP: low back and/or pelvic pain; RR: relative risks; SD: standard deviation; CI: confidence interval; I^2: I-square; IV: image value.

3.5. Labor pain

Effect of reflexology in the first stage of labor of pregnant women on labor pain was evaluated by VAS in four studies [21,31,30,32]. In comparing reflexology group with control group, all four studies demonstrated a large significant difference and large effect, both the instant efficacy data (Dolatian, Hedges' g = 2.84, 95%CI [2.21, 3.47], $P < 0.00001$; Semra, Hedges' g = 2.57, 95%CI [1.88, 3.26], $P < 0.00001$; Kaplan, Hedges' g = 2.03, 95%CI [1.49, 2.57], $P < 0.00001$; Jameei-Moghaddam, Hedges' g = 0.99, 95%CI [0.45, 1.53], $P = 0.0001$) (Table 4) and continuous efficacy data after intervention (Semra, Hedges' g = 1.03, 95%CI [0.49, 1.57], $P < 0.0001$) (Table 4). And with a random-effect model, the meta-analysis also showed that the instant efficacy of reflexology was associated with

low levels of VAS, and significant heterogeneity was observed across the included studies (MD -2.43, 95%CI [−2.81, −2.04], $P < 0.00001$, $I^2 = 51\%$) (Fig. 4A). Sensitivity analysis indicated that Jameei-Moghaddam was the origin of heterogeneity, and also the reason for high heterogeneity on VAS in the pre-post reflexology groups with no significant difference (Fig. 4B).

Dolatian [21] found that compared with the support group, which received spiritual, emotional and verbal support, VAS in the reflexology group was statistically significantly lower (Hedges' g = 1.81, 95%CI [1.29, 2.34], $P < 0.00001$) (Table 4), but no difference compared with the guide image group, which was found by Kaplan [32].

Comparing the pre-post groups, one study [32] demonstrated a large significant difference and a large effect (Hedges' g = 1.57, 95%CI [1.07, 2.08], $P < 0.00001$) (Table 4), while one study [31] did not demonstrate a significant difference and effect.

3.6. Duration of labor

Five studies [21,31,23,30,32] measured the duration of labor to evaluate the efficacy of reflexology. Dolatian [21] found that the length of the first, second and third stage of labor were significantly lower in reflexology group compared to support group (the first stage of labor, Hedges' g = 0.73, 95%CI [0.28, 1.19], $P = 0.0009$; the second stage of labor, Hedges' g = 1.81, 95%CI [1.29, 2.33], $P < 0.00001$; the third stage of labor, Hedges' g = 0.92, 95%CI [0.46, 1.38], $P < 0.0001$) (Table 4), as well as control group (the first stage of labor, Hedges' g = 1.31, 95%CI [0.83, 1.80], $P < 0.00001$; the second stage of labor, Hedges' g = 1.32, 95%CI [0.84, 1.81], $P < 0.00001$; the third stage of labor, Hedges' g = 0.53, 95%CI [0.08, 0.97], $P = 0.02$) (Table 4), which demonstrated moderate or large effect. Other four studies [31,23,30,32] showed the same significant difference and effect in the active phase (Kaplan, Hedges' g = 1.72, 95%CI [1.20, 2.23], $P < 0.00001$) (Table 4), transition phase (Kaplan, Hedges' g = 2.33, 95%CI [1.75, 2.90], $P < 0.00001$) (Table 4), the second stage (Kaplan, Hedges' g = 5.01, 95%CI [4.10, 5.92], $P < 0.00001$; Jameei-Moghaddam, Hedges' g = 0.69, 95% CI [0.17, 1.22], $P = 0.07$) (Table 4) and the third stage (Semra, Hedges' g = 0.77, 95%CI [0.25, 1.30], $P = 0.002$) (Table 4) compared with control group. Although there was no statistically significant difference and effect in comparison with other groups, the results still suggested that the duration of labor was shorter in the reflexology group.

The meta-analysis provided evidence that, compared between the reflexology group and control group, duration of the active phase had statistical significance and high heterogeneity with the random-effect model (MD -185.12, 95%CI [−382.10, 11.85], $P = 0.07$, $I^2 = 91\%$) (Fig. 5A), duration of the first stage had statistical significance and low heterogeneity with the fixed-effect model (MD -59.85, 95%CI [−80.13, −39.58], $P < 0.00001$, $I^2 = 39\%$) (Fig. 5B), duration of the second stage had statistical significance and high heterogeneity with the random-effect model (MD -16.11, 95%CI [−26.83, −5.39], $P = 0.003$, $I^2 = 94\%$) (Fig. 5C), duration of the third stage had statistical significance and no heterogeneity with the fixed-effect model (MD -2.66, 95%CI [−3.93, −1.39], $P < 0.0001$, $I^2 = 0\%$) (Fig. 5D).

In addition, the study from Semra [30] also revealed that the score of the Birth Satisfaction Scale in the reflexology group was statistically significantly higher than the control group, demonstrating a large effect (Hedges' g = 2.39, 95%CI [1.72, 3.06], $P < 0.00001$) (Table 4).

3.7. Anxiety

To evaluate the efficacy of reflexology on anxiety in pregnancy, six studies [28,29,22,25,26,30] used STAI TX-1, of one [25] without primary data. Navaee [28] found that, compared with the pre-group (Hedges' g = 1.97, 95%CI [1.35, 2.59], $P < 0.00001$)

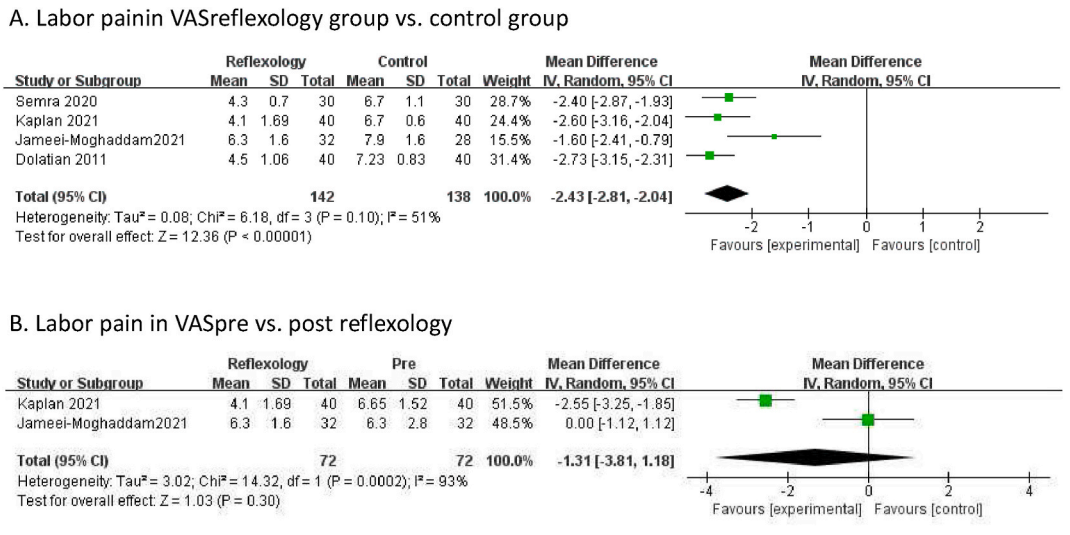


Fig. 4. Meta-analysis for the effect of reflexology on labor pain.
Note. RR: relative risks; SD: standard deviation; CI: confidence interval; I^2: I-square; IV: image value.

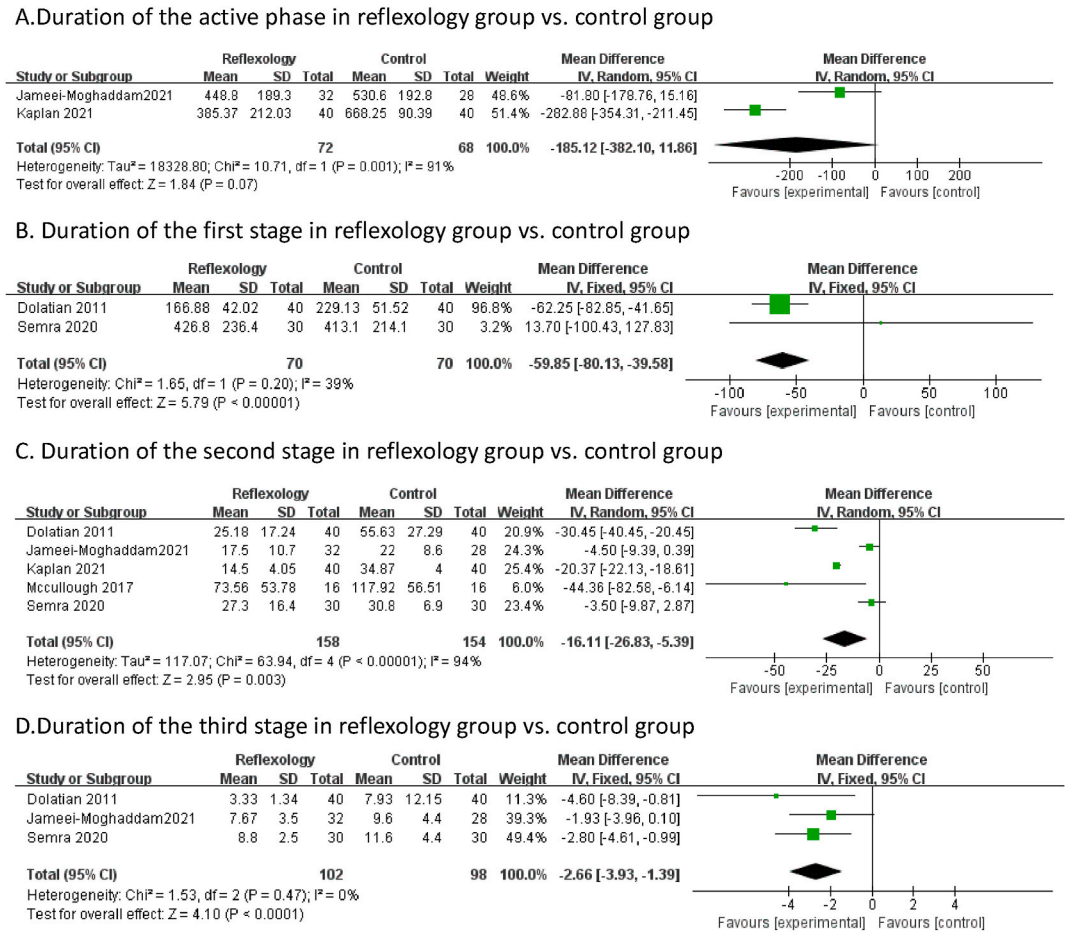


Fig. 5. Meta-analysis for the effect of reflexology on the duration of labor.
Note. RR: relative risks; SD: standard deviation; CI: confidence interval; I^2: I-square; IV: image value.

(Table 4) or the control group (Hedges' g = 0.99, 95%CI [0.45, 1.52], $P = 0.0001$) (Table 4), STAI TX-1 in the reflexology group was significantly lower with large effect, which showed that reflexology has a positive effect on anxiety before cesarean section. Compared the reflexology group with the control group, studies from Erkek [26] and Semra [30] also demonstrated statistically significant difference and effect as the same data tendency as above, not only instant efficacy after intervention (Erkek, Hedges' g = 0.41, 95%CI [0.09, 0.72], $P = 0.01$; Semra, Hedges' g = 3.43, 95%CI [2.62, 4.24], $P < 0.00001$) (Table 4) but also continuous effect until delivery (Hedges' g = 1.80, 95%CI [1.20, 2.41], $P < 0.00001$) (Table 4), which showed the reflexology applied during labor had a better effect on pregnancy anxiety. The result of STAI TX-1 in the reflexology group from Close [22] tended to decrease with no significant difference and no effect, and from Sehhatti [29] demonstrated a moderate effect comparing between the pre-post groups (Hedges' g = 0.51, 95%CI [0.04, 0.98], $P = 0.05$).

For instant efficacy after the intervention, the meta-analysis showed no statistical significance and high heterogeneity of STAI TX-1 with the random-effect model comparing the pre-post groups (MD -4.14, 95%CI [−10.96, 2.67], $P = 0.23$, $I^2 = 94\%$) (Fig. 6A), which heterogeneity of was significantly reduced ($I^2 = 0\%$) by omitting the Navaee's study [28]. And no statistical significance was showed comparing between the reflexology group and the control group with the fixed-effect model (MD -1.23, 95%CI [−3.20, 0.74], $P = 0.22$, $I^2 = 0\%$) (Fig. 6B).

For continuous effect until delivery, reflexology intervention showed significant difference and high heterogeneity with the random-effect model in STAI TX-1 (MD -9.53, 95%CI [−17.29, −1.78], $P = 0.02$, $I^2 = 91\%$) (Fig. 6C) between the pre-post groups. STAI TX-1 in the comparison between the reflexology group and control group had no statistical significance and high heterogeneity (MD -12.09, 95%CI [−24.86, 0.68], $P = 0.06$, $I^2 = 98\%$) (Fig. 6D), and sensitivity analysis indicated that the pooled conclusion was robust and unaltered by excluding each study one by one.

Cortisol in the study from McCullough [25], as evaluation indicators of chronic and long-term physiological and psychological stress, was increased by 18.82% after reflexology, but there was no significant difference and no effect between the reflexology group and control group.

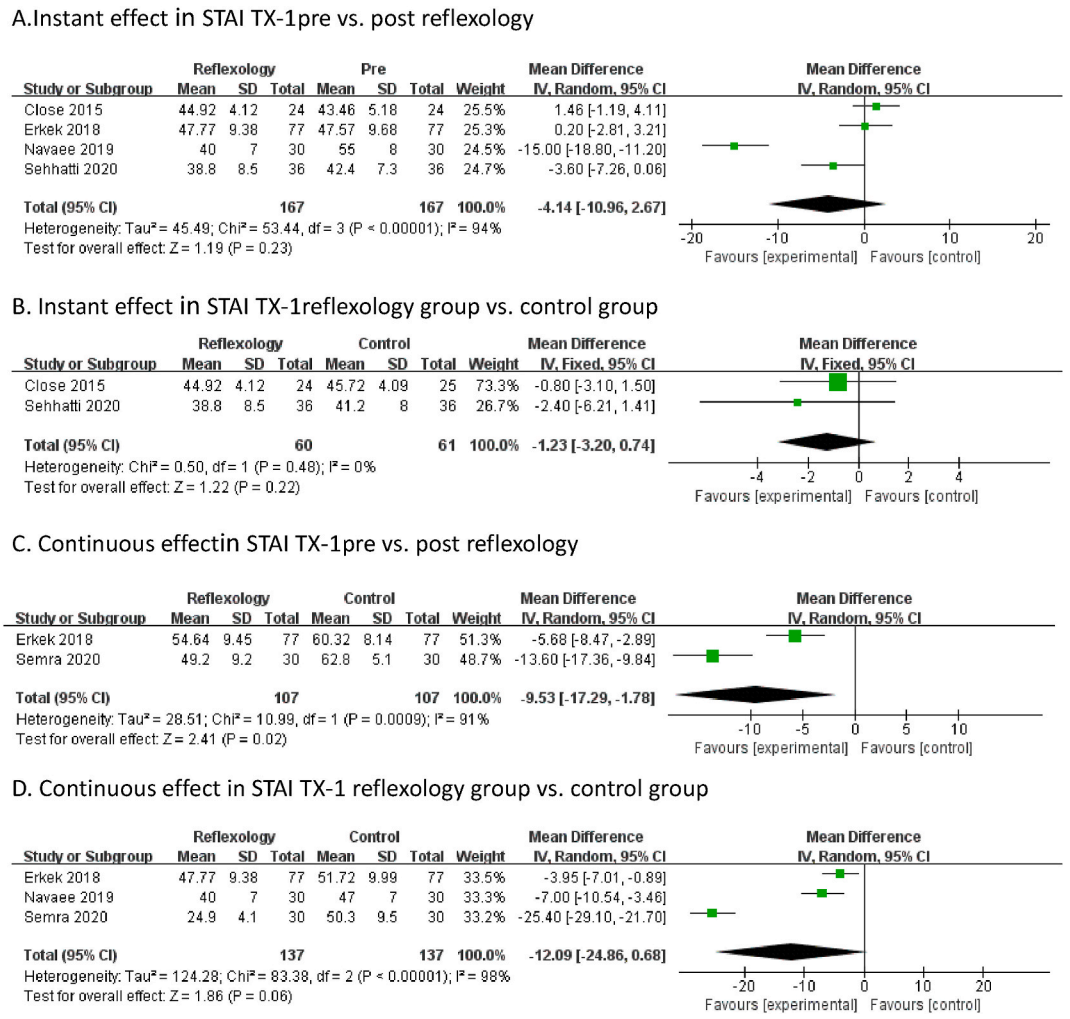


Fig. 6. Meta-analysis for the effect of reflexology on STAI TX-1.
Note. RR: relative risks; SD: standard deviation; CI: confidence interval; I^2: I-square; IV: image value.

3.8. Fatigue

Only one RCT investigated the effect of reflexology on fatigue in pregnant women. Shobeiri [24] found that, compared with the pre-group (Hedges' g = 0.91, 95%CI [0.60, 1.32], $P < 0.00001$) (Table 4) or control group (Hedges' g = 0.86, 95%CI [0.48, 1.25], $P < 0.00001$) (Table 4), the average fatigue score of the reflexology group was significantly decreased with large effect. Based on the results of this study, reflexology had a positive effect on relieving the fatigue of pregnant women.

3.9. Sleep quality

The study from Nasir [27] was to investigate the effect of reflexology on sleep quality in high risk pregnant women, which showed that reflexology had significant improvement of sleep quality assessed by Sleep Condition Indicator Scale (SCI) compared with the pre-group (Hedges' g = 0.76, 95%CI [0.28, 1.24], $P = 0.001$) (Table 4) or control group (Hedges' g = 1.82, 95%CI [1.27, 2.38], $P < 0.00001$) (Table 4).

3.10. Constipation symptoms

Sehhatti [29] revealed the effect of reflexology on idiopathic constipation symptoms. The result of the Constipation Assessment Scale (CAS) showed that there was no significant difference between the reflexology group and control group before the intervention, and 97.2% (35/36) of pregnancy with constipation diagnosis reported "No problem" on frequency of constipation severity at the end of six weeks following reflexology, in contrast to 36.1% (13/36) pre-reflexology, and 63.9% (23/36) in control group after six weeks.

3.11. Ankle and foot edema

One RCT examined pregnant women with ankle and foot edema. Mollart [20] found that the average ankle and foot circumference measurements decreased after reflexology intervention. Since the primary data was unavailable, relative analysis could not be performed.

3.12. Publication bias

Publication bias was analyzed by Begg's test. No significant publication bias was found in the every result from meta-analysis ($P > 0.05$, respectively).

4. Discussion

Currently, a few reports but no review on the efficacy of reflexology in pregnant women were published, only reviews of reflexology for sleep disturbances [33], functional constipation [34], and child health [35]. This article is the first systematic review of reflexology in pregnancy, which systematically reviewed the efficacy of reflexology on pregnancy-related symptoms by quality assessment, effect size methodology and meta-analysis after assessing the eligibility of trials and carrying out data extraction.

The included 13 RCTs in this review studied different effects of reflexology in pregnancy with no adverse effects reported, and showed the evidence supporting reflexology over other non-invasive treatments. Four studies [21,31,30,32] concluded that the use of reflexology could be effective in labor pain, five studies [21,31,23,30,32] reported that reflexology could reduce labor time, four studies [28,29,26,30] showed the efficacy of reflexology on relieving anxiety. The meta-analysis also confirmed the above results, especially of the instant efficacy of reflexology in reducing labor pain, and the continuous efficacy in reducing labor time and relieving anxiety. Three study showed the potential healing benefits of reflexology on fatigue [24], sleep quality [27], and constipation [29] during pregnancy, respectively. There was lack of available sufficient and conclusive evidence on reflexology treating LBPP and ankle and foot edema in pregnancy.

We speculated that high heterogeneity was reported in some studies, partly because the different methods of reflexology and the gestational weeks of intervention sample across the different studies. The daily reflexology time in this review varied from 15 to 50 min. The intervention frequency varied from 1 to 6 times a week, and treatment course in some studies lasted 5–6 weeks, while some studies only applied once. And the choices of the reflex points, which could also influence the efficacy of reflexology, were different [22,23,25–27,29,31,20] and not mentioned in some studies [21,24,28,30,32] making the comparison difficult. For the same efficacy from reflexology, there is no clear concept of methods to determine the reflexology zone, time, and frequency. The difference of gestational week in the studies demonstrated the versatility and safety of reflexology in pregnancy, while also reflected standardized methodological problems, that is, when is the best gestational week to start reflexology targeting different effect needs. And the relationship between a method of reflexology and the appropriate gestational week of pregnancy is also unclear. For the meaningful comparisons and reliable conclusion, enough trials for reflexology are need to be further explored and standardized.

In addition, it was remarkable that almost 80% of included RCTs were conducted in Asia, and the remaining research had been done in the UK. While reflexology was first introduced into the field of modern medicine by Dr. William Fitzgerald [7] and modified and renamed by Eunice Ingham [8], who both came from America. In fact, reflexology was thought to be Eastern in origin [36] and used to be called "compression massage", of the reason why massage was applied in the control group in two RCTs [28,31]. However, there is few description of technique and depth of pressure or massage in related studies, which need to be further studied.

The summary results indicated that reflexology could reduce labor pain and labor time, and relieve anxiety in pregnancy, and most of the included studies reported similar conclusions or trends. For the efficacy of reflexology on LBPP, fatigue, sleep quality, constipation symptoms, and ankle and foot edema during pregnancy, further studies are required.

Although this review provides the scientific basis for clinical practice and future research, only including the studies written in English could be the limitation of this study because some well-designed studies could be excluded due to language. The quality of included studies varied from low to high risk, which demonstrated the evidence could be not robust.

5. Conclusion

The current evidence suggests that reflexology in pregnancy is effective and safe, especially having a significant effect on labor pain, duration of labor, and anxiety in pregnancy, which should be viewed with caution based on the quality of included studies. However, there is insufficient evidence support the efficacy of reflexology in LBPP, fatigue, sleep quality, and constipation symptoms, and ankle and foot edema during pregnancy. Thus, RCTs with large-sample, multi-center, high-quality are indispensable to assess and verify the efficacy and safety of reflexology in pregnancy.

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Data availability statement

Data included in article/supplementary material/referenced in article.

Declaration of competing interest

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

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