The characteristics and effectiveness of pregnancy yoga interventions: a systematic review and meta-analysis

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Abstract

Background: Yoga is a popular mind-body medicine frequently recommended to pregnant women. Gaps remain in our understanding of the core components of effective pregnancy yoga programmes. This systematic review and meta-analysis examined the characteristics and effectiveness of pregnancy yoga interventions, incorporating the FITT (frequency, intensity, time/duration and type) principle of exercise prescription.

Methods: Nine electronic databases were searched: MEDLINE, PsycINFO, EMBASE, CINAHL, WHOLiS, AMED, Scielo, ASSIA and Web of Science. Randomised control trials and quasi-experimental studies examining pregnancy yoga interventions were eligible. Covidence was used to screen titles, abstracts, and full-text articles. Outcomes of interest were stress, anxiety, depression, quality of life, labour duration, pain management in labour and mode of birth. The Cochrane Collaboration’s Risk of Bias Assessment tool was used to assess methodological quality of studies and GRADE criteria (GRADEpro) evaluated quality of the evidence. Meta-analysis was performed using RevMan 5.3.

Results: Of 862 citations retrieved, 31 studies met inclusion criteria. Twenty-nine studies with 2217 pregnant women were included for meta-analysis. Pregnancy yoga interventions reduced anxiety (SMD: −0.91; 95% CI: −1.49 to −0.33; \( p = 0.002 \)), depression (SMD: −0.47; 95% CI: −0.9 to −0.04, \( P = 0.03 \)) and perceived stress (SMD: −1.03; 95% CI: −1.55 to −0.52; \( p < 0.001 \)). Yoga interventions also reduced duration of labour (MD = −117.75; 95% CI = −153.80 to −81.71, \( p < 0.001 \)) and, increased odds of normal vaginal birth (OR 2.58; 95% CI 1.46–4.56, \( p < 0.001 \)) and tolerance for pain. The quality of evidence (GRADE criteria) was low to very low for all outcomes. Twelve or more yoga sessions delivered weekly/bi-weekly had a statistically significant impact on mode of birth, while 12 or more yoga sessions of long duration (>60 min) had a statistically significant impact on perceived stress.

Conclusion: The evidence highlights positive effects of pregnancy yoga on anxiety, depression, perceived stress, mode of birth and duration of labour.

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Keywords: Pregnancy yoga, Systematic review, meta-analysis, FITT principle

Background

Pregnancy is characterised by significant physiological, social and emotional changes which can impact on maternal and fetal health and well-being across multiple domains [1, 2]. There is comprehensive evidence that anxiety, depression, and stress in pregnancy are risk factors for adverse maternal and fetal outcomes ranging from prematurity to stillbirth. Pregnancy yoga, a mind-body medicine, is popular among pregnant women and is recommended by healthcare providers as a safe and beneficial practice. However, there is limited evidence on the specific components of effective pregnancy yoga programmes.

References:

[1] Corrigan L, Eustace-Cook J, Moran P and Daly D. The effectiveness and characteristics of pregnancy yoga interventions: a systematic review protocol [version 2; peer review: 2 approved]. HRB Open Res 2020, 2:33 (https://doi.org/10.12688/hrbopenres.12967.2).

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from preterm birth and low birth weight to adverse neurodevelopmental outcomes in infants and children [3, 4]. The well-being of the mother is therefore critical for optimal pregnancy and child outcomes. Pregnant women should be provided with support, tools, resources, and appropriate types and amounts of physical activity during pregnancy to reduce the risk of complications and promote optimal pregnancy and birth outcomes [5].

Yoga is a mind-body-spirit practice combining physical postures, relaxation, and breathing techniques [2, 6]. It has been adapted for the pregnant body and is a common form of physical activity used by pregnant women and recommended by healthcare professionals [2, 7–9]. Evidence suggests that yoga during pregnancy is safe, feasible and acceptable to pregnant women and may be more beneficial than walking and standard prenatal exercises for both physical and mental health [5, 10, 11]. It is also thought to provide pregnant women with the opportunity to foster well-being and develop a connection with their baby [5, 12]. Two randomised control trials (RCTs) of pregnancy yoga report that it lowers levels of pain, stress, anxiety and depression [13, 14]. A third systematic review of yoga for pregnant women concluded that overall, pregnancy yoga RCTs resulted in improvements in stress levels, quality of life (QoL), autonomic nervous system functioning and labour parameters such as comfort, pain and duration [2].

However, other systematic reviews identified wide variation in pregnancy yoga intervention characteristics, the degree of supervision of the yoga interventions, the sample population and outcomes measured, and recommended further exploration of these factors in future trials [15]. Two recent meta-analyses demonstrated that yoga was an effective complementary treatment to manage prenatal depression and improve mode of birth outcomes [16, 17]. Both studies also identified limitations; women recruited to included studies commenced yoga practice at different gestational ages and yoga interventions varied in terms of frequency, type and intensity across trials. While the body of evidence supporting the positive impact of pregnancy yoga on pregnancy and birth outcomes is growing, there is a need to pool evidence from studies to accurately measure treatment effect and explore the mechanisms by which yoga contributes to reported benefits [2, 15]. This should include analysis of the characteristics of the pregnancy yoga interventions in order to design programmes that can offer optimal benefit.

The success of physical activity (PA) interventions is said to depend on four factors: how often you exercise, how hard you exercise, how long you exercise, and the types of exercise you choose. These factors make up the frequency, intensity, time/duration and type (FITT) principle and are frequently used to describe PA intervention characteristics [18]. The objective of this systematic review was to examine the published evidence on pregnancy yoga, describe the characteristics of each intervention using the FITT principle of exercise prescription and assess the overall effects of pregnancy yoga on a range of identified outcomes [18].

Materials and methods
Protocol
This systematic review and meta-analysis were planned and conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Additional file 1), the PROSPERO registered (CRD42019119916) and HRBopen published protocols and the recommendations of the Cochrane Collaboration [19–21].

Search strategy
The following electronic databases were searched from their inception up to November 2021:

- MEDLINE (EBSCO), CINAHL (EBSCO), PsycINFO (EBSCO), Embase (Embase.com), AMED (EBSCO), WHOLiS, Web of Science (Clarivate), ScieLo (Clarivate) and ASSIA (Proquest). The search strategy was constructed around search terms for “pregnancy” and “yoga” and adapted for each database, as necessary. No language or date restrictions were included. Each concept was searched individually compiling terms using the OR Boolean operator and then the two concepts were combined using the AND operator. PICO(S (population or problem, intervention, comparator, outcomes, study design) framework was established and guided the selection process. Additional file 2 contains this framework and the search terms and search strategy for Embase.com. Reference lists of included studies and relevant reviews were screened to ensure all suitable studies were identified. Grey Literature search of Proquest dissertations and theses, LENUS, RIAN, Google Scholar, and relevant journal conference supplements was also conducted. Only peer-reviewed published studies were included. The initial search was run on 22nd January 2019, updated on 22nd May 2020 and again on 5th November 2021.

Selection criteria
Participants
Both normal healthy and high-risk pregnant women of any gestation, age, ethnicity and country of residence.

Intervention
Studies where yoga was the primary intervention delivered to a sample of pregnant women. Multimodal
Interventions delivering yoga in conjunction with other treatments for pregnant women were excluded.

**Comparison**

Pregnant women receiving usual care or any active treatment other than yoga.

**Outcomes**

Primary outcomes of interest were stress, anxiety, depression and quality of life. Secondary outcomes were birth outcomes of labour duration, pain management in labour and mode of birth. Included studies had to assess at least one primary or secondary outcome measured using validated self-report or clinician-rated questionnaires, measures or scales or by clinical diagnosis or medical chart review.

**Study design**

Any primary study that investigated a pregnancy yoga intervention within a RCT or quasi-experimental study with a control before and after design was considered for inclusion. Case control studies, crossover trials and cross-sectional studies were excluded.

**Information retrieval and data extraction**

Search results were exported to EndNote X9 (Clarivate) and duplicate records removed (LC and JEC) [22]. Records were exported (JEC) to Covidence (Veritas Health Innovation), a web-based software platform designed to support citation screening and collaboration amongst multiple authors [23].

Author pairs (LC and DD, LC and PM, LC and NMcG) independently screened abstracts and the full text of potentially eligible studies according to inclusion/exclusion criteria, with third-party arbitration available if needed. Reasons for excluding studies at full-text review were recorded. The PRISMA flow diagram was used to show the overall process of study selection and summarise the inclusion and exclusion of studies at each stage of the review [19].

A standardised data extraction tool (Additional file 3) was developed specifically for this review based on recommendations provided in the Cochrane Handbook of Systematic Reviews of Interventions (LC) [21]. Author pairs (LC and NMcG; LC and PM) independently extracted data on study design and methods, sociodemographic characteristics, inclusion and exclusion criteria, study setting, details of experimental intervention and comparison intervention, duration of follow-up and outcomes studied, and extent of effectiveness. Discrepancies were discussed with another review author (DD) until consensus was reached. If necessary, study authors were contacted up to three times via email at fortnightly to provide further details. Data were entered into the RevMan 5.3 software and checked for accuracy (LC) [24].

**Quality assessment and assessment of confidence in the review findings**

The Cochrane Collaboration’s tool for assessing risk of bias was used to evaluate the quality of the studies [25]. Risk of bias assessment was undertaken by author pairs (LC and NMcG; LC and PM) independently. Discrepancies were resolved by discussion with a fourth reviewer (DD), if required. Where reported information was unclear or where data were missing three attempts were made to contact the primary authors for clarification.

Quality of the evidence was evaluated using the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) approach [26]. GRADEpro GDT software was used to import data from RevMan 5.3 and create the ‘Summary of findings’ Table [27]. Two review authors (LC and PM) graded the quality of the evidence for each outcome. Lack of double blinding alone was not downgraded due to difficulties blinding participants and yoga instructors. Downgrading was based on risk of bias only if a lack of blinding was accompanied by additional high risk of bias (e.g., selection bias and incomplete outcome reporting). It should be noted that the GRADE tool was developed for use in RCTs where double blinding was possible [26]. A summary of intervention effects and a measure of quality according to the GRADE approach was determined for seven outcomes; maternal stress, maternal anxiety, maternal depression, maternal QoL, duration of labour, pain management and mode of birth.

Results from included studies are presented as odds ratios (OR) with 95% confidence intervals (CI) for dichotomous outcomes. The mean difference (MD) was used for continuous data where outcomes were measured in the same way between trials, and the standardised mean difference (SMD) was used where outcomes were measured differently. The outcome measures from the individual trials were combined through meta-analysis where possible (clinical comparability of populations, interventions, outcomes and time of assessment between trials) using a random-effects model. According to the Cochrane Handbook for Systematic Reviews of Interventions a random-effects model offers the most conservative estimate of effect when between-study variations exist [25]. Data from studies that were too dissimilar to combine in a meta-analysis were described narratively in the text. Statistical heterogeneity was assessed in each meta-analysis using the $I^2$, $I^2$ and chi square statistics [25].
Subgroup analysis applying the FITT principle of exercise prescription to stratify results by frequency, intensity, time/duration and type, where appropriate, was conducted. Any statistically significant subgroup effect was reported using the $p$-value from the test for subgroup differences. The $I^2$ statistic was used to measure the magnitude of heterogeneity in each sub-group and categorised according the Cochrane Handbook for Systematic Reviews of Interventions as follows: heterogeneity might not be important ($I^2$ value 0–40%), moderate heterogeneity ($I^2$ value 30–60%), substantial heterogeneity ($I^2$ value 50–90%) or considerable heterogeneity ($I^2$ value 75–100%) [25].

Sensitivity analysis to compare including and excluding RCTs at high risk of bias was conducted for stress (perceived), depression, duration of labour and mode of birth based on identification of studies with notably higher risk of bias.

**Results**

**Results of the search**

In total 862 records were identified and 62 retained for full-text screening (Fig. 1). Thirty-one studies including 2413 pregnant women were included in the review and study sample sizes ranged from 20 to 335. Data from 29 studies including 2217 pregnant women were suitable for and included in the meta-analysis. Two studies were not included because data could not be disaggregated for meta-analysis and they are reported narratively instead.

**Study characteristics**

The characteristics of the included studies according to the FITT principle of exercise prescription are described (Table 1). Thirteen of the included studies originated from India [13, 28–39] eight from the USA [8, 11, 40–45], three from Iran [46–48], two each from China [49, 50] and Indonesia [51, 52] and one each from

![Fig. 1 PRISMA flow diagram [19]](image-url)
Japan, Thailand and the UK [53–55]. Twenty-five of the studies were RCTs, three were non-randomised control trials and three were a true-experimental post-test only control group design. Twenty studies were conducted with normal healthy pregnant women [8, 13, 29–31, 34–36, 38, 43, 46–55], two with multi-factor high-risk pregnant women [28, 32], six with pregnant women with depression or symptoms of depression [11, 39–42, 44], one with pregnant women with gestational diabetes [33], one with pregnant women with mild hypertension [37] and one with high-risk pregnant women on bedrest [45]. The gestational age at recruitment across studies ranged from 12 to 36 weeks. Control groups included routine antenatal care, usual activity, standard antenatal exercise walking 30 min twice daily, health education, social support, mom-baby wellness workshops, and parenting education sessions.

Characteristics of pregnancy yoga interventions
The frequency of the pregnancy yoga intervention ranged from a single session to daily, session length ranged from 20 to 120 min and intensity ranged from a single session to availability of 126 practice sessions. Four studies classified the yoga intervention as yoga therapy [28, 30, 34, 35], eighteen yoga sessions [8, 11, 33, 36, 39, 43–55], three yoga postures [40–42], five integrated yoga therapy [13, 29, 31, 32, 37] and one did not provide details [38]. All yoga interventions used physical postures. Of the 31 included studies, 27 did not define the specific style of yoga used in the intervention; three cited hatha yoga [43, 48, 55] and one Ashtanga Vinyasa [44].

Risk of bias
All studies were assessed as having a high-risk of bias for at least one domain. The overall risk of bias assessment across domains and the risk of bias in each included study are displayed in Fig. 2. Sixteen studies were rated high-risk of other bias due to exclusion of participants from the final analysis without explanation, baseline imbalances, loss to follow-up imbalances, self-selection bias, self-reports of compliance, lack of clarity on the administration of the yoga intervention and use of insensitive instruments to measure outcomes.

Assessment of the quality of the evidence - GRADE
The quality assessment for individual review outcomes informed by the GRADEpro Guideline Development Tool (GDT) are reported in Table 2. There was low quality evidence that pregnancy yoga interventions could be effective for each outcome included in this review.

Primary outcomes
Stress
Five RCTs with 423 participants reported post-intervention perceived stress scores measured by the Perceived Stress Scale (PSS-10) [13, 28, 35, 53] and the Pregnancy Experiences Questionnaire (PEQ) [29]. The pooled SMD (−1.03; 95% CI: −1.55 to −0.52; \( p < 0.001 \)) supports a statistically significant beneficial effect of pregnancy yoga interventions for perceived stress (Fig. 3a). A sensitivity analysis removing a study at high risk of bias supported these results and lowered heterogeneity (\( \tau^2 = 0.14, I^2 = 70\% \); \( p < 0.001 \)) [53] (Fig. 3b). Four RCTs with 279 participants reported post-intervention stress levels, measured by salivary or plasma cortisol [41, 43, 52, 53]. The pooled SMD (−0.69; 95% CI: −1.50 to 0.13; \( p = 0.10 \)) demonstrated no significant effect for physiological stress (Fig. 3c). A further two RCTs reported data on physiological stress but were not suitable for meta-analysis [49, 55]. Chen et al. looked at short-term and long-term stress and immunological effects of yoga in 94 healthy pregnant women [49]. Although yoga displayed a short-term decrease in cortisol, there were no significant differences in long-term cortisol effects between groups. The second RCT conducted by Newham et al. with 29 pregnant women reported that salivary cortisol levels were significantly lower immediately after the yoga intervention [55].

Anxiety
Eleven RCTs with 733 participants reported post-intervention anxiety symptom scores measured by the State-Trait Anxiety Inventory (STAI), Hospital Anxiety and Depression Scale – Anxiety (HADS-A) and Hamilton Anxiety Rating Scale (HAM-A) [29, 38, 40, 41, 44, 45, 47, 50–52, 55]. The pooled SMD (−0.91; 95% CI: −1.49 to −0.33; \( p = 0.002 \)) supports a statistically significant beneficial effect of pregnancy yoga interventions for anxiety (Fig. 3d).

Depression
Twelve RCTs with 679 participants reported post-intervention depression symptom scores measured by Centre for Epidemiological Studies - Depression (CES-D), Hospital Anxiety and Depression Scale - Depression (HADS-D), Edinburgh Postnatal Depression Scale (EPDS) and Hamilton Depression Rating Scale (HDRS) [11, 29, 39–45, 50, 51, 55]. The pooled SMD (−0.47; 95% CI: −0.90 to −0.04; \( p = 0.03 \)) supports a statistically significant beneficial effect of pregnancy yoga interventions for depression symptoms (Fig. 3e). Sensitivity analysis performed after removal of one study with high risk of bias from the analysis showed no difference [51].
| Study ID       | Country   | Study type                  | Sample size | Gestation (weeks) | Intervention          | Control         | Outcome of interest | Main results                                      | Frequency | Intensity | Timing | Type                                                                 |
|---------------|-----------|-----------------------------|-------------|-------------------|-----------------------|----------------|--------------------|--------------------------------------------------|-----------|-----------|--------|----------------------------------------------------------------------|
| Babbar et al. | 2016 USA  | RCT uncomplicated pregnancy | 46 (23/23)  | 28–36 weeks       | Yoga session          | PowerPoint presentation | Mode of birth   | NVB 65% yoga and 61% control                      | One time  | One       | 60 mins | Poses, breathing, shavasana                                         |
| Balaji et al. | 2017 India| RCT gestational diabetes    | 151 (75/76) | 24 weeks          | Yoga sessions         | Routine treatment       | Mode of birth   | NVB 84% yoga 26% control                          | Daily     | 3 months  | 60 mins | Loosening exercises, postures, deep relaxation, pranayama            |
| Bershadsky et al. | 2014 USA | Non-randomised control trial normal pregnancy | 50 (38/12) | 12–19 weeks       | Yoga sessions         | Usual activity         | Depression physiological stress | Cortisol levels lower past yoga and fewer depressive symptoms in yoga group | No information | No information taught sessions | 90 mins | Hatha yoga                                      |
| Bhantia et al. | 2019 India| RCT low risk pregnant women | 78 (38/40) | 18–20 weeks       | Yoga therapy          | Routine physical activity | Perceived stress Mode of birth | Perceived stress reduced 31.75% in yoga group and increased 6.60% in control (p < 0.001). NVB 92% yoga and 90% control | Tri-weekly | 36 sessions – 12 taught & 24 self-practice | 50 mins | Loosening exercises, breathing, postures, deep relaxation |
| Bolantha-kodi et al. | 2018 India| RCT normal pregnancy        | 150 (75/75) | 30 weeks          | Yoga therapy          | Standard antenatal care | Mode of birth Pain management | More NVB in yoga group (p < 0.037), duration of labour was significantly shorter (p < 0.001). Significant reduction in intravenous analgesic in yoga group (p < 0.045) and tolerance of pain was higher as shown by NPIs (p < 0.001) and PBOS scores (p < 0.0001) | Bi-weekly | 7 taught sessions & availability of 24–36 self-practice sessions | 30 mins | Integrated approach to yoga therapy (IAYT)                      |
| Chen et al.   | 2017 China| RCT healthy pregnant women  | 94 (48/46)  | 16 weeks          | Yoga sessions         | Routine prenatal care   | Physiological stress | Prenatal yoga significantly reduced cortisol (p < 0.001) | Bi-weekly | 40 taught sessions | 70 mins | Postures, deep breathing, guided imagery, deep relaxation |

Table 1: Characteristics of studies according to FITT principle.
| Study ID       | Country   | Study type                      | Sample size | Gestation (weeks) | Intervention                  | Control                        | Outcome of interest              | Main results                                                                                                                                                                                                 | Frequency          | Intensity | Timing | Type                                                                 |
|---------------|-----------|---------------------------------|-------------|-------------------|-------------------------------|--------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------|--------|----------------------------------------------------------------------|
| Chuntharapat et al. 2008 | Thailand | RCT normal pregnancy            | 74 (37/37)  | 26–28 weeks       | Yoga sessions                 | Routine nursing care          | Pain management Duration of labour | No differences between groups for pethidine usage. Shorter duration of labour in yoga group                                                                                                                     | Bi-weekly taught and tri-weekly self-practice | 6 taught sessions & 30–36 available self-practice sessions | 60 mins | Education, postures, chanting om, breath awareness, dhyana, yoga nidra |
| Davis et al. 2015 | USA     | RCT symptoms anxiety/depression | 46 (23/23)  | 28 weeks          | Yoga sessions                 | TAU                           | Depression Anxiety              | Prenatal yoga was associated with reductions in symptoms of anxiety and depression                                                                                                                  | Weekly             | 8 taught sessions and self-practice DVD | 75 mins | Ashtanga Vinyasa system of yoga modified for pregnancy               |
| Deshpande et al. 2013 | India   | RCT high-risk pregnancies       | 68 (30/38)  | 12 weeks          | Yoga therapy                  | Standard antenatal care/prenatal stretching exercises | Perceived stress | RMANOVA showed a significant decrease ($P=0.02$) in the PSS scores of the yoga group compared to the control group                                                                                           | No information      | 16 weeks | No information | No information                                      |
| Field et al. 2012 | USA     | RCT depression                   | 56 (28/28)  | 20 weeks          | Yoga postures                 | Standard prenatal care        | Depression Anxiety              | Decreased depression scores ($F=82.40, p<0.001$) and decreased anxiety scores ($F=26.23, p<0.001$) in the yoga group                                                                                       | Bi-weekly          | 24 taught sessions | 20 mins | Postures                                                             |
| Field et al. 2013 | USA     | RCT depression                   | 92 (46/46)  | 22 weeks          | Yoga postures                 | Social support                | Depression Anxiety Physiological stress | Reduced anxiety and depression in both groups with no significant group difference and reduced cortisol pre/post yoga and pre/post social support                                                                 | Weekly             | 12 taught sessions | 20 mins | Postures                                                             |
| Gallagher et al. 2020 | USA     | RCT high-risk pregnancy on bedrest | 79 (48/31)  | 23–31 weeks       | Yoga sessions                 | Standard care and no yoga     | Depression Anxiety              | Perceived anxiety and depression overall scores lower in yoga group than in control group ($p<0.001$)                                                                                                        | Bi-weekly taught, video self-practice | Average of 746 (3–16) taught sessions, and 2 (0–24) self-practice video sessions | 30 mins | Breathing, visualisation, adapted yoga moves, yoga nidra              |
| Study ID       | Country     | Study type                  | Sample size | Gestation (weeks) | Intervention                  | Control                          | Outcome of interest                      | Main results                                                                                                                                                                                                 | Frequency | Intensity | Timing | Type                                                                 |
|---------------|-------------|-----------------------------|-------------|-------------------|------------------------------|---------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|--------|----------------------------------------------------------------------|
| Hayase et al. | Japan       | Non-randomised control trial uncomplicated pregnancy | 91 (38/53)  | 20–23 weeks       | Yoga sessions                | Standard antenatal care         | Perceived stress Physiological stress | PSS scores lower in yoga group at 20–23 & 28–31 weeks' gestation. Salivary α-amylase levels in yoga group significantly decreased immediately after yoga. Weekly taught and daily self-practice. | Average of 4 to 19 taught sessions and all women practiced yoga for >15 min at home, at least three times a week based on the self-report |          |           |        | Warm-up, breathing exercises, postures, meditation                   |
| Jahdi et al.  | Iran        | RCT normal pregnancy        | 60 (30/30)  | 26 weeks          | Yoga sessions                | Routine midwifery care           | Mode of birth Duration of labour Management | Duration of the second and third stages of labour significantly shorter in yoga group (p = 0.04 and 0.01 respectively). Cæsarean section rate 13.3% in yoga group compared to 50% in control group. Analgesic use during first stage of labour showed no difference between groups (p = 0.2) | Tri-weekly taught & daily self-practice | 60 mins | 33 taught sessions and possibility of 44 self-practice sessions       |           | Postures, chanting om, breath awareness, yoga nidra, dhyana         |
| Kundarti et al. | Indonesia | RCT normal pregnancy        | 59 (30/29)  | 20–32 weeks       | Yoga sessions                | Standard antenatal care         | Anxiety Physiological stress      | Average anxiety in the intervention and control group after intervention (M = 13.16) vs (M = 35.30) and average cortisol levels (M = 16.50) vs (M = 9.91) | Weekly    | 8 taught sessions | 90 mins | Postures, breathing, meditation shavasana                           |
Table 1 (continued)

| Study ID          | Country   | Study type               | Sample size   | Gestation (weeks) | Intervention                        | Control                        | Outcome of interest          | Main results                                                                                       | Frequency | Intensity | Timing     | Type                        |
|-------------------|-----------|--------------------------|---------------|-------------------|-------------------------------------|--------------------------------|-----------------------------|---------------------------------------------------------------------------------|------------|-----------|------------|-----------------------------|
| Makhija et al. 2021 | India     | RCT mild hypertensive disorder pregnancy | 60 (30/30)    | Third trimester   | Integrated yoga                    | Routine care                   | Duration of labour            | Reduction in total duration of labour in yoga group (p = 0.011), 22 (73.3%) yoga group had vaginal delivery compared to 18 (60%) in control group | Tri-weekly | At least 4 weeks (12 sessions) | 40 mins   | Postures, breathing, meditation |
| Mitchell et al. 2012 | USA       | RCT depression           | 24 (12/12)    | 20 weeks         | Yoga postures                      | Parenting education sessions   | Depression                   | Depressive symptoms reduced to subclinical levels in 55% of yoga group compared to 11% of control group | Bi-weekly  | 24 taught sessions           | 20 mins   | Postures                      |
| Mohyadin et al. 2020 | Iran      | RCT normal pregnancy     | 84 (42/42)    | 26–37 weeks      | Yoga sessions                      | Routine midwifery care         | Anxiety, Pain management     | Anxiety lower in yoga group (p = 0.003), less pain at 4-5 cm in yoga group (p = 0.001), Shorter duration of labour in yoga group (p = 0.003) | Bi-weekly  | 6 sessions                   | 60 mins   | Postures, breathing, meditation |
| Munirekha et al. 2019 | India     | True-experimental post-test only control group design - uncomplicated pregnancy | 30 (15/15)    | 24–32 weeks      | Yoga sessions                      | Health education on antenatal care and future lactation | Mode of birth                | NVB 80% yoga group compared to 40% control group                              | Weekly     | Taught from 24 to 32 weeks until delivery | No information | Yogasanas                  |
| Narendran et al. 2005 | India     | Non-randomised control trial normal pregnancy | 335 (169/166) | 18–20 weeks      | Yoga therapy                       | Walking 30 mins twice daily    | Mode of birth                | NVB 54% yoga group compared to 49% control group                              | Daily      | Mean GA at delivery           | 60 mins   | Integrated approach of yoga therapy (IAYT) Taught then self-practice |
| Study ID          | Country   | Study type                      | Sample size       | Gestation (weeks) | Intervention          | Control   | Outcome of interest                | Main results                                                                                                                                  | Frequency | Intensity | Timing  | Type                        |
|------------------|-----------|---------------------------------|-------------------|-------------------|-----------------------|-----------|-----------------------------------|----------------------------------------------------------------------------------------|-----------|-----------|---------|-----------------------------|
| Newham et al. 2014 | UK        | RCT healthy pregnant women       | 59 (31/28)        | 20–24 weeks       | Yoga sessions         | TAU       | Anxiety, Depression, Physiologica... | Greater reduction in both anxiety and depression in the yoga group. Significant decrease in cortisol after yoga (0.15 [0.11] μg/dL vs. 0.13 [0.10] μg/dL, P = 0.003) | Weekly    | 8 taught sessions | 1.5 h  | Hatha yoga                  |
| Rakhshani et al. 2010 | India    | RCT normal pregnancy             | 102 (51/51)       | 18–20 weeks       | Integrated yoga       | Standard antenatal exercises | Quality of life | Between groups analysis showed significant improvements in the yoga group in the physical (P = 0.001), psychological (P = 0.001), social (P = 0.003) environmental domains (P = 0.001) of the WHOQOL-100 | Tri-weekly | If until delivery estimated between 54 and 66 available taught sessions | 60 mins | Lectures, breathing exercises, postures, meditation, deep relaxation |
| Rakhshani et al. 2012 | India    | RCT high-risk pregnancy          | 68 (30/38)        | 12 weeks          | Integrated yoga       | Standard care plus walking for half an hour mornings and evenings | Mode of birth | Lower rate of emergency c-section in yoga group 51.7% compared to 57.9% in control | Tri-weekly | 28 taught sessions | 60 mins | Breathing exercises, yogic postures, meditative exercises |
| Rong et al. 2021   | China     | RCT normal healthy pregnancy     | 64 (32/32)        | 18–27 weeks       | Yoga sessions         | Routine prenatal care | Anxiety, Depression, Duration of labour, Mode of birth | No statistically significant difference in post anxiety and depressions scores. Higher rate of vaginal birth (p = 0.039) and shorter duration of labour (p = 0.002) in yoga group | Tri-weekly | 12 weeks (up to 36 sessions) | 60 mins | Warm-up, postures, meditation |
| Ruqaiyah et al. 2020 | India    | Quasi-experimental pre/post with control | 24 (12/12)        | Third trimester   | No information        | No information | Anxiety in the yoga group post intervention (p = 0.002) | Lower anxiety in the yoga group post intervention (p = 0.002) | No information | No information | No information | No information |
| Study ID          | Country | Study type | Sample size | Gestation (weeks) | Intervention               | Control                     | Outcome of interest       | Main results                                                                 | Frequency | Intensity | Timing | Type                                                                 |
|------------------|---------|------------|-------------|-------------------|---------------------------|-----------------------------|---------------------------|----------------------------|---------------------------|-----------|----------|--------|-----------------------------------------------------------------------|
| Satyapriya et al. 2009 | India   | RCT normal pregnancy | 90 (45/45)   | 18–20 weeks       | Integrated yoga           | Standard prenatal exercise  | Perceived stress         | Perceived stress decreased by 31.57% in the yoga group and increased by 6.60% in the control group (P=0.001) | Tri-weekly for first month then daily self-practice | 1 month   | 120 mins | Lectures, breathing exercises, poses, meditation, deep relaxation    |
| Satyapriya et al. 2013 | India   | RCT normal pregnancy | 96 (51/45)   | 18–20 weeks       | Integrated yoga           | Standard antenatal exercises | Anxiety Depression Perceived stress | Anxiety and Depression reduced with improvement in pregnancy experience in the yoga group (P < 0.001) | Tri-weekly for first month then daily self-practice | 16-week programme estimated up to 92 available sessions | 120 mins | Lectures, breathing exercises, poses, deep relaxation, meditation   |
| Uebelacker et al. 2016 | USA     | RCT depression | 20 (12/8)    | 12–26 weeks       | Yoga sessions             | Mom-baby wellness workshops | Depression                | Although both groups had reduced depression score, yoga was preferred. | Weekly | 9 taught sessions & self-practice | 75 mins | Breathwork, warm-up, poses, relaxation, homework                      |
| Yekefallah et al. 2021 | Iran    | RCT normal pregnancy | 70 (35/35)   | 26–37 weeks       | Yoga sessions             | Routine prenatal care       | Duration of labour Mode of birth | Mean duration of labour was shorter in yoga group (p < 0.0001). 82.9% of the women in the yoga group and 65.7% in the control group had a natural delivery | Bi-weekly | Attended for 9–11 weeks (up to 22 sessions) | 75 mins | Hatha yoga                                                          |
| Yulianti et al. 2018  | Indonesia | RCT normal pregnancy | 102 (51/51)  | 22–32 weeks       | Yoga sessions             | Not treated                | Depression Anxiety         | Mean level of anxiety and depression were lower in the yoga group at both two- and four-weeks post intervention (p < 0.001) | No information | 1 month   | No information | No information |
### Table 1 (continued)

| Study ID       | Country      | Study type                                      | Sample size | Gestation (weeks) | Intervention          | Control          | Outcome of interest | Main results                                                                 | Frequency | Intensity | Timing               | Type                        |
|----------------|--------------|-------------------------------------------------|-------------|-------------------|-----------------------|-------------------|---------------------|-----------------------------------------------------------------------------|-----------|-----------|----------------------|-----------------------------|
| Yuvarani et al. 2020 | India        | Quasi-experimental pre/pots with control depression and anxiety | 30 (15/15)  | 16–20 weeks      | Yoga sessions         | Aerobic exercise    | Depression         | Aerobic exercise and yoga showed significant effect for reducing the symptoms of depression ($P \leq 0.001$) | Weekly    | 3 months (up to 13 sessions) | 20 mins | Breathing, postures |

Weekly 3 months (up to 13 sessions) | 20 mins Breathing, postures |
Fig. 2 Summary of Risk of Bias and Risk of bias for individual studies
### Table 2 Summary of findings

**Yoga for pregnancy**

**Patient or population:** pregnant women  
**Settings:** Any  
**Intervention:** yoga  
**Comparison:** treatment as usual or any other active treatment

| Outcomes                        | Illustrative comparative risks* (95% CI) | Relative effect (95% CI) | No of Participants (studies) | Quality of the evidence (GRADE) | Comments |
|---------------------------------|----------------------------------------|--------------------------|-----------------------------|-------------------------------|----------|
|                                  | Corresponding risk                     |                          |                             |                               |          |
| **Treatment as usual or any active treatment** | Yoga                                   |                          |                             |                               |          |
| **Anxiety**                     | STAI, HADS-A, Hamilton Follow-up: 2-18 weeks | The mean anxiety in the intervention groups was 0.91 standard deviations lower (1.49 to 0.33 lower) | 733 (11 studies)             | ⊘⊕⊘⊘ low²,³,⁴,⁵ | SMD -0.84 (-1.64 to -0.03) |
| **Depression**                  | CES-D, HADS-D, Hamilton, EPDS Follow-up: 2-18 weeks | The mean depression in the intervention groups was 0.47 standard deviations lower (0.90 to 0.04 lower) | 679 (12 studies)             | ⊘⊕⊘⊘ low²,³,⁴,⁵,⁶,⁷ | SMD -0.53 (-1.04 to -0.02) |
| **Perceived stress**           | PSS-10, Pregnancy experiences questionnaire (PEQ) Follow-up: 12-24 weeks | The mean perceived stress in the intervention groups was 1.03 standard deviations lower (1.55 to 0.52 lower) | 423 (5 studies)              | ⊘⊘⊘⊘ low²,⁴,⁵ |          |
| **Physiological stress**       | Salivary cortisol Follow-up: 4-20 weeks | The mean physiological stress in the intervention groups was 0.69 standard deviations lower (1.50 lower to 0.13 higher) | 279 (4 studies)              | ⊘⊘⊘⊘ very low²,³,⁴,⁵,⁶,⁷ |          |
| **Total duration of labour**   | medical records Follow-up: 10-24 weeks | The mean total duration of labour in the intervention groups was 117.75 lower (153.80 to 81.71 lower) | 472 (6 studies)              | ⊘⊘⊘⊘ low²,³,⁴,⁸ |          |
| **Normal vaginal birth**       | medical records Follow-up: 10-28 weeks | Study population OR 2.58 (1.46 to 4.56) | 1195 (12 studies) | ⊘⊘⊘⊘ very low²,³,⁴,⁵,⁶,¹⁰ |          |
| **Quality of life**            | WHOQoL100 Follow-up: mean 16 weeks | The mean quality of life in the intervention groups was 1.73 higher (0.79 to 2.67 higher) | 102 (1 study) | ⊘⊘⊘⊘ low²,³,⁴,⁵,⁶ |          |

*The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI)*

CI: Confidence interval; OR: Odds ratio  
GRADE Working Group grades of evidence  
High quality: Further research is very unlikely to change our confidence in the estimate of effect
Table 2 (continued)

**Quality of life**
One RCT with 102 participants reported post-intervention quality of life scores measured by the World Health Organization Quality of Life Assessment Instrument (WHOQoL-100) [31]. Between-group analysis showed significant improvements in the yoga group compared to the control in the physical (15.79 ± 2.77 (15–16.570, \( p = 0.001 \)), psychological (16.08 ± 2.12 (15–16.57), \( p < 0.001 \)), social relationships (16.88 ± 1.91 (16.34–17.42), \( p = 0.003 \)) and environmental domains (16.25 ± 2 (15.69–16.82), \( p = 0.001 \)). Results were not significant for independence (15.91 ± 2.2 (15.29–16.53), \( p = 0.065 \)) and spiritual domains (16.02 ± 2.42 (15.34–16.70), \( p = 0.23 \)).

**Secondary outcomes**

**Labour duration**
Six RCTs with 472 participants reported data on the duration of labour [34, 37, 46, 50, 53, 54]. The pooled MD calculated in minutes (−117.75; 95% CI: −153.80 to −81.71; \( p < 0.001 \)) supports a statistically significant beneficial effect of pregnancy yoga interventions for shorter duration of labour by an average of almost 2 h (Fig. 4a). Sensitivity analysis performed after removal of one study with high risk of bias from the analysis showed no difference [53].

**Pain management**
Four RCTs with 360 participants reported data on pain management during labour [34, 46, 47, 54]. Data from these studies were not suitable for meta-analysis. One study demonstrated a significant reduction in requirements for intravenous analgesia in the pregnancy yoga group (\( p < 0.045 \)). Tolerance of pain measured by the Numerical Pain Intensity Scale (NPIS) (\( p < 0.001 \)) and Pain Behavioural Observation Scale (PBOS) was also increased in the pregnancy yoga group (\( p < 0.001 \)) [34]. A second study found that the pregnancy yoga group demonstrated significantly higher maternal comfort during labour, measured by the Visual Analogue Sensation of Pain Scale (VASPS) and PBOS (\( p < 0.05 \)), while no differences were found between the groups for pethidine usage (\( p = 0.2 \)) [46] and the fourth study reported that the mean pain score at 4-5 cm cervical dilatation was significantly lower in yoga intervention group (\( p = 0.001 \)) [47].

**Mode of birth**
Twelve studies with 1195 participants reported data on the mode of birth [8, 30, 32–37, 46–48, 50]. Compared to control groups the vaginal birth rate was significantly higher in the pregnancy yoga groups (OR = 2.57; 95% CI: 1.52–4.35; \( p < 0.001 \)) (Fig. 4b). Sensitivity analysis performed after removal of four studies with a focus on high-risk pregnancies, with an implied increased risk of a caesarean birth, from the analysis maintained an increased likelihood of a vaginal birth in the pregnancy yoga group (OR = 1.93; 95% CI: 1.28–2.90; \( p = 0.002 \)) [32, 33, 36, 37] (Fig. 4c). As expected, removing these studies also reduced heterogeneity (\( \tau^2 = 0.09, I^2 = 29\% \); \( p = 0.002 \) compared to \( \tau^2 = 0.56, I^2 = 70\% \); \( p < 0.001 \)).

**Subgroup FITT principle of exercise prescription analysis**
The FITT principle of exercise prescription was applied across studies and detailed results are reported in Additional file 4 and Fig. 5.
### Meta-analysis primary outcomes

#### a. Yoga and TAU

| Study or Subgroup | Yoga Mean | SD Total | TAU Mean | SD Total | Std. Mean Difference | IV, Random, %95 CI |
|-------------------|-----------|----------|----------|----------|----------------------|-------------------|
| Bharla et al 2019 | 15.82     | 3.021    | 28.20    | 2.493    | -0.81                | [-0.34, -1.28]    |
| Deshpande et al. 2013 | 12.92 | 6.09     | 30.16    | 6.03     | -0.65                | [-1.14, -0.15]    |
| Hayase et al. 2018 | 15.2      | 4.9      | 38.16    | 5.8      | Not estimable        |                   |
| Satyapriya et al. 2009 | 10.88 | 4.97     | 17.33    | 5.34     | -1.24                | [-1.69, -0.79]    |
| Satyapriya et al. 2013 | 49.75 | 5.99     | 58.96    | 8.81     | -1.23                | [-1.67, -0.79]    |
| Total (95% CI)     | 164       | 168      | 100.0%   |          | -1.22                | [-1.66, -0.79]    |

**Favour TAU:**

Test for overall effect: Z = 5.51 (P < 0.0001)

#### b. Yoga and TAU

| Study or Subgroup | Yoga Mean | SD Total | TAU Mean | SD Total | Std. Mean Difference | IV, Random, %95 CI |
|-------------------|-----------|----------|----------|----------|----------------------|-------------------|
| Bharla et al 2019 | 15.82     | 3.021    | 28.20    | 2.493    | -0.81                | [-0.34, -1.28]    |
| Deshpande et al. 2013 | 12.92 | 6.09     | 30.16    | 6.03     | -0.65                | [-1.14, -0.15]    |
| Hayase et al. 2018 | 15.2      | 4.9      | 38.16    | 5.8      | Not estimable        |                   |
| Satyapriya et al. 2009 | 10.88 | 4.97     | 17.33    | 5.34     | -1.24                | [-1.69, -0.79]    |
| Satyapriya et al. 2013 | 49.75 | 5.99     | 58.96    | 8.81     | -1.23                | [-1.67, -0.79]    |
| Total (95% CI)     | 164       | 168      | 100.0%   |          | -1.22                | [-1.66, -0.79]    |

**Favour TAU:**

Test for overall effect: Z = 5.51 (P < 0.0001)

#### c. Yoga and TAU

| Study or Subgroup | Yoga Mean | SD Total | TAU Mean | SD Total | Std. Mean Difference | IV, Random, %95 CI |
|-------------------|-----------|----------|----------|----------|----------------------|-------------------|
| Bershady et al. 2014 | 0.47     | 0.55     | 3.8   | 1.46     | 0.70                | [-1.37, -0.04]    |
| Field et al. 2013 | 0.32      | 0.1      | 4.29    | 0.17     | 0.21                | [0.23, 0.66]      |
| Hayase et al. 2018 | 4.36      | 6.92     | 9.98    | 5.8      | -0.47                | [-0.89, -0.04]    |
| Kundarti et al. 2020 | 15.5     | 7.31     | 30       | 3.01     | 0.02                | [-0.46, 0.02]     |
| Total (95% CI)     | 146       | 133      | 100.0%   |          | -0.69                | [-1.10, 0.13]     |

**Favour TAU:**

Test for overall effect: Z = 1.65 (P = 0.10)

#### d. Yoga and TAU

| Study or Subgroup | Yoga Mean | SD Total | TAU Mean | SD Total | Std. Mean Difference | IV, Random, %95 CI |
|-------------------|-----------|----------|----------|----------|----------------------|-------------------|
| Davis et al. 2015 | 34.8      | 10.68    | 20       | 38.79    | 13.7                | 8.9%              |
| Field et al. 2012 | 42.6      | 6.85     | 20       | 38.96    | 9.11                | 20.8%             |
| Field et al. 2013 | 46.5      | 5.2      | 20       | 46.1     | 8.5                 | 39.5%             |
| Gallagher et al. 2020 | 5.88 | 9.21     | 48       | 9.03     | 3.97                | 9.4%              |
| Kundarti et al. 2022 | 13.16 | 13.71    | 30       | 35.3     | 20.76               | 9.1%              |
| Moryad et al. 2021 | 40.19     | 12.53    | 42       | 49.6     | 10.36               | 6.5%              |
| Newham et al. 2014 | 29.66     | 9.58     | 29       | 32.6     | 8.35                | 9.2%              |
| Rong et al. 2021  | 13.22     | 13.16    | 51       | 23.66    | 3.55                | 9.1%              |
| Yulianti et al. 2018 | 13.22 | 3.16     | 51       | 23.66    | 3.55                | 9.1%              |
| Total (95% CI)    | 383       | 350      | 100.0%   |          | -0.91                | [-1.49, -0.33]    |

**Favour TAU:**

Test for overall effect: Z = 3.10 (P = 0.002)

#### e. Yoga and TAU

| Study or Subgroup | Yoga Mean | SD Total | TAU Mean | SD Total | Std. Mean Difference | IV, Random, %95 CI |
|-------------------|-----------|----------|----------|----------|----------------------|-------------------|
| Bershady et al. 2014 | 5.87     | 3.52     | 31       | 5.32     | 10                   | 7.9%              |
| Davis et al. 2015 | 7.32      | 6.66     | 20       | 8.55     | 9.99                 | 8.2%              |
| Field et al. 2012 | 20.12     | 10.51    | 28       | 19.27    | 12.12                | 8.7%              |
| Field et al. 2013 | 23.8      | 9.3      | 40       | 25.2     | 10.4                | 9.0%              |
| Gallagher et al. 2020 | 3.33    | 2.26     | 48       | 6.06     | 3.58                | 9.9%              |
| Mitchell et al. 2012 | 17.82  | 6.87     | 12       | 21.42    | 9.78                | 7.4%              |
| Newham et al. 2014 | 5.14      | 3.86     | 29       | 6.77     | 4.82                | 8.6%              |
| Rong et al. 2021  | 7.16      | 3.16     | 32       | 8.03     | 4.08                | 8.6%              |
| Yulianti et al. 2018 | 16.24  | 3.77     | 51       | 25.82    | 4.65                | 8.6%              |
| Yuvarani et al. 2020 | 24.4     | 3.77     | 15       | 24.8     | 3.81                | 7.8%              |
| Total (95% CI)    | 367       | 312      | 100.0%   |          | -0.81                | [-1.17, 0.44]     |

**Favour TAU:**

Test for overall effect: Z = 2.12 (P = 0.03)
Frequency

The test for subgroup differences for mode of birth suggest that there is a statistically significant subgroup effect for low-frequency yoga interventions of weekly or bi-weekly sessions on mode of birth ($p < 0.001$) (Fig. 5a).

Intensity

There was a statistically significant subgroup effect on perceived stress for interventions with more than 12 sessions ($p < 0.001$) (Fig. 5b), while 6–12 sessions had the most significant impact on anxiety ($p < 0.001$) (Fig. 5c). For depression, there was no statistically significant difference for interventions with 6–12 sessions.
Interventions with more than 12 sessions had a statistically significant positive impact on the rate of normal vaginal births ($p = 0.003$) (Fig. 5e).

**Time**

Long-duration yoga interventions greater than 60 min had a statistically significant positive effect on perceived stress ($p < 0.001$) and anxiety ($p = 0.007$) (Fig. 5f & g). There was no statistically significant difference on depression scores between short ($p = 0.15$), moderate ($p = 0.35$) and long duration yoga interventions ($p = 0.27$) (Fig. 5h).

**Type**

There was a statistically significant subgroup effect for yoga sessions ($p < 0.001$) and yoga therapy ($p < 0.001$) compared to yoga postures ($p = 0.48$) on anxiety (Fig. 5i). The analysis for depression indicates a statistically significant subgroup effect for yoga therapy ($p < 0.001$) (Fig. 5j) while there was a statistically significant subgroup effect for yoga sessions on mode of birth ($p < 0.001$) (Fig. 5k).

**Discussion**

This systematic review examined the published evidence on pregnancy yoga to explore the characteristics and effectiveness of pregnancy yoga interventions. Notably only four studies specifically named a type of yoga.
The frequency, intensity, duration and content of the interventions varied widely. Encouragingly, results of the meta-analysis suggest that yoga is a beneficial non-pharmacological intervention to manage levels of stress, anxiety and depression in pregnant women. In relation to birth outcomes, meta-analysis showed that women in the yoga groups experienced shorter duration of labour up to 2 h on average, were 2.5 times more likely to experience a normal vaginal birth, had reduced intravenous analgesic administered and reported higher levels of comfort. Optimistically, low-frequency yoga interventions had a more significant impact on mode of birth while interventions with 6–12 sessions reduced anxiety.

These findings are supported by a previous qualitative review that examined yoga and its efficacy with 10 of the 15 studies demonstrating positive changes in maternal psychological or birth outcome measures [56]. A recent meta-analysis also found that yoga was an effective complementary and alternative therapy in promoting vaginal births and shortening the first and second stages of labour [16]. Notably, other studies have reported clinically meaningful changes in pain management for a multitude of conditions following yoga [57–60]. There is however a paucity of research in the area and further understanding of the mechanisms by which yoga can influence and modify the pain response is needed. Of the 31 included studies, 13 were conducted in India and a recent systematic review demonstrated that RCTs on yoga that were conducted in India were about 25 times more likely to reach positive conclusions than those conducted elsewhere [57]. Further in-depth studies are recommended to elucidate reasons for differences in conclusions between yoga RCTs conducted in India and those conducted elsewhere, and it may be beneficial to report on the results of trials conducted in India separately in future reviews. Since India is considered the home of yoga perhaps there are inherent differences in how yoga is taught and practised and how it is perceived by its population.

Of note we found no evidence of adverse events in any of the trials, suggesting that the yoga is a safe practice during pregnancy. According to Mottola & Artal (2016), in order to provide safe exercise guidelines, pregnant women should be prescribed exercises in accordance with the FITT principle [61]. Future studies should focus on specifying the frequency, intensity, duration and type of yoga in order to better understand the components of the intervention that impact optimally on both pregnancy outcomes and safety. This could then facilitate the development of a checklist of essential components for an evidence-based pregnancy yoga practice that could be replicated. The review results highlight issues regarding lack of allocation concealment and double-blinding, attrition bias, small sample sizes, a wide variety of outcome measures, non-standardised or replicable yoga interventions, lack of measurement of fidelity to the intervention and huge variation in the components of the yoga interventions. Many studies used self-practice which is difficult to monitor for both compliance and safety. High levels of compliance and safety are important for interventions to be effective so future studies should consider how the intervention is delivered and monitored. This will improve fidelity and potentially maximise effect. This is the first meta-analysis to suggest the optimal number and frequency of sessions to maximise effect and future trials can use these data to plan sessions numbers and frequency of delivery based on their intended outcomes. Importantly, women in the included studies were of middle-to-high socioeconomic status, presenting a selection bias of participants and thus reducing generalisability. Further studies should be conducted with women from lower socio-economic backgrounds.

A strength of this study is that the protocol was registered on PROSPERO and published open access. It followed the PRISMA statement, evaluated the certainty of the evidence using the GRADE methodology and all results were continuously reviewed by at least two reviewers. The findings can support the incorporation of the FITT principle into the design of interventions for future pregnancy yoga trials. In terms of limitations, inclusion of only quantitative studies published in English might have excluded those published in other languages and/or qualitative studies. While the Peer Review of Electronic Search Strategies (PRESS) for systematic reviews was not used a wide variety of databases were searched and a subject librarian supported the process of structuring and optimising the search strategy.

**Conclusion**

The present review and meta-analysis offer valuable information on the characteristics and effectiveness of pregnancy yoga interventions. The evidence supports previously cited positive effects of pregnancy yoga on anxiety, depression, perceived stress, normal vaginal birth and shorter duration of labour. Recommendations above can be used to support researchers to work collaboratively with yoga practitioners to standardise pregnancy yoga interventions and conduct more robust evidence-based evaluation. Overall, the evidence supporting yoga in pregnancy is growing, but methodological weaknesses with published studies and an insufficient number of published RCTs with reproducible evidence-based interventions highlight the need for further research. More high-quality studies are needed before the efficacy of pregnancy yoga interventions for maternal and birth outcomes can be definitively known. Future
Abbreviations

ADHD: Attention deficit hyperactivity disorder; CES-D: Centre for epidemiological studies - depression; CI: Confidence interval; EPDS: Edinburgh postnatal depression scale; FITT: Frequency, intensity, time/duration and type; GRADE: Grades of recommendation, assessment, development and evaluation; HADS-A: Hospital anxiety and depression scale - anxiety; HADS-D: Hospital anxiety and depression scale - depression; Hamilton anxiety rating scale; HDRS: Hamilton depression rating scale; OR: Odds ratio; PIH: Pregnancy induced hypertension; PRISMA-P: Preferred reporting items for systematic reviews and meta-analysis protocols; PSS-10: Perceived stress scale 10 item; QoL: Quality of life; RCT: Randomised controlled trial; RR: Risk ratio; STAI: The state-trait anxiety inventory; WHOQoL-100: World health organisation quality of life assessment instrument.

Supplementary Information

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Authors’ contributions

LC, PM, JEC and DD conceptualised the review, LC and JEC designed the search strategy and performed the searches, LC, PM, NMcG and DD performed the data extraction, risk of bias and GRADE assessments, LC performed the meta-analysis and wrote the first draft of the manuscript, PM, NMcG, JEC and DD provided critical feedback and edits to the draft. All authors approved the final manuscript.

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Availability of data and materials

The dataset generated and/or analysed during the study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was not required for this study as it did not involve conducting experimental research, nor include identifying personal data. The systematic review is being disseminated in peer-reviewed journals.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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