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Effectiveness of non-pharmacological interventions on pregnancy rates in infertile individuals undergoing IVF/ICSI: a systematic review and network meta-analysis

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Abstract

Aim To assess the impact of various non-pharmacological interventions on the likelihood of achieving pregnancy in individuals undergoing IVF/ICSI.

Background Despite significant advancements in assisted reproductive technology, the strategic utilization of non-pharmacological interventions to enhance clinical outcomes continues to pose a significant challenge in the field of reproductive medicine.

Methods Relevant studies published in English or Chinese were comprehensively selected from databases including CNKI, Wanfang Data, VIP Database, PubMed, Web of Science, and Embase up to December 2023. Studies that examined various non-pharmacological interventions during IVF/ICSI treatment, and reported subsequent pregnancy outcomes, were included. The control group received standard treatment. Study quality was assessed based on the methodology and criteria outlined in the Cochrane Collaboration Handbook. This review protocol was registered with PROSPERO (CRD42023414729).

Results Out of the initial 28,688 studies identified, 43 trials involving 5,779 women were included. When compared to the control treatment, cognitive-behavioral therapy, acupuncture, lifestyle intervention, health education, and music therapy were associated with a significantly increased likelihood of clinical pregnancy (OR 1.44, 95% CI 1.21 to 1.72; 1.89, 1.46 to 2.43; 1.75, 1.18 to 2.57; 2.10, 1.57 to 2.80; 1.52, 1.08 to 2.13, respectively). Among the non-pharmacological treatments studied, cognitive-behavioral therapy and lifestyle intervention were associated with the highest number of oocytes retrieved (OR 0.31, 95% CI 0.11 to 0.86; 0.15, 95% CI 0.04 to 0.58, compared to controls). No significant differences were observed among non-pharmacological interventions and the control group. Cognitive-behavioral therapy and health education led to the highest rate of high-quality embryos (OR 0.41, 95% CI 0.20 to 0.84; 0.52, 95% CI 0.28 to 0.97, compared to controls).

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Conclusions Non-pharmacological treatments such as cognitive-behavioral therapy, health education, lifestyle intervention, acupuncture, and music therapy showed trends suggesting better clinical outcomes in terms of pregnancy achievement compared to the control group. More high-level RCT studies are clearly necessary for future meta-analyses to better guide clinical practice. Implications for Nursing and/or Health policy: Policymakers should promote non-pharmacological programs for infertile population and develop standard guidelines. This will ensure that non-pharmacological interventions are implemented responsibly, protecting patient rights and enhancing healthcare outcomes.

Keywords Infertility, Pregnancy rate, In vitro fertilization, Intracytoplasmic sperm injection, Non-pharmacological interventions, Systematic review, Network meta - analysis

Text box 1. Contributions to the literature

- This study is a network meta-analysis to directly compare multiple non-pharmacological interventions for improving pregnancy rates in IVF/ICSI, offering evidence to guide clinical decision-making.
- Findings highlight the underrecognized role of non-pharmacological support in infertility care, complementing traditional biomedical approaches.
- Results provide actionable evidence for policymakers to integrate non-pharmacological strategies into standardized infertility treatment guidelines.
- The review underscores critical evidence gaps, urging prioritization of high-quality trials to validate these interventions' long-term efficacy and safety.

Introduction

Infertility is defined as the inability to establish a clinical pregnancy after 12 months of regular, unprotected sexual intercourse or when an individual's capacity to reproduce, either independently or with a partner, is compromised [1]. Globally, one in six individuals experiences infertility, affecting 17.8% of people in high—income countries and 16.5% in low- or middle- income countries, respectively [2]. As such, infertility has emerged as a major global public health concern. In vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI) are the main treatment modalities for infertility, providing a glimmer of hope for conception to those grappling with this condition. However, these treatments are characterized by long-term treatment protocols, substantial financial costs, invasive procedures, and uncertain outcomes. Additionally, patients undergoing IVF/ICSI treatment often face various psychological stresses due to familial and societal expectations [3].

Non-pharmacological interventions, when used as a supplement to IVF/ICSI treatment, are easily implemented, have minimal side effects, and can effectively reduce negative emotions in patients, ultimately enhancing clinical pregnancy rates [4]. Numerous researchers have utilized non-pharmacological interventions to enhance negative emotions and pregnancy outcomes in IVF/ICSI patients, yielding positive outcomes [5–7]. However, there is a lack of definitive evidence regarding the most effective non-pharmacological intervention method. This study seeks to systematically assess the impact of non-pharmacological interventions on pregnancy outcomes in IVF/ICSI patients through a network meta-analysis. The findings aim to offer evidence-based recommendations for healthcare professionals in choosing suitable non-pharmacological interventions.

Methods

The study protocol for this systematic review and network meta-analysis was registered in PROSPERO (CRD42023414729). The results of the study are presented following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) [8].

Literature search strategy and eligibility criteria

A comprehensive search of the following databases, from their inception up to December 2023, was conducted: CNKI, Wanfang Data, VIP Database, PubMed, Web of Science, and Embase. Free-text search terms were utilized and combined with logical operators. Synonyms of the search terms were generated through iterative trials and refinements. The detailed search strategies for each database are presented in Supplementary Table S1. Additionally, we carefully examined the references of the included studies and manually retrieved supplementary references as necessary to identify other potentially eligible studies that satisfied the inclusion criteria.

Participants

Participants undergoing IVF/ICSI.

Interventions and comparisons

All non—pharmacological interventions aimed at pregnancy rates were incorporated. Eligible comparators encompassed usual care.

Outcomes

Eligible studies were mandated to report the pregnancy rate as the primary outcome. Pregnancy was comprehensively defined and encompassed self-reported pregnancy, elevated hCG blood levels, visualization of the gestational sac by ultrasound, detection of the fetal heartbeat, successful establishment of a viable pregnancy, or the occurrence of a live birth. The timing of the post-treatment assessment of pregnancy outcomes was not restricted. Secondary outcomes included the number of retrieved oocytes, the fertilization rate, and the rate of high-quality embryos.

Inclusion criteria

This review will cover studies evaluating the feasibility, acceptability, effectiveness, and/or efficacy of non-pharmacological interventions for individuals undergoing IVF or ICSI. Experimental investigations, such as randomized controlled/clinical trials (RCTs), quasi-experimental studies, and single-group pre-post studies, will be eligible for inclusion. In cases of duplicate publications with the same study sample, the publication presenting the largest sample size will be incorporated. When sample sizes are similar, the first-published study from that sample will be chosen. Conference papers, reviews, and publications not in English or Chinese will be excluded.

Study selection and data extraction

Study selection, risk of bias assessments, and data extraction were performed independently by two reviewers. Any discrepancies were resolved through discussions between the two reviewers. In cases where consensus could not be reached, a third reviewer was consulted. The reference management software NoteExpress was employed for the study selection process. Initially, studies were screened based on their titles and abstracts, and then, full-text screening was conducted.

The following data elements were extracted: (1) first author, (2) publication year, (3) study location, (4) sample sizes, (5) randomization methods, (6) blinding methods, (7) allocation concealment, (8) intervention type, (9) control condition, (10) settings, (11) intervention frequency and duration, (12) completion rate, and (13) outcomes of interest. If there was any missing or unclear outcome information, the study authors were contacted. For trials with multiple publications, the original trial report was given priority, and additional details were supplemented from secondary papers.

Risk of bias and certainty of the evidence assessment

The revised Cochrane Risk of Bias Tool for Randomized Trials (RoB 2) was applied to assess the risk of bias in the included RCTs [9] (Table 1). The certainty of evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach within the network meta-analysis (NMA) framework [10, 11]. Two authors independently rated the risk of bias and the certainty of evidence. Any discrepancies were resolved through discussion. In cases where an agreement could not be reached, a third author was invited to make a judgment.

Data synthesis and statistical analysis

A network meta-analysis was conducted to simultaneously compare various non-pharmacological interventions for each outcome. A network plot was generated to depict the network structure [52]. Utilizing the mvmeta package in Stata software version 18.0, all network meta-analyses were performed within a random-effects multiple regression model. An inconsistency plot was utilized to evaluate concordance between direct and indirect evidence. Studies where all interventions had either 0% or 100% events were excluded as they do not contribute evidence for drawing relative effect conclusions.

The results from the network meta-analysis were presented as summary treatment effects in terms of odds ratios (OR) or weighted mean differences (WMD) with 95% confidence intervals (CI) to aid result interpretation regarding heterogeneity magnitude. Predictive intervals were also provided to indicate the range within which a future study estimate might fall [52]. Small study effects in the network were assessed using a comparison-adjusted funnel plot. Probabilities were summarized using the surface under the cumulative ranking curve (SUCRA) as a cumulative ranking summary statistic [52, 53]. Each intervention's efficacy was expressed as a percentage relative to an assumed best intervention. Higher SUCRA values indicate a greater likelihood of effective treatment.

Furthermore, studies that did not report the diagnosis of clinical pregnancy by ultrasound were removed from the main network, and a sensitivity analysis was conducted.

Results

Characteristics of the included studies

A comprehensive literature search yielded a total of 28,688 publications. After screening titles and abstracts, 967 studies were flagged as potentially eligible for inclusion in the review. These 967 studies were then subjected to further evaluation by retrieving their full texts. When necessary, the authors of the original studies were contacted to clarify methodological quality issues or to obtain additional information. Eventually, out of the initial 967 studies, only 43 were incorporated into the

Table 1 Risk of bias of included studies

Study name	Randomisation process	Deviations from intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall bias
Chen, 2018 [12]	Low	Low	Low	Low	Low	Low
Yang et al., 2015 [13]	Low	Low	Low	Low	Some concerns	Some concerns
Shen et al., 2022 [14]	Low	Low	Low	Low	Low	Low
Hong et al., 2015 [15]	High	Low	Low	Low	Some concerns	High
Zhong et al., 2023 [16]	Low	Low	Low	Low	Low	Low
Hong et al., 2014 [17]	High	Low	Low	Low	Some concerns	High
Mei et al., 2023 [18]	Low	Low	Low	Low	Some concerns	Some concerns
Hong et al., 2014 [19]	Low	Low	Low	Low	Some concerns	Some concerns
Zheng et al., 2012 [20]	High	Low	Low	Low	Some concerns	High
Chen et al., 2020 [21]	Low	Low	Low	Low	Low	Low
Shi et al., 2021 [22]	High	Low	Low	Low	Some concerns	High
Xia et al., 2020 [23]	Some concerns	Low	Low	Low	Some concerns	Some concerns
Xu et al., 2020 [24]	Low	Low	Low	Low	Some concerns	Some concerns
Liu et al., 2023 [25]	Low	Low	Low	Low	Low	Low
Zhu, 2012 [26]	Low	Low	Low	Low	Low	Low
Xie, 2023 [27]	High	Some concerns	Low	Low	Low	High
Liao et al., 2022 [28]	Low	Low	Low	Low	Low	Low
Zhou, 2014 [29]	Low	Low	Low	Low	Low	Low
Ma et al., 2022 [30]	Low	Low	Low	Low	Low	Low
Zhou, 2022 [31]	High	Low	Low	Low	Low	High
Wang et al., 2005 [32]	Some concerns	Low	Low	Low	Low	Some concerns
Zhang et al., 2020[33]	Some concerns	Low	Low	Low	Low	Some concerns
Wang et al., 2019 [34]	Low	Some concerns	Low	Low	Low	Some concerns
Li et al., 2012 [35]	Some concerns	Low	Low	Low	Low	Some concerns
Zhu et al., 2010 [36]	Low	Low	Low	Low	Some concerns	Some concerns
Zhu et al., 2023 [37]	High	Low	Low	Low	Low	High
Wang et al., 2016 [38]	Low	Low	Low	Low	Some concerns	Some concerns
Dong et al., 2018 [39]	Low	Low	Low	Low	Some concerns	Some concerns
Geng et al., 2018 [40]	High	Low	Low	Low	Some concerns	High
Zhang, 2018 [41]	High	Low	Low	Low	Some concerns	High
Lars et al., 2006 [42]	Low	Low	Low	Low	Low	Low
Purcell et al., 2007 [43]	Low	Low	Low	Low	Low	Low
Halpern et al., 2023 [5]	Low	Some concerns	Low	Low	Low	Some concerns
Gorayeb et al., 2012 [44]	Low	Low	Low	Low	Low	Low
Zhang et al., 2023 [45]	Low	Low	Low	Low	Some concerns	Some concerns
Aba et al., 2017 [6]	Low	Low	Low	Low	Low	Low
Guven et al., 2020 [46]	Low	Low	Low	Low	Low	Low
Chan et al., 2006 [47]	Some concerns	Low	Low	Low	Low	Some concerns
Wu et al., 2022 [48]	Low	Low	Low	Low	Low	Low
Domar et al., 2015 [7]	Low	Low	Low	Low	Low	Low
Paulus et al., 2002 [49]	Low	Low	Low	Low	Some concerns	Some concerns
Rasoulzadeh Bidgoli et al., 2020 [50]	Low	Low	Low	Low	Low	Low
Ockhuijsen et al., 2014 [51]	Some concerns	Low	Low	Low	Low	Some concerns

current systematic review and network meta-analysis (Fig. 1). The characteristics of all the studies included in this systematic review are detailed in Table 2.

A total of 5,779 women undergoing IVF/ICSI treatment received eight different non-pharmacological interventions, namely cognitive-behavioral therapy, acupuncture, lifestyle intervention, health education, transcutaneous electrical acupoint stimulation, mandala painting, pelvic floor muscle massage, and music therapy. These studies were conducted in various countries, published exclusively in Chinese or English, and were all single-center studies. Supplementary Figure S2 depicts the network plots for primary outcomes (clinical pregnancy rate) and secondary outcomes (such as the number of retrieved oocytes, fertilization rate, and high-quality embryo rate).

Risk of bias assessment results

Among the 43 studies included in the network meta-analysis, 28 trials (65.12%) presented a low risk of bias during the randomization process. In contrast, 9 trials (20.93%) were determined to have a high risk of bias. No studies were found to have a high risk of bias in terms of deviations from intended interventions and outcome measurement. Moreover, all trials demonstrated a low risk of bias regarding missing outcome data. Additionally, 22 trials (51.16%) were identified as having a low risk of bias in the selection of reported results. The results of the bias risk assessment are presented in Supplementary Figure S1.

Network meta-analysis results

Primary outcome measure: clinical pregnancy rate

In the network meta-analysis, a total of 43 studies were included, involving 5,779 women. Each study investigated a single adjuvant treatment intervention: cognitive-behavioral therapy (comprising seventeen trials with 2,402 women), acupuncture (ten trials with 1,124 women), lifestyle intervention (three trials with 568 women), health education (seven trials with 825 women), transcutaneous electrical acupoint stimulation (one trial

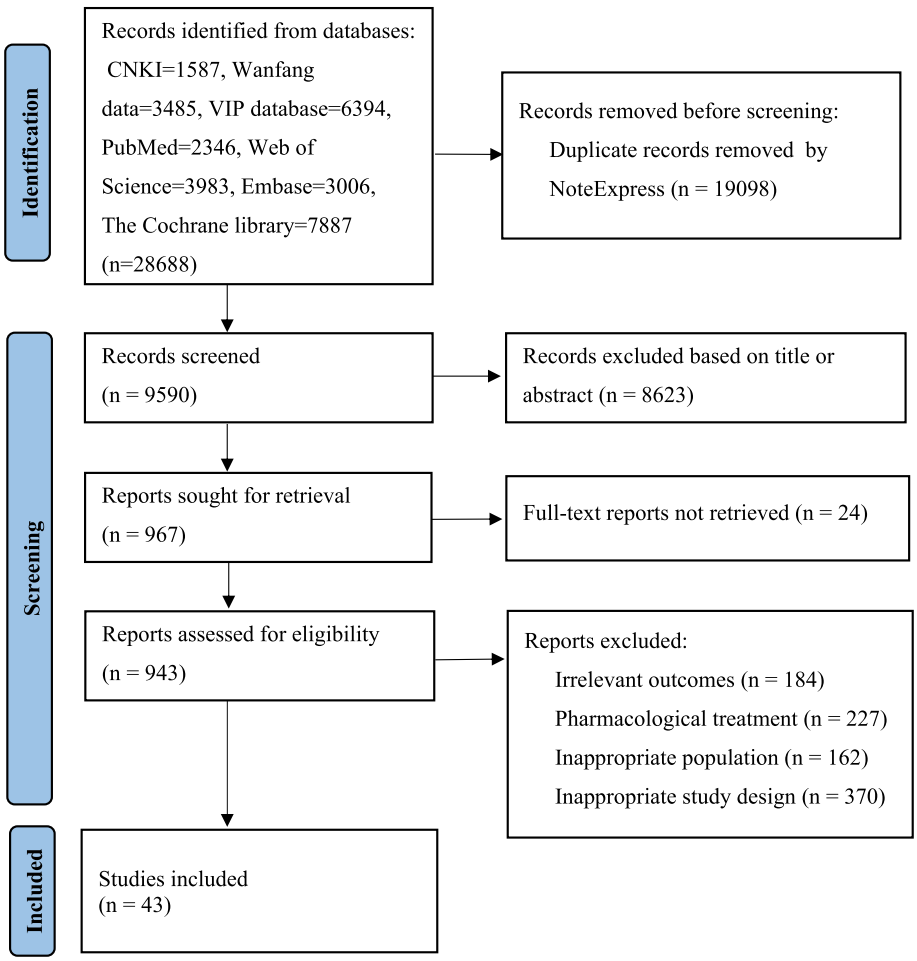

Fig. 1 PRISMA flow diagram

Table 2 Characteristics of included studies

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Chen, 2018 [12]	Asia	I: 90 (86) C: 90 (90)	NR	NR	Sealed opaque envelopes	Cognitive Behavioural Therapy	TAU	Single center	Couples: 100 min/session 1 session/week 3–4 weeks Group: 90 min/session 1 session/week 3–4 weeks	96	Pregnancy rates at 5 weeks	48.9% in control group and 64% in intervention group ($p = 0.044$)
Yang et al., 2015 [13]	Asia	I: 102 (102) C: 98 (98)	NR	NR	Random numbers table	Electroacupuncture	TAU	Single center	30 min/session 5–6 sessions/week Until the day of oocytes retrieval	100	Numbers of retrieved oocytes Fertilization rate Cleavage rate High quality embryo rate Clinical pregnancy tare OHSS incidence rate Cycle cancellation rate Early abortion rate SCF in the serum and follicular fluid Days and dosages of Gn administration	Clinical pregnancy rate and SCF in the serum and follicular fluid significantly higher in intervention group ($p < 0.05$) Days and dosages of Gn administration significantly lower in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Shen et al., 2022 [14]	Asia	I: 34 (32) C: 34 (33)	Random numbers table	Single (Investigators and data analysts)	Sealed opaque envelopes	Electroacupuncture	TAU	Single center	60 min/session 3 sessions/week 3 months	96	Endometrial thickness and growth HCG positive rate Clinical pregnancy rate Embryo implantation rate Live-birth rate	The proportion of type A endometrium on the embryo transfer day was higher in intervention group ($p < 0.01$) HCG positive rate, clinical pregnancy rate, embryo implantation rate, and live-birth rate significantly higher in intervention group ($p < 0.01$)
Hong et al., 2015 [15]	Asia	I: 53 (50) C: 56 (54)	NR	NR	No	Electroacupuncture	TAU	Single center	30 min/session 1 session/day From the day of Gn administration to the embryo transfer day	95	Cycle cancellation rate OHSS incidence rate Numbers of retrieved oocytes Fertilization rate High quality embryo rate Clinical pregnancy rate Abortion rate	Cycle cancellation rate and OHSS incidence rate significantly lower in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Zhong et al., 2023 [16]	Asia	I: 48 (46) C: 48 (48)	NR	NR	Random numbers table	Electroacupuncture	TAU	Single center	20 min/session 2–3 sessions/week 12 weeks	98	AFC Number of MII oocytes Number of high quality embryos HCG positive rate Clinical pregnancy rate	AFC, number of MII oocytes, number of high quality embryos, and HCG positive rate significantly higher in international group ($p < 0.05$)
Hong et al., 2014 [17]	Asia	I: 53 (50) C: 56 (54)	NR	NR	No	Electroacupuncture	TAU	Single center	30 min/session From the day of Gn administration to the embryo transfer day	95	Serum E_2 levels during stimulation Cycle cancellation rate OHSS incidence rate Numbers of retrieved oocytes Fertilization rate High quality embryo rate Clinical pregnancy rate Abortion rate	Serum E_2 followed similar curves in both groups Serum E_2 levels on the day of OPU and ET, cycle cancellation rate, and OHSS incidence rate significantly lower in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Mei et al., 2023 [18]	Asia	I: 54 (54) C: 54 (54)	No	NR	Random numbers table	Self-weight management	TAU	Single center	NR	100	Days and dosages of Gn administration Numbers of retrieved oocytes Fertilization rate High quality embryo rate Embryo implantation rate Clinical pregnancy rate	Days and dosages of Gn administration significantly lower in intervention group ($p < 0.05$) Numbers of retrieved oocytes, fertilization rate, high quality embryo rate, embryo implantation rate, and clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Hong et al., 2014 [19]	Asia	I: 150 (150) C: 150 (150)	Method NR	NR	Random numbers table	Emotional management	TAU	Single center	NR	100	Clinical pregnancy rate Abortion rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$) Abortion rate significantly lower in intervention group ($p < 0.05$)
Zheng et al., 2012 [20]	Asia	I: 50 (50) C: 50 (50)	NR	NR	No	Information support	TAU	Single center	NR	100	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Chen et al., 2020 [21]	Asia	I: 39 (39) C: 39 (39)	NR	NR	Random numbers table	IKAP model-based health education	TAU	Single center	≥60 min/session ≥2 sessions/week	100	Days and dosages of Gn administration Numbers of retrieved oocytes Fertilization rate Cleavage rate Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Shi et al., 2021 [22]	Asia	I: 70 (70) C: 70 (70)	NR	NR	No	Internet + health education	TAU	Single center	1 session/week 6 weeks	100	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Xia et al., 2020 [23]	Asia	I: 40 (40) C: 40 (40)	Method NR	NR	NR	Wechat-based health education	TAU	Single center	6 months	100	High quality embryo rate Clinical pregnancy rate Live-birth rate	High quality embryo rate, clinical pregnancy rate, and live-birth rate significantly higher in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Xu et al., 2020 [24]	Asia	I: 43 (43) C: 43 (43)	NR	NR	Random numbers table	Solution-focused brief therapy	TAU	Single center	30–50 min/session ≥4 sessions	100	Numbers of retrieved oocytes High quality embryo rate Numbers of embryos Biochemical pregnancy rate Clinical pregnancy rate Abortion rate	Abortion rate significantly higher in intervention group ($p < 0.05$)
Liu et al., 2023 [25]	Asia	I: 43 (43) C: 43 (43)	NR	NR	Method NR	Staged health education	TAU	Single center	NR	100	Numbers of embryos High quality embryo rate Cycle cancellation rate Clinical pregnancy rate Early abortion rate	No significant difference between two groups ($p > 0.05$)
Zhu, 2012 [26]	Asia	I: 30 (27) C: 30 (24)	NR	NR	Method NR	Transcutanclus electrical- acupoint stimulation	TAU	Single center	30 min/session	85	Fertilization rate Cleavage rate High quality embryo rate Cycle cancellation rate Embryo implantation rate Clinical pregnancy rate	Embryo implantation rate, clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Xie, 2023 [27]	Asia	I: 56 (52) C: 56 (53)	No	NR	No	Solution-focused brief therapy	TAU	Single center	30 min/session 5 sessions	94	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Liao et al., 2022 [28]	Asia	I: 63 (60) C: 63 (61)	NR	NR	Random numbers table	Mandala painting therapy	TAU	Single center	30 min/session 5 sessions/week 4 weeks	96	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Zhou, 2015 [29]	Asia	I: 40 (31) C: 40 (28)	NR	NR	Method NR	Pelvic floor muscle massage	TAU	Single center	NR	74	Numbers of retrieved oocytes Numbers of high quality embryos Fertilization rate Cleavage rate Embryo implantation rate Cycle cancellation rate Biochemical pregnancy rate Clinical pregnancy rate	Numbers of retrieved oocytes, numbers of high quality embryos, clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Ma et al., 2022 [30]	Asia	I: 105 (97) C: 102 (97)	No	NR	Random numbers table	Situational experiential health education	TAU	Single center	30 min/session	94	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Zhou, 2023 [31]	Asia	I: 67 (66) C: 67 (64)	NR	NR	No	Emotional freedom techniques	TAU	Single center	10–15 min/ session 2 sessions/day	97	Numbers of retrieved oocytes Fertilization rate Cleavage rate High quality embryo rate Clinical pregnancy rate Delivery outcome	High quality embryo rate significantly higher in intervention group ($p < 0.05$)
Wang et al., 2005 [32]	Asia	I: 188 (188) C: 162 (162)	NR	NR	No	Music therapy	TAU	Single center	NR	100	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Zhang et al., 2020 [33]	Asia	I: 45 (45) C: 45 (45)	NR	NR	Random numbers table	Whole- process digital health education	TAU	Single center	NR	100	Numbers of retrieved oocytes High quality embryo rate Embryo implantation rate Clinical pregnancy rate	High quality embryo rate, embryo implantation rate, clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Wang et al., 2019 [34]	Asia	I: 99 (99) C: 99 (97)	NR	NR	Method NR	Cognitive Behavioural Therapy	TAU	Single center	30–45 min/ session 1 session/week 4 weeks	99	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Li et al., 2012 [35]	Asia	I: 35 (35) C: 128 (128)	NR	NR	NR	Cognitive Behavioural Therapy	TAU	Single center	NR	100	Fertilization rate Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Zhu et al., 2010 [36]	Asia	I: 50 (42) C: 50 (47)	NR	NR	Random numbers table	Group psychotherapy	TAU	Single center	90–120 min/session 2 sessions/week 6 sessions	89	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Zhu et al., 2023 [37]	Asia	I: 85 (79) C: 85 (78)	No	NR	No	WeChat node health education	TAU	Single center	NR	92	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Wang et al., 2016 [38]	Asia	I: 30 (30) C: 30 (30)	NR	NR	Random numbers table	Warm acupuncture	TAU	Single center	30 min/session	100	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Dong et al., 2018 [39]	Asia	I: 50 (47) C: 50 (46)	No	NR	Method NR	Music therapy	TAU	Single center	30 min/session 2 sessions/week	93	Numbers of embryos High quality embryo rate Clinical pregnancy rate	High quality embryo rate, and clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Geng et al., 2018 [40]	Asia	I: 43 (43) C: 43 (43)	NR	NR	NR	Psychologic-al intervention	TAU	Single center	NR	100	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Zhang, 2018 [41]	Asia	I: 40 (40) C: 40 (40)	No	No	No	Psychologic-al counseling	TAU	Single center	5–8 sessions	100	Biochemical pregnancy rate Clinical pregnancy rate	Biochemical pregnancy rate significantly lower in intervention group ($p < 0.05$) Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Lars et al., 2006 [42]	Europe	I: 100 (95) C: 100 (87)	NR	NR	Sealed opaque envelopes	Acupuncture	TAU	Single center	25 min/session 2 sessions	91	Positive pregnancy test Clinical pregnancy Early pregnancy loss Ongoing pregnancy/ delivery Implantation rate	Positive pregnancy test, clinical pregnancy, and ongoing pregnancy/ delivery significantly higher in intervention group ($p < 0.05$)
Purcell et al., 2007 [43]	North America	I: 82 (82) C: 82 (82)	NR	NR	Sealed opaque envelopes	Bed rest after embryo transfer	TAU	Single center	30 min/session	100	Clinical pregnancy rate Ongoing pregnancy rate	No significant difference between two groups ($p > 0.05$)
Halpern et al., 2023 [5]	South America	I: 327 (222) C: 109 (74)	NR	NR	Method NR	Beetroot, watermelon and ginger juice supplementa-tion	TAU	Single center	From the day of embryo transfer until the day of pregnancy test	68	Implantation rate Pregnancy rate Miscarriage rate	Implantation rate and clinical pregnancy rate were significantly higher in the Supplementation compared to the Control group ($p < 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Gorayeb et al., 2012 [44]	South America	I: 161 (93) C: 124 (95)	NR	NR	Method NR	Brief cognitive behavioral intervention	TAU	Single center	NR	66	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Zhang et al., 2023 [45]	Asia	I: 65 (65) C: 65 (65)	NR	NR	Random numbers table	Comprehensive nursing intervention	TAU	Single center	NR	100	Blastocyst rate Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Aba et al., 2017 [6]	Asia	I: 100 (89) C: 100 (97)	NR	Single (Research objects)	Computer-generated random numbers	Music therapy	TAU	Single center	28 min/session 2 sessions	93	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Guven et al., 2020 [46]	Asia	I: 38 (36) C: 38 (36)	NR	NR	Method NR	Acupuncture	TAU	Single center	30 min/session 3 sessions	95	Beta HCG positivity rate Clinical pregnancy rate Ongoing pregnancy rate Live birth rate	Beta HCG positivity rate, clinical pregnancy rate, ongoing pregnancy rate, and live birth rate significantly higher in intervention group ($p < 0.05$)
Chan et al., 2006 [47]	Asia	I: 101 (65) C: 126 (108)	NR	NR	Drawing lots	The Eastern Body-Mind-Spirit intervention	TAU	Single center	180 min/session 4 sessions/week 16 sessions	76	Pregnancy rate Implantation rate Multiple pregnancy rate	No significant difference between two groups ($p > 0.05$)

Table 2 (continued)

First author, year	Region	Participants (n) I: intervention C: control (final analysis)	RM	Blinding	AC	Intervention type	Comparison	No. of centers	Frequency and duration	Intervention completion rate (%)	Outcomes of interest	Results
Wu et al., 2022 [48]	Asia	I: 43 (40) C: 44 (43)	NR	Single (Outcome assessors, statisticians)	Method NR	Acupuncture	TAU	Single center	30 min/session	95	Days and dosages of Gn administration Clinical pregnancy rate Live birth rate	Days and dosages of Gn administration significantly lower in intervention group ($p < 0.05$) Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Domar et al., 2015 [7]	North America	I: 89 (87) C: 77 (71)	Method NR	Single (Outcome assessors)	Random numbers table	Cognitive coping and relaxation intervention	TAU	Single center	NR	95	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Paulus et al., 2002 [49]	Europe	I: 80 (80) C: 80 (80)	NR	NR	Computer-generated random numbers	Acupuncture	TAU	Single center	25 min/session 2 sessions	100	Clinical pregnancy rate	Clinical pregnancy rate significantly higher in intervention group ($p < 0.05$)
Rasoulzadeh Bidgoli et al., 2020 [50]	Asia	I: 40 (29) C: 40 (31)	NR	No	Flip a coin	Collaborative infertility counseling	TAU	Single center	60 min/session 5 sessions	75	Clinical pregnancy rate	No significant difference between two groups ($p > 0.05$)
Ockhuijsen et al., 2014 [51]	Europe	I: 127 (92) C: 124 (90)	NR	NR	Random numbers table	Positive reappraisal coping intervention	TAU	Single center	2 sessions	73	Clinical pregnancy rate Clinical pregnancy with heartbeat	No significant difference between two groups ($p > 0.05$)

RM randomisation method, *AC* allocation concealment, *NR* not reported, *Gn* gonadotropin, *SCF* stem cell factor, *OPU* oocyte pick-up, *ET* embryo transplantation, *AFC* antral follicle count, *TAU* treatment as usual, *IKAP* information-knowledge-belief-behavioral

with 51 women), mandala painting (one trial with 121 women), pelvic floor muscle massage (one trial with 59 women), and music therapy (three trials with 629 women).

The findings of the network meta-analysis are detailed in Table S2. When compared to the control treatment, cognitive-behavioral therapy, acupuncture, lifestyle intervention, health education, and music therapy were associated with a significantly increased likelihood of clinical pregnancy (OR 1.44, 95% CI 1.21 to 1.72; 1.89, 1.46 to 2.43; 1.75, 1.18 to 2.57; 2.10, 1.57 to 2.80; 1.52, 1.08 to 2.13, respectively) (Table S2 and Figure S3).

We utilized the SUCRA method to establish a hierarchical ranking of the various treatments. SUCRA provides a numerical representation of the overall ranking, assigning a single value to each treatment ranging from 0 to 100%. The SUCRA values assigned to the eight adjuvant treatments and control groups were as follows: 84.9 (transcutaneous electrical acupoint stimulation), 83.6 (pelvic floor muscle massage), 70.8 (health education), 61.5 (acupuncture), 52.6 (lifestyle intervention), 38.2 (music therapy), 31.4 (cognitive-behavioral therapy), 22.2 (mandala painting), and 4.8 (control) (Figure S7 and S11). Additionally, Figure S13, an extension of the common funnel plot for multiple treatment comparisons, indicates the absence of small-study effects concerning the clinical pregnancy rate of interest.

Secondary outcome measures: number of oocytes retrieved

In the secondary outcome analysis, a total of 16 studies involving 2,002 women were included in the network meta-analysis. Among the non-pharmacological treatments studied, cognitive-behavioral therapy and lifestyle intervention were associated with the highest number of oocytes retrieved (OR 0.31, 95% CI 0.11 to 0.86; 0.15, 95% CI 0.04 to 0.58, compared to controls). The results of the network meta-analysis can be found in Table S2 and Figure S4. The SUCRA values for lifestyle intervention, cognitive-behavioral therapy, health education, music therapy, the control group, and acupuncture were 91.7%, 74.2%, 48.5%, 40.7%, 28.1%, and 16.7%, respectively (Figure S8 and S11). The funnel plot indicates a potential for publication bias and small-sample effects (Figure S13).

Secondary outcome measures: fertilization rate

Regarding the fertilization rate as a secondary outcome, 10 studies involving 1,429 women were incorporated into the network meta-analysis. No significant differences were observed among non-pharmacological interventions and the control group (Table S3, Figure S5, S9, S12). An extension of the common funnel plot for multiple treatment comparisons shows the absence of small-study effects regarding the fertilization rate of interest (Figure S14).

Secondary outcome measures: high quality embryo rate

For the high-quality embryo rate, another secondary outcome, 7 studies involving 1,070 women were included in the network meta-analysis. Five adjuvant treatments were compared with controls. Cognitive-behavioral therapy and health education led to the highest high-quality embryo rate (OR 0.41, 95% CI 0.20 to 0.84; 0.52, 95% CI 0.28 to 0.97, compared to controls). The results of the network meta-analysis are presented in Table S3 and Figure S6. The SUCRA values for cognitive-behavioral therapy, health education, transcutaneous electrical acupoint stimulation, acupuncture, the control group, and lifestyle intervention were 84.4%, 72.6%, 67.2%, 38.7%, 19.8%, and 17.3%, respectively (Figure S10 and S12). An extension of the common funnel plot for multiple treatment comparisons shows the absence of small-study effects concerning the high quality embryo rate of interest (Figure S14).

Assessment of inconsistency

Global tests confirmed homogeneity across studies ($\chi^2 = 3.24$, $p = 0.052$) with no detectable inconsistency.

Sensitivity analyses

The meta-analysis of 43 studies demonstrated consistent efficacy of non-pharmacological interventions in improving clinical pregnancy rates among IVF/ICSI patients, with a pooled risk ratio (RR) of 1.20 (95% CI: 1.12–1.29). Notably, the included studies exhibited perfect homogeneity ($I^2 = 0.0\%$, $p = 0.923$). Sensitivity analysis excluding 16 studies employing non-standardized outcome assessments (unclear methods or hormone-based detection) yielded nearly identical results (RR = 1.22, 95% CI: 1.12–1.33), while maintaining complete statistical homogeneity ($I^2 = 0.0\%$, $p = 0.986$). The complete overlap of confidence intervals between the primary and sensitivity analyses ($\Delta RR = +0.02$) confirms the robustness of findings, indicating that variations in pregnancy confirmation methodologies did not substantially influence the overall effect estimates (Table S4, Figure S15, S16).

Discussion

Principal discussion of the results

Enhancing the clinical pregnancy rate in patients undergoing IVF/ICSI procedures is a crucial clinical objective. Although numerous studies have explored non-pharmacological interventions to improve pregnancy outcomes in IVF/ICSI patients, the optimal application of these interventions remains challenging. The objective of our study is to perform a comparative analysis of different non-pharmacological interventions and offer

evidence-based recommendations for clinical practice. The findings of our systematic review and network meta-analysis can be summarized in three main aspects.

First, cognitive-behavioral therapy has demonstrated positive effects in increasing the clinical pregnancy rate, the number of retrieved oocytes, and the proportion of high-quality embryos. Second, among these adjunctive therapies, health education, acupuncture, and lifestyle interventions ranked as the top three interventions that enhanced the likelihood of achieving pregnancy. Third, among the effective intervention strategies, cognitive-behavioral therapy, despite its beneficial effects on increasing the number of retrieved oocytes and the proportion of high-quality embryos, had the lowest probability of enhancing the clinical pregnancy rate. Finally, among all the interventions investigated in this study, none had a significant impact on the fertilization rate. Notably, the inconsistent definition of the clinical pregnancy rate is a prominent issue in these studies. Thus, the establishment of a standardized definition is of great significance.

In our study, the SUCRA values have provided valuable insights into the relative effectiveness of various non—pharmacological interventions. For the clinical pregnancy rate, transcutaneous electrical acupoint stimulation demonstrated the highest SUCRA value of 84.9, closely followed by pelvic floor muscle massage with 83.6. This indicates that these two interventions have a high probability of being the most effective in enhancing clinical pregnancy rates among the options we examined. Health education also showed a relatively high SUCRA value of 70.8, suggesting its potential role in improving pregnancy outcomes. In contrast, mandala painting had a SUCRA value of 22.2 and the control group had a mere 4.8, indicating that these approaches were less likely to be the optimal choices for promoting clinical pregnancy. When considering the number of oocytes retrieved, lifestyle intervention emerged as the top—performing intervention with a SUCRA value of 91.7%. This implies that lifestyle modification is highly likely to be the most effective in increasing the number of oocytes retrieved. Cognitive—behavioral therapy also showed a relatively good performance with a SUCRA value of 74.2%. However, acupuncture had a rather low SUCRA value of 16.7% in this regard, suggesting that it may not be as effective as other interventions in promoting oocyte retrieval. Regarding the high—quality embryo rate, cognitive—behavioral therapy ranked first with a SUCRA value of 84.4%, followed by health education with 72.6% and transcutaneous electrical acupoint stimulation with 67.2%. These results suggest that these interventions are more likely to contribute to the formation of high—quality embryos. In contrast, lifestyle intervention and the control group had relatively low SUCRA values of 19.8% and 17.3% respectively, indicating their limited effectiveness in this aspect.

Overall, these SUCRA values provide a comprehensive and quantitative ranking of the non-pharmacological interventions. Medical staff can use this information to make more informed decisions when recommending treatments to infertile patients undergoing IVF/ICSI. For example, if the primary goal is to increase the clinical pregnancy rate, transcutaneous electrical acupoint stimulation and pelvic floor muscle massage could be prioritized. If enhancing the number of oocytes retrieved is the main concern, lifestyle intervention might be the first choice. And for improving the high-quality embryo rate, cognitive-behavioral therapy, health education, and transcutaneous electrical acupoint stimulation could be considered. By understanding these SUCRA-based rankings, medical staff can better tailor treatment plans to meet the specific needs of each patient, ultimately improving the overall treatment efficacy and patient satisfaction in the field of infertility treatment. Notably, ranking results should be interpreted cautiously given detected inconsistency.

Strengths of the study

Our systematic review and network meta-analysis present a compilation of data summarizing various non-pharmacological interventions aimed at enhancing clinical pregnancy rates in patients undergoing IVF/ICSI treatment. While the definition of clinical pregnancy rate may vary among studies, leading to some heterogeneity, our study provides a unique opportunity to rank multiple non-pharmacological interventions through a pooled analysis. Additionally, we report the primary outcomes of IVF/ICSI, which could have significant implications for clinical practice. It is important to note that we employ network meta-analysis to simultaneously compare the effects of different interventions, allowing for indirect comparisons among various intervention modalities. The outcomes of the interventions primarily include clinical pregnancy rate, number of retrieved oocytes, fertilization rate, and rate of high-quality embryos. Furthermore, we rank the interventions to assess their strengths and weaknesses. This data serves as a valuable resource for clinical practice and may be advantageous in the selective use of non-pharmacological interventions to improve clinical outcomes in IVF/ICSI treatment cycles.

Limitations of the study

Our study has several limitations that warrant acknowledgment. First, there was variability in the definition of clinical pregnancy among the included studies. This variability, influenced by factors such as the timing

and method of diagnosis, may have affected the overall assessment of outcomes. As a result, a conclusive determination regarding the overall quality of evidence could not be made. Notably, the sensitivity analysis indicated that differences in pregnancy confirmation methodologies had no substantial impact on the overall effect estimates within the scope of this study.

Second, the protocols for non-pharmacological interventions and routine nursing procedures showed significant discrepancies in terms of initiation timing, duration, and implementation processes. Given the limited number of studies, a comprehensive analysis of this clinical heterogeneity was challenging. Consequently, the current systematic review only enabled broad comparisons between different non-pharmacological therapies and standard treatments. With the inclusion of more studies in the future, it will be possible to evaluate the potential moderating effects of these variables on the efficacy of the investigated interventions.

Third, certain studies were excluded from this paper due to factors such as study design and outcome measures. This led to an incomplete examination of all non-pharmacological interventions in our analysis.

Finally, there is a dearth of research exploring the combined impact of these non-pharmacological therapies on the growth and well-being of children born as a result of the respective interventions. Future studies focusing on long-term monitoring of the offspring from these interventions will be crucial for validating the safety of these non-pharmacological measures and for supporting the future formulation of clinical recommendations.

It should be noted that this study did not conduct meta-regression analysis. The decision was mainly based on two reasons. First, the heterogeneity among the included studies was relatively low, suggesting minimal influence of potential confounding study characteristics on effect sizes. Second, the limited number of studies (n =43) in our network meta-analysis might lead to unstable results if meta-regression were performed. Consequently, we cannot completely rule out the impact of unmeasured confounding factors associated with study characteristics (such as sample size, intervention duration, and participant demographics) on our results. This limitation may potentially affect the generalizability of our conclusions, especially when applying our findings to populations or study designs that deviate substantially from those in our included studies. For instance, the effect sizes reported in this study may not be directly applicable to future studies with significantly larger sample sizes or different participant demographic profiles. In future research, we plan to incorporate meta-regression analysis by including a sufficient number of high-quality studies. This will enable a more comprehensive understanding of the impact of study characteristics on effect sizes and yield more generalizable and reliable conclusions.

Clinical implications and conclusion

The present network meta-analysis indicates that cognitive-behavioral therapy has emerged as the favored non-pharmacological intervention for patients undergoing IVF/ICSI. This is evidenced by outcome measures such as the clinical pregnancy rate, the number of retrieved oocytes, and the high-quality embryo rate. Previous research has demonstrated variability in the impact of cognitive-behavioral therapy on IVF/ICSI outcomes. This variability may be influenced by factors such as subject selection bias, methodological disparities, and data collection discrepancies [12, 34, 35, 44, 47]. Cognitive-behavioral therapy might enhance clinical outcomes by addressing negative emotions such as anxiety and depression[44]. Our findings suggest that although cognitive-behavioral therapy significantly improves the number of retrieved oocytes and the high-quality embryo rate, its effect on the clinical pregnancy rate is only moderately efficacious. We hypothesize that the response to cognitive-behavioral therapy may differ among various patient subgroups. Therefore, further in-depth investigations into the application of cognitive-behavioral therapy are necessary to enhance our understanding of its adjunctive role in patients undergoing IVF/ICSI.

In the present meta-analysis, the application of adjuvant health education treatment exhibited positive effects. Health education was found to enhance clinical pregnancy rates and embryo quality safely and effectively. Theoretically, a comprehensive and targeted health education approach can help patients develop a more systematic understanding of their conditions and treatments. Moreover, patient-provider communication, characterized by patience and enthusiasm, may contribute to alleviating patient stress. Among the seven papers included in this review, it was noted that health education led to an improvement in clinical pregnancy rates in five studies and an increase in the high-quality embryo rate in two studies [21–23, 25, 30, 33, 37]. The discrepancies in research findings might be ascribed to variations in the specific implementation strategies and target populations of health education.

In the current investigation, data from only three studies [5, 18, 43] were analyzed regarding non—pharmacological treatment via lifestyle intervention, which encompasses aspects such as diet and rest [5, 18, 43]. These data indicate a potential beneficial impact on clinical outcomes. In the present network meta—analysis, our findings suggest that lifestyle intervention has the most pronounced effect on increasing the number of retrieved oocytes. Additionally, it also shows a certain

positive influence on improving clinical pregnancy rates. This implies promising prospects for the application of lifestyle intervention in the infertile population. Notwithstanding, these results require validation through additional prospective studies. Given the limited number of studies analyzed thus far, further research is essential to firmly establish the effectiveness of lifestyle intervention in this context. Such prospective studies should be designed to comprehensively assess the impact of different lifestyle modification strategies on a larger and more diverse sample of infertile patients, thereby providing more robust evidence for clinical practice.

Acupuncture has long been employed as an adjunctive therapy in patients undergoing IVF/ICSI to enhance clinical outcomes. It functions by regulating channels and collaterals and harmonizing Qi-blood yin-yang [5, 18, 43]. In the multiple eligible studies included in the present network meta-analysis, acupuncture was associated with a higher clinical pregnancy rate [13–17, 26, 38, 42, 46, 48, 49]. Nevertheless, it did not demonstrate significant improvements in the number of retrieved oocytes, the fertilization rate, nor the high-quality embryo rate. The studies incorporated in these meta-analyses showed substantial heterogeneity. This inconsistency might be ascribed to the diverse overall effects of the interventions. Moreover, factors such as the types of acupuncture, acupoint selection, treatment timing, and treatment duration are likely to be crucial determinants affecting the efficacy of these interventions.

Prior research has indicated that music therapy can elicit positive thoughts and emotional experiences in patients. It achieves this through mechanisms such as stimulating dopamine release, enhancing immunity, and reducing neuroinflammation [54, 55]. It is postulated to possess the ability to regulate both psychological and physiological processes. In the present network meta-analysis, music therapy was found to significantly increase the clinical pregnancy rate. Nevertheless, as only three studies were included in this analysis [6, 32, 39], further well-designed randomized controlled trials are essential to confirm the potential benefits of non-pharmacological treatment with music therapy. Given the limited sample size in the current analysis, additional research is required to comprehensively evaluate the efficacy of music therapy in this context. These future trials should be carefully designed to account for various factors that may influence the outcomes, thereby providing more robust evidence for the application of music therapy in enhancing clinical pregnancy rates.

In conclusion, based on the available evidence, for patients undergoing IVF/ICSI, clinical protocols that use non-pharmacological treatment with cognitive-behavioral therapy, health education, lifestyle intervention, acupuncture and music therapy produced better clinical outcomes in terms of pregnancy achievement than were achieved in the control group. Evidently, more high-quality RCTs are required for future meta-analyses to more effectively guide clinical practice. Given the potential implications of these non-pharmacological interventions, well-designed RCTs should be conducted to comprehensively assess their efficacy, taking into account various factors that may influence treatment outcomes. This will provide more robust evidence for the optimal use of these interventions in clinical settings for IVF/ICSI patients.

Implications for nursing practice and policy

Shaping nursing policies for non-pharmacological interventions

Policymakers need to acknowledge the transformative potential of non-pharmacological interventions in nursing practice and formulate policies that facilitate their standardized and responsible integration. It is crucial to strengthen data privacy and security regulations to safeguard patient information while simultaneously fostering innovation. Moreover, financial resources should be allocated to enhance the technological infrastructure necessary for the implementation of non-pharmacological interventions in healthcare settings. This will not only ensure the proper utilization of these interventions but also contribute to the overall improvement of patient care within the framework of IVF/ICSI treatment and broader healthcare services.

Advocating standard non-pharmacological interventions use in nursing

Nurses assume a pivotal role in advocating for the standardized use of non-pharmacological interventions. Policies ought to foster clear communication concerning the collection, storage, and sharing of medical record data. This would empower patients to make well-informed decisions about their healthcare. By ensuring transparency in data-related processes, patients can better understand how their information is utilized in the context of non-pharmacological intervention implementation, thereby enhancing their engagement in the decision-making process regarding their treatment, especially within the framework of IVF/ICSI treatment and broader healthcare scenarios where non—pharmacological approaches are being integrated.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
Liu KX: Conceptualization, Methodology, Writing – original draft. Wu YY: Data curation, Writing – original draft. Zhang M: Formal analysis, Writing – original draft. Jia M: Formal analysis, Writing – original draft. Wang D: Visualization, Writing – review & editing. Zhang CX: Project administration, Writing – review & editing. Guan YC: Supervision, Writing – review & editing. Tian PL: Supervision, Writing – review & editing.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Informed consent was not applicable. The study protocol was formally approved by the Research Ethics Committee of the Third Affiliated Hospital of Zhengzhou University (Ethics Approval Number 2023-102-01).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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