

Role of Structured Exercise Intervention in managing Pregnancy related Fatigue- A Systematic Review

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ABSTRACT

Background: Fatigue is one of the most prevalent and distressing symptoms experienced during pregnancy. It is adversely affects maternal physical, psychological and functional well-being. Despite its high incidence among antenatal women, there is a lack of evidence based non-pharmacological and exercise-based treatment methods.

Objective:To systematically review and critically analyze the effectiveness of exercise-based intervention on fatigue among pregnant women.

Methodology:A literature search was carried out in different databases such as PubMed, Scopus, PEDro and Google scholar in accordance with PRISMA 2020 guidelines Experimental control trials with emphasis on randomized control trials evaluating effect of exercise-based intervention on pregnancy induced fatigue. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) scale, and risk of bias was evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool. Data were synthesized narratively due to heterogeneity in interventions and outcome measures.

Result: Studies meeting the inclusion criteria, comprising of exercise interventions like aerobic exercise, resistance training, relaxation exercise etc. were included. PEDro scores ranged from low to high methodological quality. Higher-quality trials demonstrated consistent and clinically meaningful reductions in fatigue and improvements in quality of life. Most studies showed some concerns for risk of bias, primarily due to lack of blinding and reliance on self-reported outcome measures.

Conclusion: Exercise-based and relaxation interventions appear to be safe and effective strategies for reducing pregnancy-related fatigue. Evidence is strongest for structured resistance and aerobic exercise programs, with relaxation techniques offering valuable adjunctive benefits.

Keywords: Antenatal women, Exercise, Exercise Therapy, Fatigue, Pregnancy, Pregnancy related Fatigue.

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INTRODUCTION

Pregnancy is an important milestone in a woman's life. Although pregnancy is usually thought to be a happy time, there can also be considerable stress during this time due to many of the physical and emotional changes that accompany pregnancy. Many of the physical and emotional changes that accompany pregnancy are out of the control of the pregnant woman, so her body is more likely to be affected by these changes. The physical changes that pregnant women experience can impact their ability to carry out daily activities. [1]. Throughout pregnancy, most women will experience feelings of tiredness due to lack of energy. When fatigue is discussed

during pregnancy, it is frequently described as a complex and multifactorial syndrome.

Fatigue is generally defined as a sensation of being exhausted and having less ability to tolerate physical activity, and/or lower cognitive ability to think clearly. Although there is no agreed upon explanation as to why women experience fatigue during pregnancy, several sources point to hormonal factors influencing the condition (especially progesterone) as some of the reasons for fatigue experienced by pregnant women. There are also multiple conditions caused by pregnancy that contribute to fatigue including low blood pressure, hypoglycemia,

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metabolic disorder (changes to a woman's metabolism), and pregnancy related anemia [2].

Maternal fatigue has been associated in research with a variety of negative outcomes including: inefficient uterine contractions during labor, difficulty managing daily activities, higher rates of cesarean section, preterm birth, low fetal birth weight; depressed mood; and disrupted sleep patterns (Effati-Daryani, 2021). Maternal fatigue associated with pregnancy can severely impact a woman's quality of life. It has been found that the physiological/psychosocial changes that occur during pregnancy can affect a woman's perception of her overall well-being and contribute to decreased life satisfaction [3].

Research shows that fatigue is experienced throughout all trimesters of pregnancy, however [4] it was found in a study that fatigue in early pregnancy is reported to be associated with poor quality of sleep and psychological distress (> 70%). Fatigue typically decreases by early in the second trimester, however approximately fifty to eighty percent of women report experiencing persistent fatigue throughout the remainder of their pregnancy [5].

Pregnant women experience different types of fatigue during their pregnancy due to the various pregnancy-related complications that arise. Hormonal changes, such as hormonal changes during early pregnancy, such as higher amounts of estrogen and progesterone can decrease the amount of energy women can generate. Furthermore, hormonal changes during pregnancy affect the central nervous system, which can cause pregnant women to feel sedated, less energetic, and have mood changes [6]. In addition to these hormonal changes, women experience cardiovascular adaptations during pregnancy that cause their heart to work harder than before by 30%-50% to accommodate the needs of the fetus (American Pregnancy Association, 2020) [7].

In addition to hormonal changes, women also experience musculoskeletal changes, hematological, nocturia, and psychological problems, all of which can be attributed to their pregnancy [5]. Therefore, these types of changes create an overall state of fatigue.

Physical activity has been shown to be a low-cost, non-pharmacological, and accessible intervention with proven benefits for both physical and mental health. Current clinical practice guidelines recommend that women regularly engage in moderate-intensity physical activity during uncomplicated pregnancies (American College of Obstetricians and Gynecologists, 2020). Physical activity has been shown to improve cardiovascular fitness, increase muscle strength, improve metabolic efficiency, enhance sleep quality, and enhance psychological well-being during pregnancy [8] thus, there are potentially several physiological and psychosocial mechanisms whereby exercise can help relieve the fatigue that is associated with pregnancy [9].

The American College of Obstetricians and Gynecologists (ACOG) encourage pregnant/postpartum women to

participate in moderate-to-vigorous intensity level physical activity for 20 to 30 minutes on most days of the week. ACOG recommends that pregnant/postpartum women engage in moderate-to-intense physical activity for 20-30 minutes daily for the majority or all of the week to help promote physical/mental wellbeing. Research demonstrates that exercise will assist in improving physical and mental health of pregnant/postpartum women, such as for example: reducing symptoms of depression or managing weight. Therefore, exercise may be an acceptable and effective alternative for decreasing fatigue during pregnancy [10].

Physical exercise is defined simply put as any purposeful movement by muscles that requires energy [11]. Additionally, there have studies, reviews, and meta-analyses conducted which have shown that exercise has a positive impact on decreasing depression, especially in cancer survivors [12]. Furthermore, it has been shown that aerobic exercise considerably lessens. Additionally, engaging in aerobic exercise has been shown to significantly reduce Postpartum depressive symptoms in women [13].

Despite growing interest in antenatal exercise, the evidence regarding its specific effects on fatigue remains fragmented, with variations in exercise type, intensity, frequency, and duration across studies. Furthermore, differences in study design, outcome measures, and gestational age at intervention initiation make it challenging to draw definitive conclusions. This review aims to examine the effect of exercise interventions on fatigue in pregnant women and to provide evidence-based insights to guide clinical practice and future investigations.

METHODOLOGY

The search was conducted to rule out Effect of Exercise Therapy in Pregnancy induce Fatigue. The systematic review was conducted using the Preferred Reporting Items of the Systematic Review and Meta-analyses (PRISMA) guidelines. The review was registered in PROSPERO with id: CRD420251235712.

Data sources and search strategy

The search strategy was made on the basic keywords related to topic such as exercise, fatigue and pregnancy. Comprehensive search was conducted in PEDro, PubMed, Scopus and Google scholar. The search strategy was developed using PICO Framework as per PRISMA guidelines (2020). Both keywords and Medical Subject Headings were used. A combination of keywords, including exercise, exercise therapy, antenatal exercise, fatigue, pregnancy induced fatigue and pregnancy. Boolean operators "OR" and "AND" were applied to optimize the search by broadening or narrowing the scope as necessary. MeSH terms used were Antenatal, Fatigue, Exercise, Exercise therapy, Pregnancy.

Eligibility Criteria

Inclusion Criteria

The Systematic Review has incorporated Experimental control trials which have examined effectiveness of physiotherapeutic exercise-based intervention on pregnancy induced fatigue in pregnant women. Studies were included only if it involved antenatal women and implemented exercise therapy intervention such as resistance exercise, aerobic exercise, group-based exercises, relaxation exercises etc. Included studies were required to report outcomes related to faigue using validated tools and scales.

Exclusion Criteria

Reviews, Meta-analyses, Longitudinal studies, Case reports, Conference abstracts, Protocol pilot studies, Studies in languages other than English and studies that did not involve an exercise-based intervention were excluded from the study.

Study selection

The title and abstracts of the retrieved records were screened to identify relevant articles. Subsequently, full text of the selected studies was reviewed in detail to determine eligibility according to predefined inclusion and exclusion criteria. Only studies that met all the eligibility criteria were included in final synthesis.

Data Extraction

After developing the data extraction forms, two authors PM (Poorvi Mathur) and RJ (Renuka Jakhar) independently extracted detailed information regarding the trials, including study attributes (author, publication year, research design, study location, and duration), participant

characteristics (age, sex, population type, and sample size), interventions (type of physiotherapy applied, intensity, session frequency, total number of sessions, protocol duration, progression, and safety measures), control treatments, primary outcome measures, and key findings. For studies with unclear or incomplete data, the authors were contacted for clarification. Any disagreements between the reviewers were resolved through consultation with a third reviewer PA (Pooja Anand) or by reaching a consensus.

Synthesis

The data was synthesised using a narrative approach to assess the study techniques and to compare and contrast the results of the included investigations. This facilitated a structured approach to comparison of study characteristics, participant characteristics, outcome measures, key results and physiotherapy intervention related to fatigue in Antenatal females.

Quality assessment

The methodological quality of the studies was assessed using the 11-point PEDro scale. As the first criterion of the PEDro scale was not scored, each study was evaluated based on the remaining 10 criteria, which were rated as either "Yes" (score = 1) or "No" (score = 0). The total score for each study, with a maximum of 10 points, was calculated by summing the individual criterion scores. Studies were then categorized based on their total score as follows: poor (score < 4), fair (score 4–5), good (score 6–8), or excellent (score > 8).

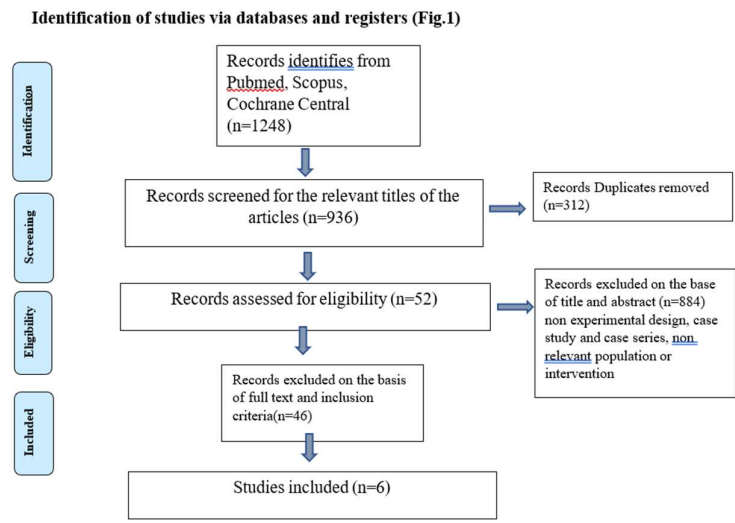


Fig 1: PRISMA Flowchart depicting the results of systematic research, screening and selection.

RESULT

Literature search

A comprehensive search identified 1248 records across PubMed, Scopus, PEDro, Google Scholar. After duplicate removal with help of zotero application 936 unique studies were screened. Of these, 884 were excluded after title/abstract screening due to different population or intervention given and non-experimental study design. 52

full-text articles were assessed for eligibility, and 46 were excluded (e.g., non-fatigue outcome, non-randomized design, not exercise intervention). Finally, 6 articles satisfied all eligibility criteria and were synthesized.

Study Characteristics

Study design

All included studies utilized experimental design, consisting of randomized control trials and controlled experimental studies. The control group did not get any experimental intervention but were given regular care. The experimental group did structured exercises including- **Moderate intensity resistance training**, Squat exercises, Birth ball exercises, Aerobic exercises, Relaxation exercises meant to reduce fatigue and related outcomes.

Participants

579 Participants took part in the 6 studies that were included, there were 30 to 200 participants in each study. The studies included antenatal women between 18-40 years of age which were having healthy pregnancies, low back pain or insomnia with no outward complications like- placental abruptions, multiple pregnancies, respiratory or circulatory problems.

Intervention

Exercise based intervention for reducing fatigue and related outcomes in pregnant females were focus of every study. The intervention included aerobic exercises, resistance exercises, relaxation techniques, birth ball exercises. Each session was given for about 15 minutes to

1 hour and were given 2-5 days per week, The duration of intervention given ranges from 2 weeks to 8 weeks.

The intensity of exercise ranged from low to moderate to high intensity exercises. There were no adverse effects reported by any researcher of the experimental treatment.

Evaluation of Methodological Quality and Risk of Bias Assessment

PEDro rating scale (Table 1) was used to evaluate the quality of included studies. Out of 6 studies, the quality scores ranged from **5/10 to 8/10**. One study scored **5/10**, one scored **7/10**, three scored **6/10** and one study scored **8/10** None of the included studies showed poor quality as they all scored above 4/10, every study met the criteria of variability, baseline similarity, measures key outcomes and between group statistical analysis mentioned in PEDro scoring, 4 out of the 6 studies did not disclose blinding and concealed allocation.

The Cochrane risk of bias-2 tool was employed to evaluate the risk of bias in the studies included in the analysis [14], One study was given “low risk”, Three studies were given “some concern” while Two studies were given “high risk”, the results are depicted in Figure 2 and 3.

Table 1 PEDro scoring

| S no. | Author Year | Eligibility criteria | Randomly allocated | Concealed allocation | Similar baseline | Subject blinding | Therapist blinding | Assessor blinding | Measure of key outcomes for >85% subjects | Intention to treat analysis for 1 key outcome | Between group statistical comparison of atleast 1 key outcome | Variability for atleast 1 key outcome | Total (/10) |
|-------|-----------------------------------|----------------------|--------------------|----------------------|------------------|------------------|--------------------|-------------------|---|---|---|---------------------------------------|-------------|
| 1 | O'Connor PJ et al. (2018). | yes | yes | yes | yes | no | no | yes | yes | yes | yes | yes | 8/10 |
| 2 | Malmir M. et al. (2022). | yes | yes | yes | yes | no | no | no | yes | yes | yes | yes | 7/10 |
| 3 | Kartilah T., Februanty S. (2020). | yes | yes | no | yes | no | no | no | yes | yes | yes | yes | 6/10 |
| 4 | Tella BA et al. (2010) | yes | yes | no | yes | no | no | no | yes | yes | yes | yes | 6/10 |
| 5 | Mahmoudirad G. et al. (2017) | yes | yes | no | yes | no | no | no | yes | yes | yes | yes | 6/10 |
| 6 | Rong Zhang et al(2022) | yes | no | no | yes | no | no | no | yes | yes | yes | yes | 5/10 |



Fig.2 Risk of bias assessment

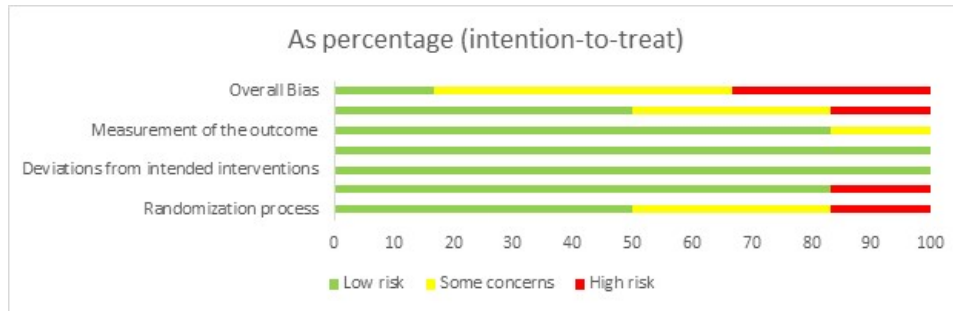


Fig.3 RoB graph

Clinical Relevance of Included Studies

The present analysis evaluated the clinical relevance of interventions aimed at reducing fatigue among pregnant women using [15] established criteria. Overall, the included studies demonstrated moderate clinical applicability, although none fulfilled all criteria required for full clinical relevance.

All studies provided an adequate description of the study population, including age, gestational period, and inclusion criteria, allowing comparison with clinical populations. Furthermore, the outcome measure (fatigue) was consistently assessed using validated tools such as fatigue scales and questionnaires, indicating strong clinical importance across studies.

The interventions—including resistance training, squat exercises, progressive muscle relaxation (PMR), Benson’s relaxation, aromatherapy, and aerobic exercises—were generally described in sufficient detail, enabling replication in clinical settings. These interventions are also practical and feasible within antenatal care, enhancing their translational value.

However, variability was observed in the reporting and calculation of effect sizes. Cohen’s d could be calculated for most studies, revealing a wide range of effects. One study reported a very large effect size (d = 2.81), indicating a substantial reduction in fatigue following squat exercises. Similarly, studies involving resistance training, Benson’s relaxation technique and PMR with aromatherapy demonstrated moderate to large effect sizes (d ≈ 0.5–0.64), suggesting clinically meaningful improvements.

In contrast, one study reported inconsistent fatigue scores, resulting in an unrealistically large calculated effect size (d > 9), which limits its interpretability and clinical applicability. Such discrepancies highlight concerns regarding data accuracy and reporting quality. Additionally, none of the included studies explicitly evaluated the balance between benefits and potential harms or costs. As full clinical relevance requires positive responses across all criteria, the included studies collectively demonstrate partial but not complete clinical relevance, with limitations primarily related to data reporting and effect size interpretation.

Grading of Evidence

The overall **quality and consistency of evidence was graded using Agency for Healthcare Research and Quality (AHRQ), 2011 and was found moderate**, with variations observed across the included studies. Several studies demonstrated **statistically significant between-group differences**, supporting the effectiveness of interventions in reducing fatigue. Specifically, five studies reported significant improvements in fatigue following intervention, whereas one study presented **inconsistent post-intervention fatigue values**, limiting the reliability of its findings. In general, **intervention groups showed a reduction in fatigue levels**, while control groups exhibited **minimal or no improvement**.

Among the included studies, one study was considered to have a **high level of evidence** due to its large effect size and clearly reported outcomes (Malmir, 2022), whereas others were categorized as providing **moderate evidence**, primarily due to smaller effect sizes or borderline statistical significance (O’Connor PJ, 2018; Zhang R,

2022). However, not all studies reported consistent findings, as some demonstrated **borderline or non-significant results**, contributing to heterogeneity in outcomes.

This variability can be attributed to differences in **study design, sample size, intervention duration and intensity, and adherence to protocols**, as well as the use of diverse **fatigue assessment tools**. For instance, different instruments such as the **Multidimensional Symptoms Fatigue Inventory-Short Form (MSFI-SF)** and **SF-36 quality of life questionnaire** (Malmir, 2022), the **Fatigue Assessment Instrument** (Zhang R, 2022), and the **Profile of Mood States (POMS)** along with SF-36 (O'Connor PJ, 2018) were used across studies. The use

of varied measurement tools may influence the comparability and interpretation of results.

The interventions themselves also varied, including **resistance training, birthing ball exercises, squat exercises, and relaxation-based techniques**. These interventions were typically delivered over several weeks in structured formats with defined frequency, duration, and intensity, contributing to their clinical feasibility.

Overall, the **variation in methodological quality, intervention protocols, and outcome reporting** contributes to heterogeneity in findings, thereby limiting the ability to draw definitive conclusions regarding the effectiveness of these interventions

Table 2 Details of included studies

| Author | Aim | Study Design | Outcome measures | Type of intervention | No. of participants | Assessment instrument | Intervention frequency and duration | Result |
|----------------------------|--|--|-----------------------------------|--|--|--|---|--|
| O'Connor PJ et al. (2018). | To test if the adoption of twice weekly, low-to-moderate intensity resistance training during weeks 22–34 of pregnancy can improve quality of life and mood. | Randomized controlled trial parallel arm control | Quality of life, Mood and Fatigue | Low-to-moderate intensity resistance training 6 exercises (leg extension, leg press, lat pull-down, leg curl, lumbar extension, abdominal exercise) | Total n = 134 Resistance training: 44 Pregnancy education: 45 Wait-list control: 45 | The Profile of Mood States (POMS) The Short Form Health Survey (SF-36) | 2 sessions/week for 12 weeks~17 minutes of active resistance exercise | Low-to-moderate intensity resistance training during mid-pregnancy is effective and safe for reducing fatigue-related decline in quality of life. |
| Malmir M. et al. (2022). | The study aimed to examine the effect of squat exercises on fatigue and the life quality of pregnant women admitted to health centers | Randomized Controlled Trial | Fatigue, Quality of Life (QoL) | Resistance exercise – Squat exercises | 100 pregnant women (Intervention n=50, Control n=50) | Multidimensional Symptoms Fatigue Inventory–Short Form (MSFI-SF) • SF-36 Quality of Life questionnaire | 8 weeks, 1 session/week, 50 minutes/session | Significant reduction in fatigue and significant improvement in all QoL domains in the squat exercise group compared to control |
| Kartilah T., Februan | This study aims to determine | Quasi-experimental, pretest– | Fatigue level | Progressive Muscle Relaxation | 52 pregnant women | Visual Analog Scale for | 4 days/week for 2 weeks | Significant reduction |

| | | | | | | | | |
|------------------------------|--|--|--|--|--|--|---|--|
| ti S. (2020). | the effectiveness of giving progressive muscle relaxation (PMR) and aromatherapy to complaint of fatigue in pregnant women | posttest with control group | | (PMR) + Aromatherapy | | Fatigue Questionnaire | | n in fatigue in intervention group compared to control (p < 0.05); PMR + aromatherapy more effective |
| Tella BA et al. (2010) | This study aims to determine the effect of aerobic exercises on level of insomnia and fatigue in pregnant women | Randomized controlled trial (two-group experimental study) | Level of insomnia and level of fatigue | Aerobic exercises (6-minute walk, stair climbing, mild jogging, ball throwing) + sleep hygiene education | 30 pregnant women (randomly allocated into 2 groups of 15) | Insomnia Severity Index (ISI); Quality of Life (QoL) Fatigue Questionnaire | Aerobic exercise program for 6 weeks (sessions included warm-up, aerobic activity, and cool-down); control group received sleep education only | Aerobic exercise group showed significant reduction in insomnia and fatigue post-intervention compared to education-only group (p < 0.05) |
| Mahmoudirad G. et al. (2017) | This study aimed at investigating the effects of Benson's relaxation response on fatigue during pregnancy | Two-group randomized controlled trial | Fatigue | Benson's relaxation response | 54 pregnant women (27 per group) | Fatigue Severity Scale (FSS) | 15–20 min, twice daily, for 1 month | Significant decrease in fatigue in intervention group (P=0.035); increase in fatigue in control group (P=0.013); |
| Rong Zhang et al. (2022) | To evaluate the effect of birth ball abdominal core training on fatigue, waist pain, and | Randomised control trial | Fatigue, Waistpain, Delivery outcome | Birth ball exercises based on abdominal core training | Total 209 intervention n=109 control n=100 | Fatigue Assessment Instrument, Visual Analogue Scale, Modes of delivery, Duration of labor, Degrees of | three to four times per week, 30 min at a time for 8 weeks | Birth ball exercise can relieve fatigue and waist pain of primipara in |

| | | | | | | | | |
|--|---|--|--|--|--|--|--|---|
| | delivery outcomes in middle and late pregnancy. | | | | | perineal laceration, Postpartum hemorrhage, Neonatal weight and APGAR scores | | middle and late pregnancy and improve Delivery outcomes |
|--|---|--|--|--|--|--|--|---|

DISCUSSION

The present review examined the effectiveness of non-pharmacological interventions, including exercise-based and relaxation-based approaches, in reducing fatigue among pregnant women. Overall, the findings suggest that these interventions are associated with **clinically meaningful improvements in fatigue**, although the strength and consistency of evidence vary across studies due to methodological and reporting differences.

A key finding of this review is that most included studies reported **favorable outcomes following intervention**, particularly with exercise modalities such as resistance training, squat exercises, and aerobic exercise, as well as relaxation-based techniques like progressive muscle relaxation (PMR) combined with aromatherapy and Benson’s relaxation response. Quantitative synthesis using Cohen’s d demonstrated **moderate to large effect sizes** in several studies. For instance, resistance training and PMR interventions yielded effect sizes in the range of **d ≈ 0.5–0.64**, indicating moderate to substantial reductions in fatigue levels [16] [17]. These findings are clinically important, as even moderate reductions in fatigue can significantly enhance functional capacity and quality of life in pregnant women.

Notably, one study evaluating squat exercises reported a **very large effect size (d = 2.81)**, suggesting a pronounced therapeutic benefit. While this indicates strong effectiveness, such large effect sizes should be interpreted cautiously, as they may be influenced by sample size, study design, or measurement sensitivity [18]. In contrast, another study demonstrated an **extremely large and implausible effect size (d > 9)** due to inconsistencies in reported fatigue scores, thereby limiting its interpretability [19]. This discrepancy underscores the importance of **rigorous data reporting and critical appraisal of statistical outcomes**; as inaccurate or inconsistent data can lead to overestimation of intervention effects.

The observed improvements in fatigue can be explained through both **physiological and psychological mechanisms**. Exercise-based interventions are known to enhance **cardiovascular efficiency, muscular strength, and oxygen utilization**, which collectively reduce perceived exertion and fatigue during daily activities [11]. Additionally, regular physical activity improves **neuromuscular coordination and endurance**, contributing to better energy conservation. These findings are consistent with prior research demonstrating that antenatal exercise improves **functional capacity and overall maternal well-being** [10].

Similarly, relaxation-based interventions such as PMR and aromatherapy may reduce fatigue through **psychological pathways**, including stress reduction, improved sleep quality, and enhanced emotional regulation [17]. The combination of physical and psychological benefits highlights the importance of a **multidimensional approach** to fatigue management during pregnancy. Previous studies have also suggested that fatigue during pregnancy is influenced by both **biological changes and psychosocial factors**, supporting the effectiveness of interventions that address both domains [5] [1].

From a clinical relevance perspective, most studies provided sufficient detail regarding **participant characteristics, intervention protocols, and outcome measures**, allowing for translation into clinical practice. The interventions evaluated in this review are largely **non-invasive, cost-effective, and easy to implement**, making them suitable for integration into routine antenatal care programs. However, a notable limitation across all studies is the absence of explicit evaluation of the **risk–benefit ratio**. Although the interventions appear safe, particularly as they are non-pharmacological, the lack of formal assessment of potential risks, adherence challenges, and cost implications limits comprehensive clinical decision-making.

The findings of this review are consistent with existing literature, which supports the role of **exercise and physiotherapy interventions in improving maternal health outcomes**. Previous studies have reported that regular physical activity during pregnancy is associated with reduced fatigue, improved mood, and enhanced quality of life [3]. Similarly, relaxation techniques have been shown to alleviate psychological stress and improve sleep, thereby indirectly reducing fatigue. However, the current review also highlights gaps in the literature, particularly regarding **standardization of intervention protocols and outcome measures**.

Another important consideration is the **clinical significance versus statistical significance** of findings. While some studies reported statistically significant results, the corresponding effect sizes provide a more meaningful interpretation of clinical impact. Moderate to large effect sizes observed in several studies suggest that these interventions produce **tangible benefits that are relevant to patient care**. Conversely, studies with inconsistent or unreliable data highlight the need for improved methodological rigor.

LIMITATIONS

Several limitations should be acknowledged. First, the **heterogeneity of included studies** limits the ability to

draw definitive conclusions. Second, inconsistencies in **data reporting and effect size calculation** reduce the reliability of some findings. Third, the absence of **long-term follow-up data** prevents assessment of sustained benefits. Finally, the lack of **risk–benefit analysis** across studies limits the evaluation of overall clinical utility.

Implications for Clinical Practice and Future Research

The findings of this review suggest that incorporating **exercise and relaxation interventions into routine antenatal care** may be beneficial in managing fatigue among pregnant women. Clinicians should consider prescribing **individualized exercise programs** tailored to the patient’s condition, gestational stage, and fitness level.

Future research should focus on conducting **high-quality randomized controlled trials**, using **standardized fatigue measurement tools**, reporting **complete statistical data for effect size calculation**, evaluating **long-term outcomes and safety profiles**, including **cost-effectiveness and adherence analysis**. Such efforts will enhance the reliability and applicability of evidence in this field.

CONCLUSION

In summary, this systematic review indicates that exercise-based and relaxation interventions are effective, safe, and clinically meaningful approaches for managing fatigue during pregnancy. Aerobic and resistance training programs showed the most consistent and substantial improvements, while relaxation techniques served as useful complementary or alternative strategies for fatigue reduction. Non-pharmacological interventions demonstrate promising potential in alleviating fatigue among pregnant women. However, despite the presence of moderate to large clinically meaningful effects in several studies, the overall strength of evidence remains moderate, primarily due to methodological limitations and variability in findings. Consequently, further high-quality, well-designed research is required to establish more definitive conclusions and support evidence-based clinical practice.

Conflict of Interest

There is no conflict of interest.

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