

Lifestyle Optimization Programs Delivered by Nurses for Fertility Enhancement: A Global Systematic Review and Meta-Analysis

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Abstract

Background: Infertility affects 10–15% of couples globally, presenting significant psychological and physical challenges. While medical fertility treatments are standard, the contribution of structured, nurse-led lifestyle modification programs—encompassing diet, exercise, stress management, and sleep hygiene—to reproductive outcomes is not comprehensively quantified. This systematic review and meta-analysis aimed to assess the effectiveness of nurse-delivered lifestyle interventions in improving fertility outcomes and patient-reported well-being in infertile populations.

Methods: A systematic search was performed across four databases (PubMed, Scopus, Web of Science, and Cochrane Library) from inception to July 2025 for Randomized Controlled Trials (RCTs) and quasi-experimental studies. Eligibility included adult infertile populations receiving a structured, nurse-led lifestyle optimization intervention compared to usual care. Two independent reviewers screened studies, extracted data, and assessed the risk of bias using the Cochrane Risk of Bias 2.0 tool (RoB 2). A random-effects model was used for meta-analysis, calculating pooled Risk Ratios (RR) for binary outcomes (pregnancy, live birth) and Standardized Mean Differences (SMD) for continuous outcomes (psychological well-being). Heterogeneity was assessed using the I^2 statistic.

Results: Eighteen studies, comprising 2,345 participants, met the inclusion criteria. The pooled analysis revealed that nurse-led lifestyle optimization significantly increased clinical pregnancy rates (RR = 1.34, 95% CI: 1.12–1.61, $p < 0.001$, $I^2 = 38\%$) and improved patient-reported psychological well-being (SMD = 0.42, 95% CI: 0.21–0.63, $p < 0.001$, $I^2 = 55\%$) compared to usual care. Subgroup analysis highlighted that interventions with a minimum duration of 12 weeks and those incorporating both dietary and stress-reduction components demonstrated the

largest effect sizes. There was an insufficient number of studies to meta-analyze live birth rates.

Conclusion: Structured, nurse-led lifestyle optimization programs offer a clinically significant benefit, enhancing both reproductive outcomes (clinical pregnancy) and psychosocial health in individuals experiencing infertility. These findings advocate for the essential integration of such interventions into standard global fertility care protocols, underscoring the innovative role of nurses in holistic reproductive medicine.

Keywords: Nurse-led interventions, infertility, lifestyle optimization, fertility enhancement, systematic review.

I. INTRODUCTION

Background and Rationale

Infertility, defined as the inability to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse, impacts approximately 10–15% of couples worldwide, translating to an estimated 48 million couples and 186 million individuals [1]. Beyond the physical barrier to conception, infertility is associated with substantial psychological distress, including elevated levels of anxiety, depression, and stress, often comparable to that experienced by patients with other chronic medical conditions [2]. The economic burden on both couples and healthcare systems, primarily driven by high-cost assisted reproductive technology (ART) treatments, is also considerable.

While advancements in ART have improved clinical outcomes, they often overlook the modifiable environmental and behavioral factors that fundamentally influence reproductive health [3]. Lifestyle optimization, encompassing crucial components such as healthy diet, regular physical activity, effective stress management, and adequate sleep

hygiene, has been consistently identified as a vital non-medical approach to enhance natural conception and improve the success rates of ART [4, 5].

Knowledge Gap and Theoretical Framework

Registered nurses (RNs) and advanced practice nurses (APNs) are uniquely positioned within the healthcare system to deliver structured, continuous, and patient-centered lifestyle interventions. Their expertise in health education, behavior change counseling, and psychosocial support makes them ideal candidates to lead these programs [6]. However, despite the acknowledged link between lifestyle and fertility, and the established role of nursing in chronic disease management, the aggregate clinical effectiveness of nurse-led, multi-component lifestyle optimization programs specifically for fertility enhancement remains critically underexplored and unquantified through rigorous meta-analysis.

This systematic review and meta-analysis is grounded in the Theory of Planned Behavior (TPB), which posits that health behavior change is predicted by an individual's attitudes, subjective norms, and perceived behavioral control. Nurse-led interventions are perfectly aligned with TPB, as they focus on enhancing self-efficacy (perceived control) and providing personalized feedback and education (attitudes and subjective norms) necessary for sustained lifestyle change.

Study Objectives

The primary objective of this systematic review and meta-analysis was to:

Quantify the effect of nurse-led, multi-component lifestyle optimization programs on clinical pregnancy rates and live birth rates in infertile populations compared to usual care.

Determine the effect of these programs on patient-reported psychological well-being (e.g., anxiety, depression, quality of life).

Investigate sources of heterogeneity and identify which specific intervention components (e.g., diet vs. stress reduction) and durations are most effective.

II. METHODS

Review Design and Registration

This systematic review and meta-analysis was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [7] and the guidelines outlined in the Cochrane Handbook for Systematic Reviews of Interventions [8].

Search Strategy

A comprehensive, pre-specified search strategy was employed across four major electronic databases: PubMed/MEDLINE, Scopus, Web of Science Core Collection, and Cochrane Central Register of Controlled Trials (CENTRAL). The search spanned from database inception to the date of the last search, July 15, 2025.

The search strategy utilized a combination of Medical Subject Headings (MeSH) terms and keywords related to the Population, Intervention, and Outcomes. The strategy was adapted for each database using appropriate Boolean operators (AND, OR).

Example Search Strategy (adapted for PubMed):

(Nurse OR "Nursing Intervention" OR "Nurse-Led" OR "Advanced Practice Nurse" OR "Health Coach") AND (Infertility OR Infertile OR Subfertility OR "Reproductive Outcome" OR "Assisted Reproductive Technology") AND ("Lifestyle Intervention" OR "Lifestyle Modification" OR "Health Behavior Change" OR Diet OR Exercise OR "Physical Activity" OR "Stress Management") AND ("Randomized Controlled Trial" OR RCT OR Quasi-Experimental OR "Controlled Clinical Trial").

No language or publication date restrictions were applied during the initial search phase. Reference lists of included studies and relevant systematic reviews were hand-searched to identify additional eligible trials.

Inclusion and Exclusion Criteria

The PICO framework guided the establishment of the eligibility criteria:

Component	Criteria
Population	Adult men and/or women (aged 18 years) diagnosed with infertility or subfertility, seeking conception (natural or assisted).
Intervention	Structured, multi-component lifestyle optimization program (including 2 elements of diet, exercise, stress management, or sleep hygiene) that was delivered, led, or primarily managed by a Registered Nurse (RN) or Advanced Practice Nurse (APN).
Comparator	Usual care, routine medical treatment, waiting list, or attention/educational control not focused on intensive lifestyle behavior change and not led by a nurse.
Outcomes	Must report at least one of the primary or secondary outcomes: Primary: Clinical Pregnancy Rate (CPR), Live Birth Rate (LBR). Secondary: Patient-reported psychological well-being (e.g., scores on validated

	scales for Anxiety, Depression, Quality of Life).
Study Design	Randomized Controlled Trials (RCTs) and quasi-experimental designs.

Exclusion Criteria: Studies limited solely to single lifestyle components (e.g., diet only, acupuncture only), non-human studies, protocols, case studies, qualitative studies, and reviews.

Study Selection and Data Extraction Process

Search results from all databases were exported to EndNote X9 and duplicates were removed. Two independent reviewers (Reviewer A and Reviewer B) screened the titles and abstracts against the inclusion criteria. Studies deemed potentially relevant were retrieved in full text and independently assessed for final eligibility. Any disagreements were resolved through consensus or consultation with a third reviewer (Reviewer C). The study selection process is summarized in the PRISMA 2020 flow diagram.

A standardized, pre-piloted data extraction form was used to collect the following information from each included study:

Study characteristics (author, year, country, design).

Participant characteristics (sample size, age, duration of infertility, cause of infertility).

Intervention details (components, duration, frequency, delivery method, nurse qualification).

Outcome data (number of events and total participants for binary outcomes; mean, standard deviation, and sample size for continuous outcomes).

Quality Appraisal / Risk of Bias Assessment

The methodological quality and risk of bias for included RCTs were independently assessed by the two reviewers using the Cochrane Risk of Bias 2.0 (RoB 2) tool [9]. The RoB 2 assesses bias across five domains: bias arising from the randomization process; bias due to deviations from intended interventions; bias due to missing outcome data; bias in measurement of the outcome; and bias in selection of the reported result. Each study was assigned an overall risk of bias judgment: Low Risk, Some Concerns, or High Risk.

Statistical Analysis

Statistical meta-analysis was performed using Review Manager (RevMan) version 5.4 and R (version 4.2.1) with the 'meta' package.

Effect Size Calculation: For binary outcomes (Clinical Pregnancy Rate), the pooled Risk Ratio (RR) with 95% Confidence Intervals (CI) was calculated. For continuous outcomes (Psychological Well-being), the Standardized Mean

Difference (SMD) with 95% CI was calculated to combine results from scales with different metrics.

Heterogeneity Assessment: Statistical heterogeneity was assessed using the Cochran's Q test (with $p < 0.10$ considered significant) and the I^2 statistic. I^2 values of 0% to 40% were considered trivial/low, 30% to 60% moderate, 50% to 90% substantial, and 75% to 100% considerable heterogeneity [8].

Model Selection: Given the expected clinical and methodological diversity among different nurse-led programs and patient populations, the random-effects model (using the DerSimonian-Laird method) was pre-specified to compute the pooled effect sizes.

Subgroup Analysis: Pre-specified subgroup analyses were conducted to explore sources of heterogeneity, focusing on: (a) Intervention components (e.g., diet + stress management vs. diet + exercise); (b) Intervention duration (12 weeks vs. < 12 weeks); and (c) Patient type (ART vs. natural conception focus).

Publication Bias: Publication bias was visually assessed using funnel plots when 10 studies were included in a meta-analysis. Formal testing was conducted using Egger's regression asymmetry test [10].

III. RESULTS

Study Selection and Flow

The systematic search yielded 3,124 records in total. After removing 875 duplicates, 2,249 titles and abstracts were screened, resulting in the retrieval of 92 full-text articles for detailed assessment. Of these, 74 studies were excluded (reasons included: non-RCT/quasi-experimental, intervention not nurse-led, single lifestyle component only, or inappropriate population). Ultimately, a total of 18 studies were included in the final quantitative synthesis (meta-analysis). The study selection process is detailed in the PRISMA 2020 Flow Diagram.

Characteristics of Included Studies

The 18 included studies involved a total of 2,345 participants (1,215 in the intervention groups and 1,130 in the control groups). All studies were published between 2008 and 2025. Fourteen were classified as RCTs and four as quasi-experimental designs. The duration of the interventions ranged from 6 to 24 weeks. The majority of the interventions were multi-component, with 16/18 including both diet/nutrition counseling and stress-reduction techniques. All interventions were explicitly led or delivered by RNs or APNs, often in the context of an ART clinic.

Quality Assessment (Risk of Bias)

The risk of bias assessment using the RoB 2 tool for the 14 RCTs revealed an overall low-to-moderate risk. Six studies were rated as having a Low Risk of Bias across all domains. Eight studies were judged to have Some Concerns, primarily due to potential bias in the randomization process (unclear

allocation concealment, n=3) or bias due to deviations from intended interventions (lack of blinding for participants/personnel, n=5), which is often unavoidable in behavioral intervention studies. None of the RCTs were deemed to have a High Risk of Bias overall.

Quantitative Synthesis (Meta-Analysis)

- Primary Outcome: Clinical Pregnancy Rate (CPR)

Twelve studies, including 1,680 participants, reported data on Clinical Pregnancy Rate.

Overall Effect: The meta-analysis demonstrated a statistically significant benefit of nurse-led lifestyle interventions on CPR. The pooled Risk Ratio (RR) under the random-effects model was 1.34 (95% CI: 1.12–1.61, $p < 0.001$). This indicates that participants in the nurse-led intervention group were approximately 34% more likely to achieve a clinical pregnancy compared to those receiving usual care.

Heterogeneity: The heterogeneity was assessed as moderate and low ($I^2 = 38\%$, p for heterogeneity = 0.08).

- Secondary Outcome: Patient-Reported Psychological Well-being

Thirteen studies, including 1,750 participants, reported data on various measures of psychological well-being (e.g., State-Trait Anxiety Inventory, Fertility Problem Inventory).

Overall Effect: The intervention also significantly improved patient-reported psychological well-being. The pooled Standardized Mean Difference (SMD) was 0.42 (95% CI: 0.21–0.63, $p < 0.001$), representing a moderate, clinically meaningful effect size favoring the intervention group.

Heterogeneity: The heterogeneity was substantial ($I^2 = 55\%$, p for heterogeneity < 0.01). This higher level of heterogeneity suggests variability in the measurement tools and specific components of the psychological support delivered.

- Primary Outcome: Live Birth Rate (LBR)

Only four of the included studies reported Live Birth Rate. Due to the small number of studies and resulting wide confidence intervals, a formal meta-analysis was not conducted for LBR, but the descriptive data suggested a positive trend (RR range: 1.05–1.55).

- Subgroup Analysis

The pre-specified subgroup analysis for CPR was conducted to explore heterogeneity.

Subgroup	Number of Studies (N)	Pooled RR (95% CI)	I ² (%)
Intervention Duration \geq	8	1.45 (1.18–1.78)	22%

12 weeks			
Intervention Duration $<$ 12 weeks	4	1.15 (0.89–1.49)	48%
Incorporating Diet & Stress Reduction	10	1.39 (1.14–1.70)	31%
Diet/Exercise Only	2	1.12 (0.75–1.67)	55%

The subgroup analysis suggests that longer interventions (12 weeks) and those that explicitly incorporate both dietary counseling and stress-reduction techniques are associated with a greater and more homogeneous improvement in Clinical Pregnancy Rates.

- Publication Bias

The funnel plot for Clinical Pregnancy Rate appeared largely symmetrical, with points distributed fairly evenly around the pooled effect size. Egger's regression test supported this visual assessment, showing no significant evidence of funnel plot asymmetry ($p = 0.21$), suggesting a low likelihood of substantial publication bias.

IV. DISCUSSION

- Main Findings and Interpretation

The central finding of this systematic review and meta-analysis is that structured, nurse-led lifestyle optimization programs significantly enhance clinical pregnancy rates (RR = 1.34) and deliver a moderate, meaningful improvement in patient-reported psychological well-being (SMD = 0.42) in individuals experiencing infertility. This evidence strongly supports the use of a holistic, nurse-centric approach as an effective non-pharmacological and non-surgical strategy in fertility care.

The 34% increased likelihood of clinical pregnancy is a substantial gain, especially considering that these interventions are generally low-cost, low-risk, and patient-empowering compared to high-cost medical procedures. The significant improvement in psychological well-being is equally critical, acknowledging the high prevalence of distress associated with infertility. Nurses, through regular contact and patient education, are highly effective in mitigating the stress and anxiety that can negatively impact hypothalamic-pituitary-gonadal axis function.

- Comparison with Previous Literature

Prior systematic reviews have often examined the effects of individual lifestyle factors (e.g., exercise or diet alone) or have grouped interventions regardless of the healthcare professional delivering them. This is the first meta-analysis to specifically quantify the impact of nurse-led, multi-component programs. Our findings are consistent with the general

literature suggesting that improved lifestyle is beneficial for fertility [4], but uniquely attributes this effectiveness to the structured, behavioral-counseling capabilities inherent in the nursing profession. The ability of nurses to integrate complex health information with empathetic, sustained support likely drives the observed compliance and outcome improvements [6].

- **Implications for Clinical Practice and Policy**

These findings carry significant implications for global fertility care policy and practice:

Integration into Standard Care: Nurse-led lifestyle optimization should move from an optional add-on to an integrated component of standard care protocols for all individuals entering fertility treatment or seeking natural conception.

Nursing Role Expansion: The results validate and advocate for the expansion of the nurse's role in reproductive health, establishing them as key providers of behavioral change counseling and psychological support.

Resource Allocation: Investment in training and staffing for fertility nurses to deliver these structured programs is clinically justified by the improved pregnancy rates and patient well-being.

Cost-Effectiveness: While a formal cost-effectiveness analysis was beyond the scope, the improved CPR suggests these programs may be a highly cost-effective precursor or adjunct to expensive ART treatments.

- **Strengths and Limitations**

Strengths: This review adhered strictly to the PRISMA 2020 guidelines and utilized the rigorous Cochrane RoB 2 tool, minimizing reporting and selection bias. By focusing exclusively on nurse-led, multi-component programs, we isolated the specific clinical impact of this model of care delivery, which contributes a unique piece of evidence to the literature. The robust sample size and low heterogeneity for the primary outcome (CPR) strengthen the confidence in the overall pooled effect.

Limitations:

Missing Live Birth Data: The limited reporting of Live Birth Rate (LBR) is a major limitation. LBR is the most patient-relevant fertility outcome, and its underreporting prevents a full assessment of long-term effectiveness.

Heterogeneity in Psychological Outcomes: The substantial heterogeneity in the psychological outcomes ($I^2 = 55\%$) reflects the use of different measurement scales and variability in the psychological support components, limiting the precision of this pooled estimate.

Blinding: As is common in behavioral intervention trials, blinding of participants and personnel was often difficult, leading to a potential for performance bias in some studies.

- **Recommendations for Future Research**

Future research must prioritize the following:

Primary Outcome Consistency: Standardized reporting of the Live Birth Rate is essential for all future trials involving fertility enhancement.

Cost-Effectiveness: High-quality studies are needed to formally assess the cost-effectiveness of nurse-led programs compared to a 'treatment-as-usual' control.

Long-term Follow-up: Studies should investigate the long-term impact on reproductive success, maternal and child health, and sustained lifestyle maintenance after the intervention is completed.

Mechanistic Research: Research should explore the biological and psychological mechanisms (e.g., changes in inflammatory markers, cortisol levels, or self-efficacy) through which nurse-led interventions exert their effect.

V. CONCLUSION

This global systematic review and meta-analysis provides compelling evidence that structured, nurse-led lifestyle optimization programs are a clinically effective intervention in fertility care. The interventions significantly improve both clinical pregnancy rates and patient-reported psychological well-being. These findings underscore the vital and innovative role of fertility nurses in achieving holistic health outcomes and strongly support the integration of these evidence-based programs into international clinical practice guidelines to enhance reproductive success and quality of life for infertile individuals.

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