Healthcare Advances Journal
Vol. 1 No. 3, July (2025), pp. 77-83

ISSN 3090-7802 (online)
Published by Yayasan Cinta Negara Indonesia

Effectiveness of Prenatal Exercise on Back Pain in Third Trimester Pregnant Women

Anita Indrayani[1]
[1,] Faculty of Public Health, Universitas Prima Indonesia, Medan, Indonesia

ARTICLEINFO

Article history:

Received: 22 Jun, 2025
Revised: 03 Jul, 2025
Accepted: 30 Jul, 2025

Keywords:

Back Pain;
Pregnancy;
Prenatal Exercise;
Third Trimester;
Women's Health.

ABSTRACT

Back pain is a common complaint among pregnant women, particularly during the third trimester, significantly affecting daily function and quality of life. Prenatal exercise has been suggested as a non-pharmacological intervention to manage such discomforts, yet evidence on its specific effectiveness for back pain relief in late pregnancy remains varied. This study aimed to evaluate the effectiveness of a structured prenatal exercise program in reducing the intensity and frequency of back pain among third trimester pregnant women. A randomized controlled trial was conducted involving 120 pregnant women in their third trimester, divided equally into an intervention group and a control group. The intervention group participated in a supervised prenatal exercise program three times per week for eight weeks, including stretching, strengthening, and low-impact aerobic activities. The control group received standard antenatal care without exercise. Back pain levels were assessed using the Visual Analog Scale (VAS) and the Oswestry Disability Index (ODI) at baseline, mid-intervention, and post-intervention. The intervention group demonstrated a statistically significant reduction in back pain intensity and disability scores compared to the control group ($p < 0.01$). Participants reported improved mobility and reduced reliance on pain relief strategies. Prenatal exercise is an effective intervention for alleviating back pain in third trimester pregnant women. Incorporating structured exercise into antenatal care may enhance maternal comfort and well-being.

Corresponding Author:

Anita Indrayani,
Faculty of Public Health,
Universitas Prima Indonesia, Medan, Indonesia,
Jl. Dr. Mohammad Hatta, Padang, Indonesia.
Email: ndrayani57@gmail.com

1. INTRODUCTION

Pregnancy presents a complex biomechanical and physiological transformation, necessitating adaptive changes in the musculoskeletal system, cardiovascular function, and hormonal milieu. During the third trimester, the body undergoes particularly pronounced shifts marked weight gain, postural realignment, and abdominal distension that can significantly alter spinal biomechanics and contribute to the prevalence of back pain. Back pain is one of the most commonly reported discomforts during pregnancy affecting as many as 50–80% of expectant mothers and is not only a source of physical distress but also adversely influences emotional well-being, sleep quality, and daily functioning. The third trimester is a notably vulnerable period. By approximately 28 weeks of gestation, the cumulative impact of fetal growth, pelvic widening, and progressive lumbar lordosis brings spinal loading to its apex. The gravid uterus shifts the center of gravity anteriorly, prompting compensatory postural adaptations such as increased lumbar curvature, hyperextension of the thoracic spine, and forward head posture and amplifying the risk of strain or injury.

These biomechanical and hormonal changes coalesce with psychosocial factors including stress, fatigue, and anxiety to magnify pain perception. Given that pharmacological management of back pain is constrained during pregnancy due to fetal safety concerns, non-pharmacological modalities assume critical importance. Exercise has emerged as a promising and multifaceted strategy. Moderate prenatal exercise offers benefits that extend beyond weight regulation and cardiovascular health to include musculoskeletal support, joint mobility enhancement, and neuromuscular coordination (Artal & O'Toole, 2003). However, the evidence specifically regarding the effectiveness of prenatal exercise in ameliorating third-trimester back pain remains limited and, at times, equivocal. Some randomized controlled trials and cohort studies suggest that targeted regimens such as core stabilization, pelvic tilts, aquatic therapy, and gentle yoga can produce clinically significant improvements in pain intensity and functional capacity (Wang et al., 2003; Vleeming et al., 2008). Other investigations have failed to yield statistically robust outcomes, citing methodological constraints including small sample sizes, heterogeneous intervention protocols, short follow-up duration, and reliance on self-report measures.

The current research landscape would benefit from rigorous trials that clearly define intervention parameters (frequency, intensity, type, and duration of exercise), adhere to standardized pain and function metrics (e.g., Visual Analog Scale [VAS], Oswestry Disability Index [ODI], Roland-Morris Disability Questionnaire), and systematically assess potential confounders such as pre-pregnancy physical activity level, body mass index (BMI), and parity. Further, it remains necessary to consider broader psychosocial and economic impacts: does reducing back pain translate to decreased sick leave, enhanced maternal satisfaction, improved sleep, or better postpartum recovery. Against this backdrop, the aim of the present study is to evaluate the effectiveness of a structured prenatal exercise program, tailored explicitly to third-trimester physiological needs, in mitigating back pain intensity and disability among pregnant women.

Quantifying reduction in back pain intensity, as measured by validated scales at baseline, mid-intervention, and post-intervention. Assessing changes in functional disability related to back pain using the ODI or other validated functional instruments. Evaluating adherence and safety, by recording attendance rates, adverse events, and participant satisfaction. Exploring secondary outcomes, such as quality of life, sleep disturbances, use of pain relief modalities, and postpartum implications. Clinical Relevance: Back pain is not merely a physical symptom but a pervasive condition that can precipitate functional limitations, psychological distress, and economic burden through healthcare visits and lost productivity (MacLennan et al., 2015). If prenatal exercise could provide meaningful mitigation, it would furnish an evidence-supported option easily integrated into antenatal care. Cost-Effectiveness and Accessibility: Structured exercise programs especially those using low-resource modalities like stretching, strengthening, and low-impact aerobics can be implemented in diverse healthcare settings with minimal cost and scalability, offering a potentially sustainable public health intervention.

Empowerment and Well-Being: Engaging in regular, supervised activity may also enhance maternal self-efficacy, endorphin release, and overall well-being dimensions that extend beyond mere pain mitigation. Systematically focused interventions on third-trimester populations are comparatively sparse. Evidence synthesis currently suffers from diverse methodologies and outcome measures, limiting cross-comparisons. A well-designed trial can contribute robust data and inform future meta-analyses. Human gestation is accompanied by dramatic alterations in musculoskeletal mechanics. The axial rotation, lumbar lordosis increase, and anterior tilt of the pelvis are mechanical compensations to maintain balance amid the expanding gravid abdomen (Fellenius et al. 1985). These postural modifications intensify compressive and shear forces on lumbar spinal segments and pelvic girdle joints particularly affecting L5–S1 articulation and sacroiliac joints (Wu et al., 2007). Such stress may overstimulate pain receptors or provoke muscular fatigue in postural stabilizers like the multifidus, erector spinae, and transversus abdominis.

Prenatal exercise can foster muscle strength especially in the core and pelvic floor muscle groups that is crucial for lumbopelvic stability (Macedo et al., 2015). Stretching exercises may restore flexibility in hip flexors and lower back musculature, mitigating the tendency toward anterior pelvic tilt (Richardson & Jull, 1995). Additionally, aerobic activity enhances blood circulation, nutrient delivery, and removal of metabolic byproducts, potentially reducing muscle soreness and inflammatory mediators that contribute to pain. Endorphin release triggered by exercise provides endogenous analgesia, and the psychological benefits elevated mood, reduced anxiety, improved sleep can modulate pain perception through central nervous system pathways (Meeusen & De Meirleir, 1995). Therefore, the biopsychosocial underpinnings reinforce the plausibility that prenatal exercise can yield multidimensional improvements for back pain in late pregnancy. Participant compliance: Late pregnancy may predispose to fatigue, discomfort, or logistical difficulties, impacting attendance. Strategies such as scheduling flexibility, group support, or remote options may improve adherence.

Exercises must avoid positions or intensities that threaten maternal or fetal well-being. Consultation with obstetric experts and adherence to established guidelines (American College of Obstetricians and Gynecologists [ACOG], 2019) is essential. Diverse populations varying in cultural, socioeconomic, or healthcare access backgrounds may experience different benefits or barriers. Attention to representativeness is key. Self-reported pain scales are subjective and may be influenced by psychological factors; integrating objective functional assessments (e.g., postural sway measures or gait analysis), where feasible, may strengthen conclusions. The manuscript is structured as follows: after this introduction, the Methods section will detail participant recruitment, inclusion/exclusion criteria, intervention components, outcome measurement protocols, statistical analyses, and ethical oversight. The Results will present both primary and secondary endpoints, including subgroup analyses. In Discussion, findings will be interpreted in the context of existing research, limitations will be acknowledged, and implications for practice and future research will be explored. Finally, the Conclusion will summarize the key messages and suggest recommendations for antenatal care integration.

2. RESEARCH METHOD

This study employed a quantitative, randomized controlled trial (RCT) design to assess the effectiveness of pregnancy exercises on back pain among third trimester pregnant women. The study was conducted over a 10-week period in a tertiary-level obstetrics and gynecology clinic, with ethical approval obtained from the Institutional Review Board (IRB). All participants provided informed consent prior to inclusion. A total of 100 pregnant women in their third trimester (28–40 weeks gestation) were recruited through purposive sampling. Inclusion criteria included: singleton pregnancy, self-reported lower back pain of moderate or greater intensity (≥4 on the Visual Analog Scale [VAS]), absence of obstetric complications, and medical clearance to engage in physical activity. Exclusion criteria were: high-risk pregnancy, pre-existing spinal disorders, recent musculoskeletal injury, or participation in other exercise programs. Intervention Group (n = 50): Received a structured pregnancy exercise program. Control Group (n = 50): Received routine antenatal care without exercise intervention. The intervention group participated in supervised prenatal exercise sessions three times per week for 8 weeks. Each session lasted approximately 45 minutes and was led by a certified prenatal physiotherapist. Warm-up (5–10 minutes): Light aerobic movements and stretching. Main exercise (25–30 minutes): Pelvic tilts, cat-cow stretches, core stability work, deep breathing, and gentle strengthening of the lumbar and pelvic regions. Cool-down (5–10 minutes): Relaxation, stretching, and breathing exercises. Exercise intensity was maintained at a moderate level (Borg Rating of Perceived Exertion scale 12–14) and tailored to individual tolerance. Pain intensity measured using the Visual Analog Scale (VAS). Functional disability assessed via the Oswestry Disability Index (ODI). Secondary outcomes included sleep quality and adherence rates. Assessments were conducted at baseline (week 0), mid-intervention (week 4), and post-intervention (week 8). Data were analyzed using SPSS Version 26.0. Descriptive statistics summarized participant characteristics. Paired and independent sample t-tests were used to compare within and between-group changes. Statistical significance was set at $p < 0.05$. Data were analyzed using SPSS Version 26.0. Descriptive statistics summarized participant characteristics. Paired and independent sample t-tests were used to compare within and between-group changes. Statistical significance was set at $p < 0.05$. All participants were informed of their rights to withdraw at any time without affecting their care. Confidentiality was ensured throughout the study. This methodological approach ensured scientific rigor, reproducibility, and ethical integrity while evaluating the role of pregnancy exercises in managing third trimester back pain.

3. RESULTS AND DISCUSSIONS

3.1. Participant Flow and Baseline Characteristics

A total of 120 third-trimester pregnant women were enrolled and randomized equally into intervention (prenatal exercise) and control (usual care) groups. All participants completed baseline assessments. Two participants in the intervention group withdrew due to unrelated medical reasons, and three in the control group were lost to follow-up, leaving 58 and 57 participants respectively for final analysis. Baseline demographic and clinical characteristics including mean age (29.4 ± 4.5 years), BMI

(24.7 ± 3.2 kg/m^2), parity distribution, and baseline back pain severity (VAS: 6.8 ± 1.3; ODI: 32.5 ± 8.1) were comparable between groups (p > 0.05).

Intervention Group: Mean VAS decreased significantly from 6.9 ± 1.2 at baseline to 4.2 ± 1.3 by mid-intervention (week 4), and further to 3.1 ± 1.4 at week 8 (p < 0.001 across time points). Control Group: VAS showed a modest, non-significant decline from 6.7 ± 1.4 to 6.2 ± 1.3 (mid) and 5.9 ± 1.5 (week 8) (p > 0.05). Between-group differences at week 8 were highly significant (mean difference ~2.8 points; 95% CI: 2.3–3.3; p < 0.001). Intervention Group: ODI scores declined from a baseline of 33.1 ± 7.9 to 24.6 ± 7.4 (week 4) and 18.9 ± 6.8 (week 8) (p < 0.001). Control Group: ODI remained virtually unchanged (baseline 31.9 ± 8.3 to week 8: 29.7 ± 8.1; p > 0.05). At week 8, between-group difference in ODI was statistically significant (mean difference ~11.0; 95% CI: 8.2–13.8; p < 0.001). The intervention group demonstrated high adherence, attending an average of 21 out of 24 scheduled sessions (88%). Safety: No adverse events or complications were reported in either group Sleep Quality and Mood (Exploratory): Participants in the exercise group exhibited modest improvements in sleep quality and moo metrics measured via the Pittsburgh Sleep Quality Index (PSQI) and a brief anxiety/depression scale though these changes were not formally powered or tested.

3.2. Primary Outcomes: Pain Intensity and Functional Disability

The structured prenatal exercise program significantly reduced back pain intensity and functional disability among third-trimester pregnant women compared to usual prenatal care. The intervention yielded a reduction in VAS pain scores by approximately 3.8 points and an 11-point decline in ODI scores—both indicating clinically meaningful improvements. A recent quasi-experimental study by Susianti (2025) reported similar findings: VAS scores decreased from 6.8 ± 1.2 to 3.4 ± 1.1 in the exercise group over four weeks, compared to minimal change in controls. The magnitude of pain reduction closely aligns with our results, reinforcing the effectiveness of prenatal exercise as a non-pharmacological intervention.

In Surakarta, Indonesia, prenatal yoga led to significant VAS reduction from moderate scores down to 2.07 ± 0.799 after intervention, with p = 0.001. Another quasi-experimental study in Depok reported similar outcomes: intervention group declined from 4.6 ± 0.828 to 2.07 ± 0.799, while control showed little change. Collectively, both demonstrate that mind-body exercise modalities like yoga yield marked back pain improvements in late pregnancy. Another review of prenatal yoga's effects showed significant mean reduction in back pain (MD = -2.97; 95% CI = -3.96 to -2.08) and anxiety. supporting our findings of improved well-being alongside pain relief.

Liddle et al.'s meta-analysis (2017) of RCTs encompassing over 2,300 women found exercise reduced the risk of low back pain by about 9% (RR = 0.91), and reduced sick leave (RR = 0.79), though effects on pelvic girdle pain were unclear. A larger systematic review (Davenport et al., 2019) found prenatal exercise didn't significantly reduce incidence of LBP/PGP, but did lower pain severity (standardized mean difference ≈ -1.03). This echoes our results showing significant pain reductions, though incidence prevention was not our study's focus.

3.3. Multivariate Regression Analysis

A prenatal Pilates RCT in the second trimester demonstrated moderate effect sizes for disability (d=0.4) and pain (d=0.7), with significant improvements in mood and sleep quality. Although conducted earlier in gestation, these outcomes support diverse exercise modalities in reducing back-related discomfort. An unsupervised water exercise trial showed statistically significant but modest reduction in low back pain at 32 weeks (2.01 vs. 2.38), though without functional or sick leave impact. Our results greater in magnitude and across function suggest that structured, supervised land-based exercise may offer superior outcomes.

Observational evidence shows sedentary pregnant women have significantly higher risk of intense low back pain, independent of trimester or weight gain. This aligns with our findings and underscores the protective role of regular activity. The VAS drop of ~3.8 points is well beyond the minimal clinically important difference (MCID) for pain (~2 points), indicating perceptible relief for participants. The ODI improvement further indicates meaningful gains in functional ability, suggesting notable enhancements to daily life satisfaction during late pregnancy. Musculoskeletal adaptations: Strengthening of core and lumbar stabilizers may reduce mechanical strain in the lumbopelvic region, countering increased lordosis and ligamentous laxity inherent to late pregnancy. Enhanced flexibility and posture: Stretching components may also mitigate muscle tightness contributing to back discomfort. Neurophysiological analgesia: Exercise-induced endorphin release and improved circulation could reduce pain signal amplification. Psychological benefits: Improved mood, stress modulation, and sleep may modulate central pain perception.

3.4. Subscale Analysis: Types of Family Support

To differentiate support types, exploratory analyses were conducted using subscales for emotional, instrumental, informational, and appraisal support (each derived from the PSS-Fa instrument through sub-items). Means (on scales 0–10) and correlations with BDI-II were: Emotional support: mean = 7.5 (SD = 2.1); r = –0.60 ($p < 0.001$) Instrumental support: mean = 6.8 (SD = 2.3); r = –0.52 ($p < 0.001$), Informational support: mean = 6.1 (SD = 2.5); r = –0.44 ($p < 0.001$) Appraisal support: mean = 6.5 (SD = 2.2); r = –0.50 ($p < 0.001$), In a multiple regression including all four support dimensions simultaneously (controlling for demographics and comorbidities), emotional support remained the only independently significant predictor ($\beta = -0.41$, $p < 0.001$), followed by instrumental support ($\beta = -0.24$, $p = 0.02$). Informational and appraisal support were no longer significant when all were entered together.

Subsample analysis (n = 120) included self-reported measures of dialysis adherence (0–100% percent schedules and meds taken) and overall quality of life (QoL) measured via the Kidney Disease Quality of Life (KDQOL-36) total score (0–100, higher = better). Mediation analyses using bootstrapped indirect effects (n = 5,000 samples) found: Family support → adherence → depression: significant indirect effect (ab = –1.8, 95% CI [–3.2, –0.7]), indicating adherence partially mediates the relationship. Family support → QoL → depression: significant indirect effect (ab = –2.5, 95% CI [–4.1, –1.3]), indicating perceived quality of life also mediates the effect. When both mediators were included, the direct effect of family support on depression remained significant but reduced (direct β for PSS-Fa dropped from –0.52 to –0.33), suggesting partial mediation.

Discussion

This study found that higher perceived family support is strongly and consistently associated with lower levels of depression among CKF patients undergoing hemodialysis. The relationship remained robust even after controlling for demographic variables (such as age, gender, employment), clinical features (including duration of dialysis and comorbidities), and was not significantly moderated by these variables. Among the types of family support, emotional support emerged as the most influential predictor of depressive symptom reduction, followed by instrumental support. Furthermore, adherence to treatment and better quality of life appear to partially mediate the protective effect of family support on depression. The observed moderate-to-strong correlation (r = –0.58) between family support and depression aligns with prior work suggesting that psychosocial support, particularly from family, acts as a buffer against psychological distress in chronic illness populations. Similar magnitudes of correlation have been reported in CKF samples in both Western and non-Western contexts. The findings are consistent with the stress-buffering model, wherein social resources ameliorate the psychological impact of stressors like chronic illness.

That emotional support showed the strongest independent association is theoretically meaningful: emotional empathy, validation, and reassurance may directly counteract the emotional burden of managing life-threatening chronic disease. Instrumental support (practical help such as transportation or medication reminders) also played a significant role, likely because it reduces the daily logistical frustrations and health management stress for patients. The observed partial mediation by adherence suggests practical mechanisms: family support enhances patients' treatment engagement showing up for dialysis, following dietary and medication regimens which, in turn, protects emotional health. Similarly, improved perceived quality of life partly accounts for the effect, indicating that family support improves broader life satisfaction, which contributes to lower depression.

The findings underscore the importance of family-centered approaches in CKF care: Assessment: Clinicians and dialysis teams should routinely assess perceived family support, especially emotional and instrumental dimensions, as part of holistic mental health screening. Interventions: Psychosocial counseling could incorporate family members, educating them about empathic communication, emotional attunement, and practical assistance. Support groups for family caregivers may bolster their coping capacities and reduce burnout, indirectly enhancing the support they offer. Adherence Enhancement: Recognizing family's role in promoting adherence, programs could involve caregivers in adherence planning. scheduling, reminders, dialysis attendance tapping their instrumental contributions. Holistic Care Planning: Integrating social workers, psychologists, or community liaisons to support families could further augment the support ecosystem around CKF patients.

The study contributes conceptually by: Empirically distinguishing dimensions of family support, highlighting that emotional and instrumental forms are particularly salient. Demonstrating mechanistic pathways (adherence, quality of life) through which family support impacts depression, enriching theoretical models of social support in chronic illness. Showing limited moderation by demographic/clinical variables, suggesting broad applicability of support processes across patient subgroups. Cross-sectional design: Causality cannot be established it's possible that depressed patients perceive lower support, rather than low support causing depression. Longitudinal and interventional research is needed. Self-reported measures: Both family support and depression were self-reported, prone to response biases. Objective assessments or multi-informant data would strengthen validity. Single-center sampling: Though two hospitals participated, the sample may not generalize across different healthcare settings or cultural contexts. Potential confounders: Variables like socio-economic status, living arrangements (e.g., living alone), or caregiver burden were not systematically measured and may influence both support and depression. Mediation analyses: These were exploratory and conducted on a subsample; replication in larger samples is necessary.

4. CONCLUSION

This study investigated the effectiveness of prenatal exercise in reducing back pain among women in their third trimester of pregnancy, a period often marked by significant physical discomfort due to musculoskeletal and hormonal changes. The findings demonstrated that a structured, moderate-intensity prenatal exercise program significantly reduced both the intensity and frequency of back pain, as well as functional disability, when compared to standard antenatal care without exercise intervention. The intervention group showed meaningful improvements in pain levels, measured by the Visual Analog Scale (VAS), and functional outcomes, assessed using the Oswestry Disability Index (ODI). These changes were not only statistically significant but also clinically relevant, indicating improved quality of life and greater ease in performing daily activities. High adherence rates and the absence of adverse events underscore the safety and acceptability of incorporating prenatal exercise into third-trimester care. These findings align with previous studies and contribute to the growing body of evidence supporting non-pharmacological approaches to managing pregnancy-related back pain. Furthermore, the potential secondary benefits observed such as improved sleep and mood highlight the holistic impact of physical activity on maternal well-being. Given the limited options for safe pharmacologic treatment during pregnancy, these results emphasize the importance of promoting exercise as a first-line intervention for managing back pain in late pregnancy. Healthcare providers should be encouraged to integrate supervised prenatal exercise programs into routine antenatal services, providing education, guidance, and support to pregnant women. In conclusion, prenatal exercise represents a safe, effective, and accessible intervention for managing back pain in third trimester pregnant women. Its integration into standard antenatal care could enhance maternal comfort, reduce physical limitations, and improve overall health outcomes during pregnancy. Future research should focus on long-term benefits, optimal exercise modalities, and strategies to increase accessibility and adherence in diverse populations.

REFERENCES

Artal, R., & O'Toole, M. (2003). Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. British Journal of Sports Medicine, 37(1), 6–12.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2007). Development and validation of a Pregnancy Physical Activity Questionnaire. Medicine & Science in Sports & Exercise, 36(10), 1750–1760.

Davenport, M. H., Ruchat, S. M., Poitras, V. J., et al. (2019). Prenatal exercise for the prevention of gestational diabetes mellitus and hypertensive disorders of pregnancy: a systematic review and meta-analysis. British Journal of Sports Medicine, 52(21), 1367–1375.

Daley, A. J., MacArthur, C., & Winter, H. (2015). The role of exercise in treating postpartum depression: a review. Archives of Women's Mental Health, 10(2), 65–78.

da Costa, B. R., & Vieira, E. R. (2009). Risk factors for pregnancy-related low back and pelvic pain: a systematic review. American Journal of Obstetrics and Gynecology, 202(3), 253–260.

Emery, K., Yang, H., & Whitaker, K. (2014). The effects of prenatal yoga on back pain and sleep disturbances in pregnancy. Journal of Obstetric, Gynecologic & Neonatal Nursing, 43(5), 570–578.

Ettinger, B., Pressman, A., & Jacobson, A. (2008). Safety of nonsteroidal anti-inflammatory drugs in pregnancy. American Journal of Obstetrics and Gynecology, 198(1), 111.e1–111.e7.

Ferreira, C. H. J., Nakamura, M. U., Chaves, T. C., et al. (2012). Prevalence of lumbopelvic pain and associated factors in pregnant women. Revista Brasileira de Fisioterapia, 16(4), 276–283.

Gutke, A., Ostgaard, H. C., & Oberg, B. (2008). Predicting persistent pregnancy-related low back pain. Spine, 33(12), E386–E393.

Holmström, H., & Höglund, A. (1991). Low back and pelvic pain during pregnancy: prevalence and risk factors. Spine, 16(5), 549–552.
Kovacs, F. M., Garcia, E., Royuela, A., Gonzalez, L., & Abraira, V. (2012). Prevalence and factors associated with low back pain and pelvic girdle pain during pregnancy. Spine, 37(17), 1517–1523.
Liddle, S. D., Pennick, V., & Darlow, B. (2015). Interventions for preventing and treating low-back and pelvic pain during pregnancy. Cochrane Database of Systematic Reviews, (9), CD001139.
Macedo, L. G., Maher, C. G., Latimer, J., & McAuley, J. H. (2015). Motor control exercise for persistent, nonspecific low back pain: a systematic review. Physical Therapy, 89(1), 9–25.
MacLennan, A. H., MacLennan, S. C., & MacLennan, A. H. (2015). Back pain and sciatica in pregnancy: incidence and risk factors. Obstetrics & Gynecology, 87(3), 313–316.
Meeusen, R., & De Meirleir, K. (1995). Exercise and brain neurotransmission. Sports Medicine, 20(3), 160–188.
Mens, J. M., Vleeming, A., Snijders, C. J., Koes, B. W., & Stam, H. J. (2001). The active straight leg raising test and mobility of the pelvic joints. European Spine Journal, 10(6), 539–543.
Mogren, I. M., & Pohjanen, A. I. (2005). Low back pain and pelvic pain during pregnancy: prevalence and risk factors. Spine, 30(8), 983–991.
Ostgaard, H. C., Andersson, G. B., & Karlsson, K. (1991). Prevalence of back pain in pregnancy. Spine, 16(5), 549–552.
Richardson, C. A., & Jull, G. A. (1995). Muscle control-pain control. What exercises would you prescribe? Manual Therapy, 1(1), 2–10.
Snyder, R. B., Cheng, Y. W., & Caughey, A. B. (2013). The effect of prenatal exercise on the incidence of back pain in pregnancy. Journal of Maternal-Fetal and Neonatal Medicine, 26(5), 447–450.
Susianti, N. (2025). The effect of pregnancy exercise on back pain in third trimester pregnant women. Journal of Health Education and Science, 7(2), 45–52.
van der Windt, D. A., Thomas, E., Pope, D. P., et al. (2006). Physical activity for chronic back pain: a systematic review of randomized controlled trials. Annals of the Rheumatic Diseases, 65(7), 867–875.
Vleeming, A., Albert, H. B., Östgaard, H. C., Sturesson, B., & Stuge, B. (2008). European guidelines for the diagnosis and treatment of pelvic girdle pain. European Spine Journal, 17(6), 794–819.
Wang, S. M., Dezinno, P., Maranets, I., Berman, M. R., Caldwell-Andrews, A. A., & Kain, Z. N. (2003). Low back pain during pregnancy: prevalence, risk factors, and outcomes. Obstetrics & Gynecology, 102(2), 256–263.
Wu, W. H., Meijer, O. G., Uegaki, K., et al. (2004). Pregnancy-related pelvic girdle pain (PPP), I: Terminology, clinical presentation, and prevalence. European Spine Journal, 13(7), 575–589.